

# VERTICAL SILICON NANOWIRE GATE-ALL-AROUND TUNNELING FIELD EFFECT TRANSISTOR WITH LOW THRESHOLD SWING

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## ABSTRACT

*In this work, we report a high performance Field-effect transistor on vertical Nanowire with silicon drain source contacts and scaled metallic gate length, which is fabricated by simple process. Silicon Nanowire (SNWs) is the best on tunneling field effect transistor (TFET). Which is uses a CMOS vertical gate all around and compatible in nature. When the temperature reduces then the segregated silicon oxidation for the sources occurs. The threshold is calculated on room temperature when examine three of drain current, and then there would be an excellent characteristics is being show by field effect transistor (FET) without as bipolar behavior and with high  $I_{on}/I_{off}$  ratio. Moreover, an SS of 50 mV/decade is maintained for three orders of drain current. This demonstration completes the complementary pair of TFET (Tunneling field-effect transistors) to implement CMOS- like circuits.*

**Keywords:** Vertical Silicon Nanowire (SiNWs), Gate-all-around (GAA), Tunneling field effect transistor (TEFT), sub-threshold swing (SS), top-down

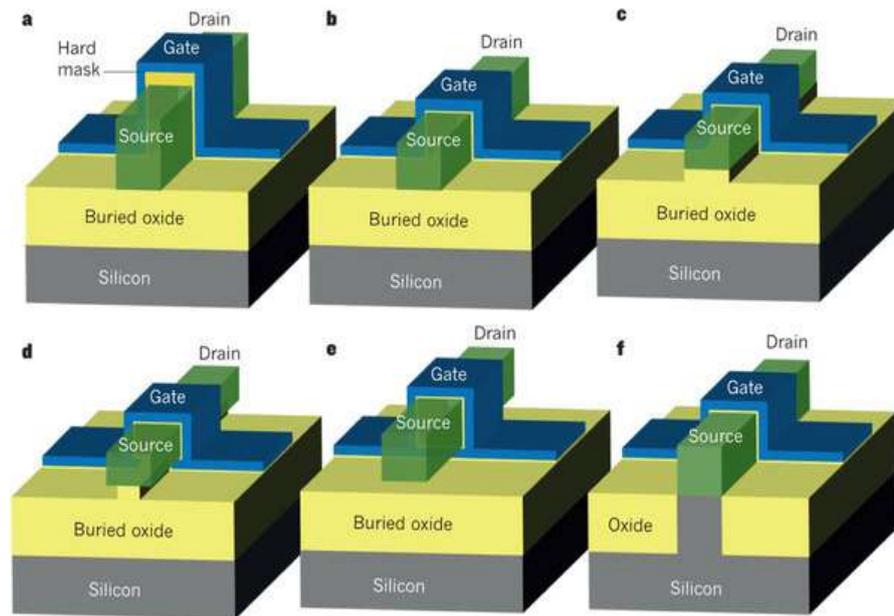
## I INTRODUCTION

We know that our several years the performance of metal oxide semiconductor Field effect transistor (MOSFET) has been degraded due to the excessive scaling Process. CMOS technology is the driving for the increasing integrated circuit (IC) chip speed and functionality. Nanowire replaced electronic equipment in almost all application because of its much advantage that is smaller in size, light in weight longer life, high efficiency, more mechanical strength and smaller power consumption. The sub threshold is carried out by the one of the most important characteristics and denoted by 'sub-threshold'. The sub threshold is defined as the change in gate voltage is required for a change of an order of magnitude of current from OFF to ON state.

Thermionic emission-carrier diffusion process plays a vital role to carry out the 'SS' of MOSFET. When we increase the current in OFF state then we can prepare to

Find the scaling down of MOSFET supply voltage. Semiconductor Nanowires can be prepared in High-yield with reproducible electronic properties as required for large-scale integrated systems and compared with "top-down" nanofabricated device structures, "bottom-up" synthesized Nanowire materials offer well controlled size in at least one critical device dimension, channel width that is at or beyond the limits of lithography.

In silicon Nanowire FET that is generated by pattern on the SOI wafer coated with light sensitive liquid and removes the material from wafer surface is used etching process.



**Fig 1: Vertical Silicon nanowire TFET process flow schematic. (a) Vertical pillar etch and As implantation to form the drain region, (b) isolation oxide deposition and gate stack formation, (c) the top amorphous-Si etched to expose source side of TFET, (d) source implanted with BF<sub>2</sub>, (e) dopant segregated Ni silicidation, (f) contact opening and Al metallization.**

This is the promising constraints for various applications because TEFT can provide low OFF linkage and the ‘sub-threshold swing’ (SS) below the 60mV/molecules.

Tunneling through barrier is the process by which the carrier transport takes place in TEFT.

The vertical gate All-Around (GAA) Nanowire transistor (NWs) will be more valuable in the future because it’s

- i. Excellent to gate channel coupling.
- ii. High integration for circuit functionality.
- iii. And the compatibility with the existing CMOS.

## II PURPOSED GAA NANOWIRE

GAA Nanowire will increase on the chip device density and show the good gate controllability process of integration of TEFT. The GAA Nanowire based devices to for SONOS type of memory applications, that’s gate dielectrics has to be necessarily thicker.



**Fig 2: Progration of device structure from conventional single gate planner device to GAA structure**

### III DEVICE FABRICATION

Top-down CMOS technology is the introduced for the fabrication of N-channel gate all-around (GAA) Si-Nanowire based TEFT, TEFT device used for ultra low power and energy efficient applications.

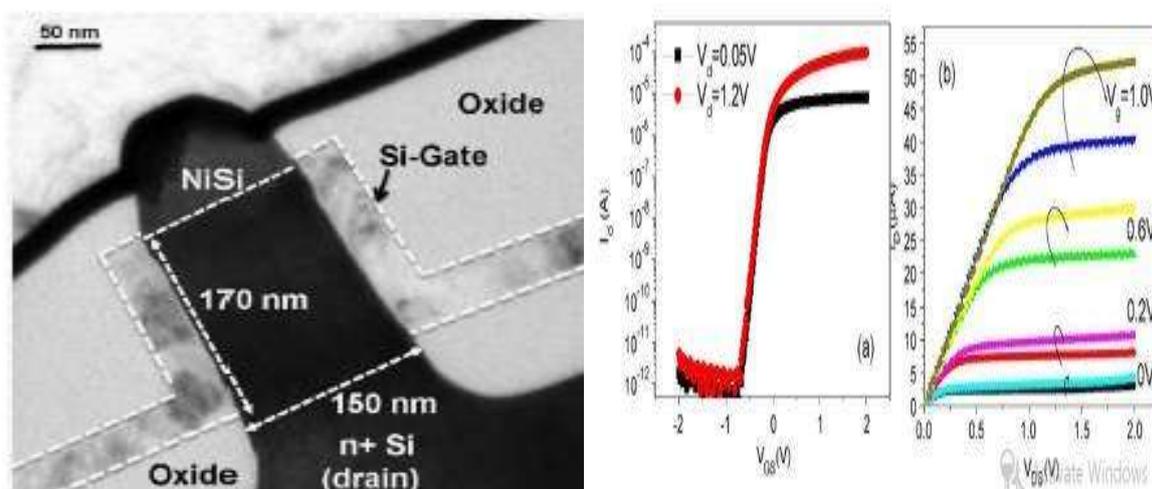
These are the graphs which are the plotted by hard mask of silicon nitride (SiN) using deep RIE to form vertical SiNWs. Thermal oxidation is controlled at 1000c for half an hour by using BF<sub>2</sub> ( $10^{15}$  cm<sup>-2</sup>/10 keV) and activated at 1000<sup>0</sup>C for 5 second.

The gate is vertically positioned. In this processing this loss to pay attention that only tip of the Nanowire should be exposed. The isolation of HDP oxide takes place and again it gate deposited over there.

There are two steps of Ni-deposition (sputtering).

- i. Rapid thermal annealing at 220<sup>0</sup>c for 30 sec.
- ii. 440<sup>0</sup>c/30s in N<sub>2</sub> ambient condition.

There is dying of 1500nm and a fabricated TEFT device along with the gate length 170nm.



**Fig 3 (a):- Cross-sectional TEM image of a vertical SiNW TFET device with a Diameter of 150 nm and a gate length of 170 nm(b)  $I_d$ - $V_g$  characteristic of a vertical SiNW TFET with a low SS of 30 mV/ decade.**

CMOS device scaling, which has continued for more than the last four decades is facing severe as a result of excessive increase in power consumption caused by increasing OFF-State leakage and non scalability of the operating voltage (V<sub>dd</sub>). V<sub>dd</sub> scaling requires simultaneous scaling of threshold voltage for maintaining a certain ON-to-OFF ratio of the device currents, which however leads to a substantial increase in the sub-threshold leakage (OFF state) current, owing to the non scalability of the sub-threshold swing (SS) of MOSFETs. The Sub-threshold in MOSFET is governed by thermal diffusion of carriers over a potential barrier and has theoretical lower limit 60mV/decades at room temperature. Tunneling field-effect transistors (TFETs) employ a fundamentally different injection mechanism in the form of band-to-band.

Sub-threshold swing in tunnel FET is given by

$$SS = [d \log I_D]^{-1} / dv_{GS} \text{ [mV/decade]}$$

And room temperature is given by

$$SS_{MOSFET} = \ln(10) KT/q \text{ [mV/decade]}$$

Sub-threshold swing is band to band tunneling current process.

And Tunneling is given by

$$I = x V_{eff} \epsilon \exp(-y/\epsilon)$$

Where,

$$X = Bq^3 \sqrt{2m^* E_g} / 4 [\hbar^2]$$

$$y = 4 \sqrt{m^* E_g}^{3/2}$$

V<sub>eff</sub> - bias tunneling TEFT

ε - Electric field

Final resultant will be given

$$SS_{TFET} = \ln [1/vr * dv_r/dv_{gs} + \epsilon + b / \epsilon^2 * d \epsilon / dv_{gs}]^{-1}$$

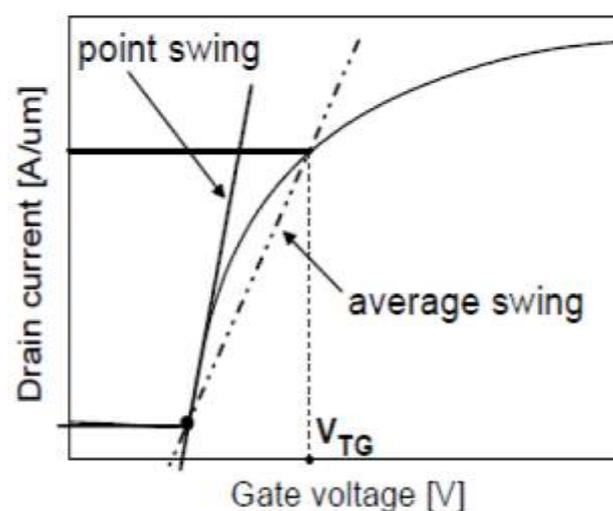


Fig 4: Point Swing and Average Swing of the I<sub>d</sub> V<sub>g</sub> Curve

#### IV RESULTS AND DISCUSSION

- a. TEFT shows following characteristics are a gated p+i-n+ diode which works under reverse bias in OFF state. And in the ON state, gate voltage pulls down the energy band of the channel region and reduces the width of the tunneling barrier.
- b. There are large potential barrier in between the source and channel.
- c. The energy band in channel region diminished by the gate voltage in the ON-state.
- d. Shows the input transfer condition if a silicon NW TFET with small dimension and the gate length of 170nm.
- e. In the ON state the voltage also reduces the width of the tunneling barrier.
- f. Retains the sub-threshold swing (SS) value is of 30mv/decade.
- g. 70mv is achieved as a result of excellent gate control by gate all-around (GAA).

#### V CONCLUSION

In concise, there are few records which have been depicted when we demonstrated a SiNWs Based p-type TEFT device that is a record of low sub-threshold swing with 30mv/decade at a room temperature, when applied the voltage in low quantity.

The  $I_{on}/I_{off}$  has been achieved almost by three decade change in drain current and an  $I_{on}/I_{off}$  ratio of  $>10^5$ . In addition, a sub-50- mV/decades value was observed for three orders of drain current. This work substantiates TFET in vertical GAA Nanowire architecture as a potential candidate for future energy-efficient electronics. Moreover, by using other known designs like hetero structure-based TFETs with smaller band gap material at the tunneling interface[6] as well as high-k gate dielectrics [6],[8].one can achieve further enhancement in ON current. Vertical SiNW-GAA structures also provide excellent gate electrostatic control, high integration density for circuit functionality and compatibility with existing CMOS technology.

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# DIFFERENT TYPES OF ELECTRICAL SIGNALS PRODUCED BY HUMAN BODY

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## ABSTRACT

*This article will allow readers to understand electrical processes going inside the human body. It will also provide idea of bio-potential produced in human body. These bio-potential produce a physiological phenomenon known as bio signals. Bio signals have been very helpful in examining activities of brain, eye, heart, muscles etc. As a result there have been technologies like EEG, ECG, EOG, ERG, MMG, MEG.*

**Keywords:** *Types Of Bio-Potential, Classification of Bio-Signals, Sources of Bio-Potential.*

## I INTRODUCTION

*A human body is combination of multiple cells. These cells are made up of different chemical substances like sodium, potassium, calcium, chloride etc. These cells are categorized as excitable cells and non-excitable cells. Excitable cells are cells that create a tiny current when stimulated, for example, muscle fibers, neurons etc. Non excitable cells do not carry electricity but are responsible in protecting, nourishing, and supporting excitable cells, for example, glia, satellite cells, Schwann cells. Cell membrane is used to separate cells from their environment i.e. intracellular and extracellular. A lipid bilayer cell membrane acts as barrier between the two environments. The intracellular environment is rich in potassium ions while extracellular environment has abundance of sodium and chloride ions. Hence, both environments are at different potential, therefore, a flow of ions results between the two environments creating a potential difference. This potential difference is called bio potential. The bio-potential can be measured using electrodes, amplified using instrumentation amplifiers and monitored to study functioning of various organs like heart, brain, eye, muscles etc.*

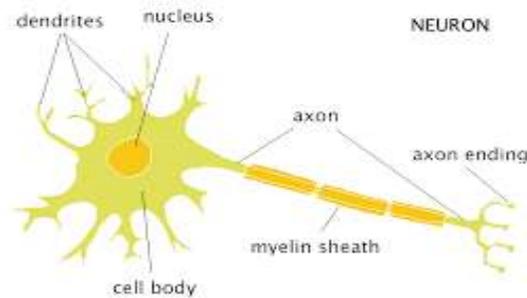
## II TYPES OF BIO-POTENTIAL

Bio-potentials are of two types. They are

1. Action potential

## 2. Resting potential.

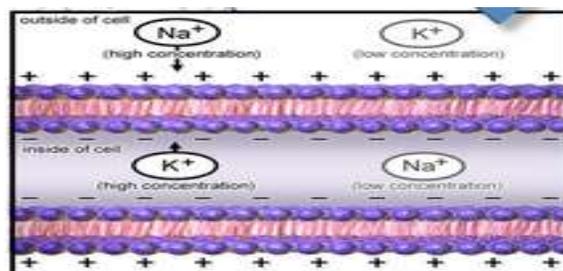
Action potential is basically experienced by nerve cells or neurons. It helps them to communicate with each other. A neuron consists of cell body, dendrites and axon. Cell body has a nucleus that controls flow of ions inside and outside cell membrane. An axon acts as a transmitter while dendrites act as receiver of action potential inside and outside cell membrane. Figure 1 shows a typical neuron.



**Figure-1: A Typical Nerve Cell**

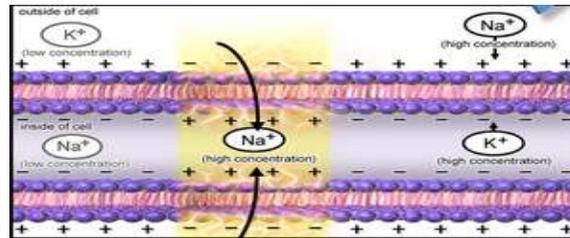
Proteins stuck over the cell membrane form ion channel. Some of them are known as gated channel while other are called resting channel along with pumps. Opening and closing of gate depends upon what chemical ion is attached to it. Hence there is sodium and potassium gate that respond i.e. open or close to maintain positive and negative imbalance. Cell membrane has sodium potassium pumps that supply energy into and outside cell in form of ions to maintain positive and negative imbalance. Sodium ions are pumped out while potassium ions are pumped in. Neurons have quite negative charge inside them called anions and sodium and potassium ions are positively charged.

There are two stages that are experienced. First stage is when axon is resting, all the sodium and potassium gates are closed, and there is higher concentration of potassium and lower concentration of sodium inside the cell while there is lower concentration of potassium and higher concentration of sodium outside the cell. Sodium is pumped inside and potassium is pumped outside the cell membrane. At this time anions give negative charge to maintain positive negative balance. The potential developed here is called resting potential. Due to this movement, a constant potential is maintained. Figure 2 shows condition of resting potential.



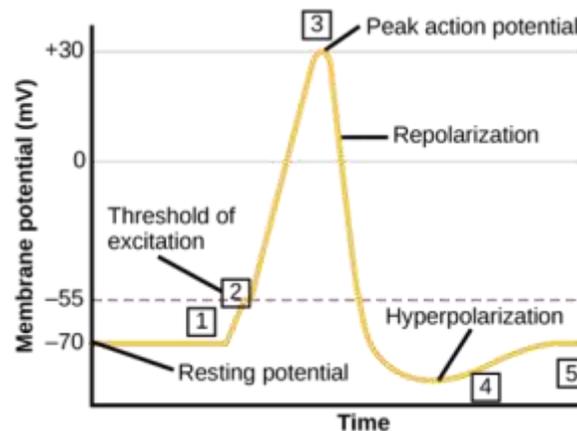
**Figure-2: Resting potential stage**

Second stage is when axon is active, that is a continuous ion exchange occurs along the length of axon. Sodium ions enter the cell creating a positive inside and negative outside. Now the sodium gate is closed and the potassium gate gets opens to supply more potassium outside. Due to this the inside becomes negative and the outside is positive. As to maintain a constant potential, sodium has to be outside and potassium to be inside, so now sodium pump pumps out the sodium outside the cell and potassium pump pumps potassium inside. This way the potential is maintained. This type of bio-potential is called action potential. Figure 3 shows condition of action potential.



**Figure 3: Action Potential Stage**

The membrane potential is plotted against time to show voltage level of action and resting potential in a typical neuron. Figure 4 shows the graph of action and resting potentials.



**Figure-4: Graph of Action and Resting Potential**

### III CLASSIFICATION OF BIO-SIGNALS

According to existence of bio signals, they are classified as:

- Permanent bio signals
- Induced bio signals

Permanent bio signals are available inside the body and there do not require any artificial impact, trigger. Example: ECG signal.

Induced bio signals require artificial triggering or excitation. They exist for short duration. Example: electric plethymography.

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According to dynamic nature of bio signal, they are classified as:

- Static bio signal
- Dynamic bio signal

Static signal carry information in a static level. They do not change with time and are slow in nature.

Example: body temperature

Dynamic signal undergo changes with time. Example: heart beat

According to origin of bio signal, they are classified as:

- Electric bio signal (eg. EEG, ECG, EMG)
- mechanic bio signal (eg. mechanorespirogram)
- thermal bio signal (eg. core body temperature)
- magnetic bio signal (eg. MMG)
- optic bio signal (eg. optoplethysmogram)
- acoustic bio signal (eg. phonocardiogram)
- chemical bio signal (eg. cortisol secretion)

## IV SOURCES OF BIO-POTENTIAL

### 4.1 Electroencephalogram (EEG)

Electroencephalography is an imaging technique used commonly in medical field, to study brain functioning. In this multiple electrodes is placed over the scalp and the voltage fluctuation resulting due to current flow in neurons. When neurons in brain get active, a current results due to exchange of ions. These ions are of sodium (Na<sup>+</sup>), potassium (K<sup>+</sup>), calcium (Ca<sup>++</sup>), and chloride (Cl<sup>-</sup>). A difference in potential is experienced across the channel in cell membrane. Neurons keeps on maintain its resting potential and create action potential. Ions have the property to repel similar type and attract the opposite one. In similar fashion, when more ions are pushed out of the neurons a wave like structure generates in the neurons these create voltage fluctuations. These wave when subjected to electrodes; its ions attract or repel the metal of electrodes. This pulling and pushing of ions to metal of the electrode create voltage differences that are recorded over to obtain an EEG signal.

An EEG signal consists of four different wave structures:

1. Gamma waves have frequency above 30 Hz and are not fit for medical purpose.
2. Beta waves have frequency between 14-30 Hz and are below 30 $\mu$ V. these are resulted due to tension. They show attentive state and wakefulness.
3. Alpha waves have frequency between 8-14 Hz and are below 50  $\mu$ V. they show relaxed and mentally inactive state.
4. Theta waves have frequency between 4-8 Hz
5. Delta waves have frequency between 0.3- 4 Hz

EEG signal are used to distinguish between non rapid eye movement stage and rapid eye movement stage. It is also helpful in diagnosing sleep disorders, head injuries, brain infection, brain death etc.

#### 4.2 Electrocardiogram (ECG)

Electrocardiography is again one of the most useful techniques of medical field. In this electrodes are placed over the chest or thorax and heartbeat is continuously monitored. Heart is a four chambered organ having upper two atria and lower two as ventricles. The muscle cells of heart are negatively charged during the resting state. The exchange of sodium and potassium ions across the cell membrane results in decrease of negative charge of cells to zero. This is called depolarization and it results in contraction of muscles. A continuous high ion concentration across the cell membrane results into a current that creates an external potential field. This field excites the neighboring cell and this neighbor to neighbor transfer creates a good amount of electric potential that propagate into the body surface exciting muscular tissues. At each heartbeat, these wave spreads over the atrium and then to ventricle through atrioventricular node. A rise and fall of voltage creates the electrocardiogram signal.

An electrocardiogram consists of following waves:

1. P wave shows activation of the right atrium. It's duration is 80ms
2. QRS complex shows rapid depolarization between right and left ventricles. It's duration is 80 – 100 ms.
3. T wave shows repolarization of ventricles. It's duration is 160 ms.
4. U wave shows repolarization of interventricular septum.

ECG is used to diagnose blood clots, hypotension, Dizziness, high blood pressure congestive heart failure etc.

#### 4.3 Electromyogram (EMG)

Electromyography is a technique used to record the electrical activities of skeletal muscles. Motor unit is the smallest unit that controls muscular contraction. Muscular membrane has resting potential maintained by ions inside and outside the membrane. Depolarization and repolarization are seen in motor neurons resulting in excitation and contraction of muscle fibers. In depolarization state, sodium ions get inside and potassium ions are pumped out of the muscle fiber membrane. In repolarization condition gets reversed i.e. sodium outside and potassium inside. This creates a potential difference along the length of muscle fiber. These potential differences are recorded to get electromyogram. EMG signal is algebraic sum of action potential of many muscle fibers as one motor unit.

EMG signal can be used in medical field, ergonomics, rehabilitation, sports science.

#### 4.4 Electrooculogram (EOG)

Electrooculography is one of great medical technique in which electrodes are placed on forehead near the eyes to record eye movements. It records the resting potential between cornea and retina known as corneal retinal potential. Electrically active nerves in the eye produce potential difference. Cornea are said to be positive while retina is negative, as a whole eye acts as dipole. Eye movements can be recorded by placing electrodes either left or right of eye or above and below eye. When eye moves towards one of the electrode it is positive side of retina and to the

other electrode it is negative side. Eye movement gives the positive and negative impulses due to presence of action potential which is about -0.06 to +0.06 volt. Four to five electrodes are used to record EOG signal. Two of them are placed on sides of eye to detect horizontal movement while other two are placed above and below to detect vertical movement. EOG is used in ophthalmological diagnosis.

#### **4.5 Mechanomyogram (MMG)**

Mechanomyogram is a technique that uses mechanical signal to observe muscle activity. When a muscle is contracted, a peak is experienced in a MMG signal. As we know a muscle is combination of millions of muscle fibers. When these fibers are oscillated, vibration is experienced in muscles. In this technique, electrodes are placed over the skin surface. These vibrations create pressure wave showing muscle activity. An MMG signal can be recorded using an accelerometer or microphone, piezo electric contact sensors.

MMG is used to find muscular pain, fatigue, diseases etc.

#### **4.6 Magnetoencephalography (MEG)**

It is one of popular technique to record neuronal brain activity. Brain consists of millions of neurons that are responsible for transmission and reception of information from body. Neurons of brain undergo ions exchange chemically that creates a magnetic field across the cell membrane. Axon of the neuron has bidirectional current hence two dipoles of opposite polarity exist. This leads to cancellation of magnetic field. Post synapses of neurons have unidirectional current. Hence magnetic field persists here. Magnetic field of a single neuron cannot be measured so neurons of same spatial orientation are taken together and their combined magnetic field is measured using sensitive magnetometers. Superconducting quantum interference devices commonly known as SQUIDS are best suited to measure MEG signal. MEG provides high spatial and temporal resolution.

MEG is used to study brain processes, parts of brain, neuro feedback etc.

#### **4.7 Galvanic Skin Response**

Galvanic skin response is a method to study electrical properties of human skin. It is also called electro dermal response. When a human body comes under the interaction of environment, some changes are seen in person's psychological state. Due to this some changes are observed in electrical properties of its skin. As it is a known fact that human skin is a good conductor of electricity so ions exchange is experienced between external and internal environment of skin. This leads to flow of electric current in skin. Hence we can say that human skin possesses resistance or conductance. In GSR, a constant voltage is applied through electrodes on human skin. This leads to current flow that can be measured and then we can find resistance or conductance by simply dividing voltage applied by electrodes with current flowing in skin. Thus, skin observes two types of conductance, one is tonic and other is phasic. In tonic stage of conductance, there is absence of any external environment, hence a

baseline conductance called skin conductance level is observed. In phasic stage of conductance, changes in external environment like some stimuli leads to changes in skin conductance. These are called skin conductance response. GSR finds application in lie detection tests, hypnotherapy, psychotherapy, behavior therapy.

#### 4.8 Electroretinogram (ERG)

Electroretinogram is another helpful technique to study electrical response of retina human eye. It helps in diagnosing status of retina in case of eye diseases. When a light stimulus is applied through LED or strobe lamp, an electrical activity takes place in neural and non- neural cells of retina. This produces a biphasic waveform comprising of three important waves known as

- a-wave
- b-wave
- c-wave

Due to sodium ion channel closure in outer membrane, there exists hyperpolarization of photoreceptors. a- waves are reflected from rods and cones of outer photoreceptor layers of the retina. When a light stimulus is applied on the retina, rhodopsin gets triggered leading to activation of transducin. This further activates cyclic guanosine monophosphate phosphodiesterase(cGMP). cGMP helps sodium ions to move inside the membrane. a waves are negative in nature and are measured from baseline to trough of a wave.

b-waves are positive corneal deflection from inner retina. Due to hyperpolarization of photoreceptors, there is decrease in number of sodium ions. This leads to depolarization of bipolar cells which further increases amount of potassium ions. This balancing of sodium and potassium ions across the cell membrane generates current. These are measured from trough of a-wave to the peak of b-wave.

c-waves are result of pigments of retina i.e. epithelium and photoreceptors ERG is helpful in diagnosing retinitis pigmentosa, cone dystrophy, choroideremia.

#### V CONCLUSION

Bio potential is gaining importance in research in both medical as well as electronics field. They are hot topic of research today because they are concerned with human health and wellbeing. Signals like ECG, EEG, EMG, EOG, not only examine a person's health but also diagnoses illness of a person. In future, these signals can be helpful in finding various therapies for treatment of diseases that are still unknown.

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# CHARACTERIZATION OF NANO-PARTICLE SIZE IN CONVECTIVE HEAT TRANSFER THROUGH A CYLINDRICAL ANNULUS

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## ABSTRACT

*We want to characterize behavior of various physical effects based on nano particle size during convective heat transfer through various geometries. It is found that the viscosity is greatly effected due to the small size of the metal particle dissolve in the fluids. The fluid convey cylindrical in general. The nano fluid flows and exhibits interesting characteristics in Heat transfer. We investigates theoretically the effect of particle size and the layer around it on heat transfer under the influence of magnetic field and heat source in porous medium. The magnitude of heat transfer decreases with increase in particle size.*

**Keywords:** *MHD Nano, Fluid, Annulus, Porous Material.*

## I INTRODUCTION

The investigation for enhancing the heat transfer through a fluid gives birth to the nano-fluid due to the presence of metal particle in the fluid enhances the heat transfer widely. The literature is providing an excellent support for the enhancement of heat transfer.

Xuan and Li [10] presented a study on the thermal conductivity of nano-fluid comprise of copper nano-particles. The measured data showed that adding 2.5-7.5% copper oxide nano particles to the water increased its conductivity by about 24-78%. Rafee [4] had concluded that for a constant heat transfer rate, by increasing the length ratio of an annulus ( $L/D_h$ ), firstly the entropy generation ratio will decrease until reaches its minimum value.

Free convection flow and heat transfer in hydro magnetic case is important in nuclear and space technology (Singh KR 1963[6], Yu CP 1969 [8], Yu CP 1970[9]). In particular, such convection flow in a vertical annulus region in the presence of radial magnetic field had been studied by Sastry and Bhadram (1978) [5]. Nanda and Purushotham (1976) [2] had analyzed the free convection of a thermal conducting viscous incompressible fluid induced by traveling thermal waves on the circumference of a long vertical circular cylindrical pipe. Whitehead (1972) [7], Neeraja (1993) [3] had made a study of the fluid flow and the heat transfer in a viscous incompressible fluid confined in an annulus bounded by two rigid cylinders. The flow was generated by periodical traveling waves

imposed on the outer cylinder and the inner cylinder was maintained at constant temperature.

Ali J. Chamkha [1] had studied the Heat and Mass Transfer from MHD Flow over a Moving Permeable Cylinder with Heat Generation or Absorption and destructive Chemical Reaction. He found that the diffusion decreased with increase in chemical reaction.

The above studies motivated to investigate theoretically the effects of particle size, heat source on convective heat transfer in a nano - fluid while passing through horizontal porous annulus in the presence of magnetic field.

## II FORMULATION OF THE PROBLEM

We consider free and force convection flow of Cu-water nano-fluid through a porous medium in a circular cylindrical annulus in the presence of heat source, in which inner and outer walls are maintained at a constant temperature and concentration. The flow velocity, temperature and concentration in the fluid to be fully developed. The fluid region has constant physical properties and the flow is a mixed convection flow taking place under thermal and molecular buoyancies and uniform axial pressure gradient. When the momentum and energy are coupled, and also the flow is unidirectional along the axial cylindrical annulus. The boussenisque approximation is invoked so, that the density variation is confined to the thermal and the molecular buoyancy forces. By making use of the above assumptions the governing equations are:

$$\frac{\partial}{\partial r} (r u) = 0 \quad (1)$$

$$\frac{\mu_{nf}}{\rho_{nf}} \left( \frac{\partial^2 w}{\partial r^2} + \frac{1}{r} \frac{\partial w}{\partial r} + \frac{\partial^2 w}{\partial z^2} \right) - \frac{\mu_{nf}}{\rho_{nf} k} w - \frac{\sigma B_0^2}{\rho_{nf}} w + \frac{g(\rho\beta_T)_{nf} (T-T_0)}{\rho_{nf}} = 0 \quad (2)$$

$$w \frac{\partial T}{\partial z} = \frac{\alpha_{nf}}{r} \frac{\partial}{\partial r} \left( r \frac{\partial T}{\partial r} \right) - \frac{Q}{(\rho c_p)_{nf}} (T-T_0) \quad (3)$$

The appropriate initial and boundary conditions for the problem are given by

$$\begin{aligned} T &= T_0, \quad w = 0 \quad \text{on} \quad r = a \\ T &= T_m, \quad w = 0 \quad \text{on} \quad r = a+s \end{aligned} \quad (4)$$

Thermo-Physical properties are related as follows:

$$\rho_{nf} = (1-\phi)\rho_f + \phi\rho_s, \quad \alpha_{nf} = \frac{k_{nf}}{(\rho c_p)_{nf}}$$

$$(\rho c_p)_{nf} = (1-\phi) (\rho c_p)_f + \phi (\rho c_p)_s$$

$$(\rho\beta)_{nf} = (1-\phi)(\rho\beta)_f + \phi(\rho\beta)_s$$

$$\frac{\mu_{nf}}{\mu_f} = 1 + 2.5\phi + 4.5 \left[ \frac{1}{\left( \frac{h}{d_p} \left( 2 + \frac{h}{d_p} \right) \right) \left( 1 + \frac{h}{d_p} \right)^2} \right]$$

$$k_{nf} = k_f(1-\phi) + \beta_1 k_p \phi + c_1 \frac{d_f}{d_p} k_p Re^2 d_p pr \phi \quad (5)$$

where  $\beta_1 = 0.01$  is a constant for considering the Kapitza resistance per unit area

$c_1 = 18 \times 10^6$  is a proportionality constant

$$Re_{dp} = \frac{d_p}{\gamma_f} \frac{\kappa T}{3\pi\mu_f d_p l_f} = \frac{1.381 \times 10^{23} T}{\gamma_f 3\pi\mu_f (0.738)}$$

$$d_f = 0.384 \text{ nm for water, } pr = \text{Prandtl number} = \frac{\nu_f}{\alpha_f}$$

$$l_f = \text{Mean free path} = 0.738, \kappa = \text{Boltzmann constant}, T = 300\text{K}$$

We introduce the following dimensionless variables:

$$R = \frac{r}{a}, \quad Z = \frac{z}{a}, \quad W = \frac{w}{v_f}, \quad U = \frac{u}{v_f}, \quad \theta = \frac{T - T_0}{T_m - T_0} \quad (6)$$

Using equations 4, 5, 6 and the thermo-physical properties than the Equation 2 & 3 can be written in the following dimensionless form:

$$\left( 1 + 2.5\phi + 4.5 \left[ \frac{1}{\left( \frac{h}{d_p} \left( 2 + \frac{h}{d_p} \right) \left( 1 + \frac{h}{d_p} \right) \right)^2} \right] \right) \left( \frac{\partial^2 W}{\partial R^2} + \frac{1}{R} \frac{\partial W}{\partial R} \right) \frac{1}{\left( 1 - \phi + \phi \frac{\rho_s}{\rho_f} \right)} - \frac{1}{D} \left( 1 + 2.5\phi + 4.5 \left[ \frac{1}{\left( \frac{h}{d_p} \left( 2 + \frac{h}{d_p} \right) \left( 1 + \frac{h}{d_p} \right) \right)^2} \right] \right) \frac{1}{\left( 1 - \phi + \phi \frac{\rho_s}{\rho_f} \right)} W - \frac{1}{\left( 1 - \phi + \phi \frac{\rho_s}{\rho_f} \right)} M W + \frac{1}{\left( 1 - \phi + \phi \frac{\rho_s}{\rho_f} \right)} G r \theta = 0$$

$$W \frac{\partial \theta}{\partial z} = \frac{1}{Pr} \left[ \left( 1 - \phi + 0.01 \phi \frac{k_p}{k_f} + \frac{k_p}{k_f} \frac{\rho_f^2 c_{pf}}{d_p \mu_f^3} 28632.9991 \times 10^{-52} \right) \frac{1}{\left( 1 - \phi + \phi \frac{(\rho c_p)_s}{(\rho c_p)_f} \right)} \left[ \frac{\partial^2 \theta}{\partial R^2} + \frac{1}{R} \frac{\partial \theta}{\partial R} \right] - \frac{1}{Pr} Q_H \left[ \frac{1}{1 - \phi + \phi \frac{(\rho c_p)_s}{(\rho c_p)_f}} \right] \theta \right]$$

Where the corresponding boundary conditions (4) can be written in the dimensionless form as:

$$W = 0, \theta = 0 \text{ on } R = 1$$

$$W = 0, \theta = 1 \text{ on } R = 1+s$$

Here Pr is the Prandtl number, M is the magnetic parameter (Hartmann number),  $Q_H$  is the heat source parameter,  $D^{-1}$  is the Darcy number, Gr is the Grashof number, which are defined as:

$$Pr = \frac{\nu_f}{\alpha_f}, M = \frac{\sigma B_0^2}{\mu_f} a, Q_H = \frac{Q}{k_f} a, \frac{1}{D} = \frac{a}{k}, Gr = \frac{g(\rho\beta_T)(T_m - T_0)}{\nu_f^2}$$

The local Nusselt number Nu in dimension less form:

$$Nu = - \frac{k_{nf}}{k_f} \theta' (1+s)$$

### III SOLUTION OF THE PROBLEM

The cross section of the cylinder which considers and appears in the annulus form for numerical computations. The governing equations are solved for momentum (w) and temperature ( $\theta$ ) by using method of lines with the help of Mathematical package across the cylindrical annulus subject to the boundary conditions.

#### IV RESULTS

The profiles of momentum and temperature are drawn at  $Pr = 7$  for constant axial temperature and axial concentration gradients.

From Figs. 1 - 8 the flow is maximum in the mid region of the annulus. The momentum decreases with solid volume fraction ( $\phi$ ). If the amount of Cu nano-particles increases, the momentum decreases due to Brownian motion. The width of an annulus affects the flow very much. The flow is maximum for width of an annulus ( $s$ ). The velocity enhances with increase of the thickness of the layer ( $h$ ) around the nano-particle due to increase in friction. The velocity is maximum for 10nm or more and almost constant for 2nm or less thickness. The flow has obstructed by the Cu nano-particle very much.

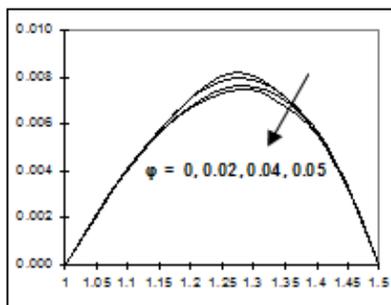


Fig.1 Variation of  $w$  with  $\phi$

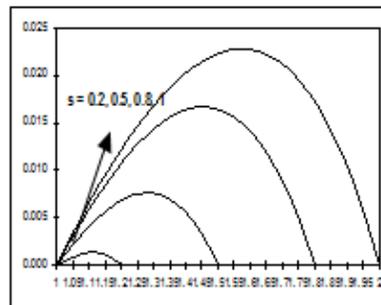


Fig.2 Variation of  $w$  with  $s$

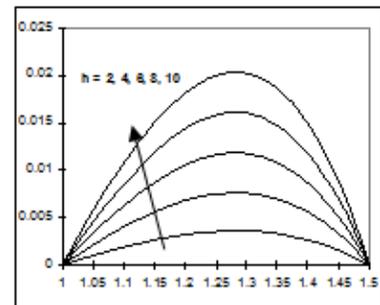


Fig.3 Variation of  $w$  with  $h$

As the Particle size ( $d_p$ ) increases from 20nm to 100nm the velocity is decreased due to low Brownian motion. The velocity is maximum for small particles at about 20nm and the velocity is almost constant at about 100nm or more. The velocity increases with increase in thermal Grashof numbers ( $Gr$ ). The velocity decreases with increase in the Hartmann number ( $M$ ) and the velocity found maximum in the absence of the magnetic field. The velocity decreases with increase in heat source ( $Q_H$ ). The flow increases with increase in the porosity ( $D^{-1}$ ).

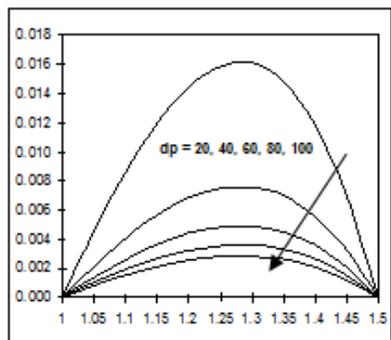


Fig.4 Variation of  $w$  with  $d_p$

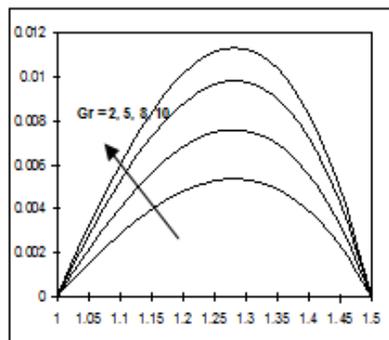


Fig.5 Variation of  $w$  with  $Gr$

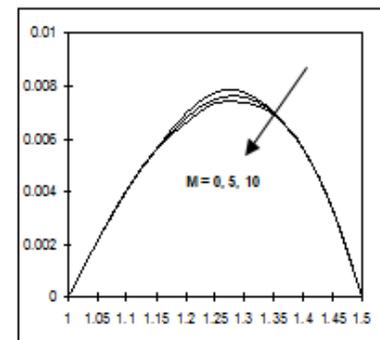


Fig.6 Variation of  $w$  with  $M$

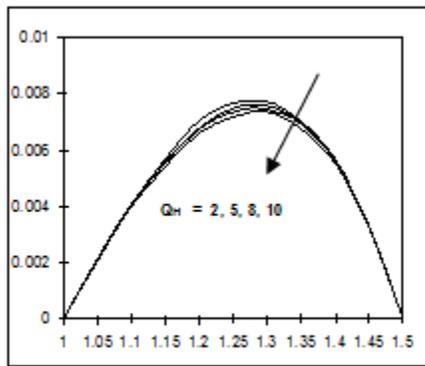


Fig.7 Variation of w with  $Q_H$

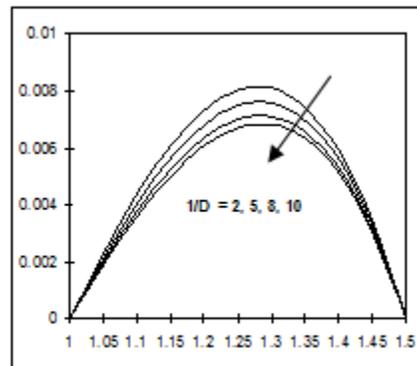


Fig.8 Variation of w with  $D^{-1}$

From Figs. 9 – 14 the heat transfer takes place from inner cylinder to outer cylinder linearly for all variations of  $\phi$ ,  $s$ ,  $h$ ,  $d_p$ ,  $Q_H$  and  $D^{-1}$ . The temperature enhances with increase in volume fraction ( $\phi$ ) of Cu particles. The temperature increases rapidly with increase of the width ( $s$ ) of an annulus. The temperature is maximum in an annulus when the inner and outer cylinders are of the same radius. The layer ( $h$ ) around the nano-particle reduces the temperature due to less thermal conductivity of CuOH when compared with Cu. The temperature enhances with increase in size of the particle ( $d_p$ ). The temperature decreases with increase in heat source ( $Q_H$ ). The temperature reduces with the increase in porosity ( $D^{-1}$ )

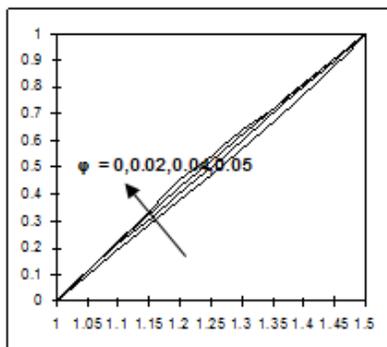


Fig.9 Variation of  $\theta$  with  $\phi$

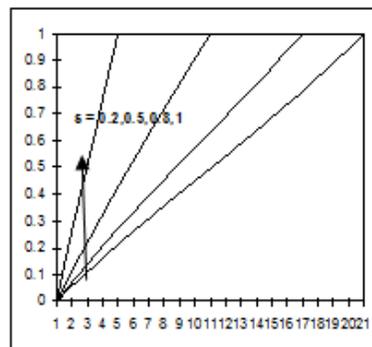


Fig.10 Variation of  $\theta$  with  $S$

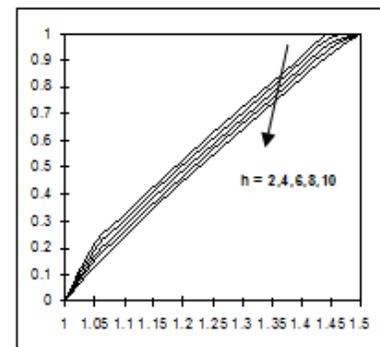


Fig.11 Variation of  $\theta$  with  $h$

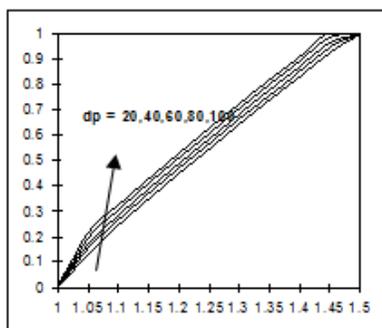


Fig.12 Variation of  $\theta$  with  $d_p$

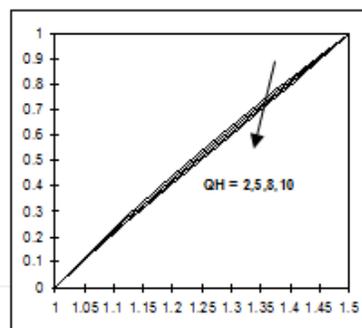


Fig.13 Variation of  $\theta$  with  $Q_H$

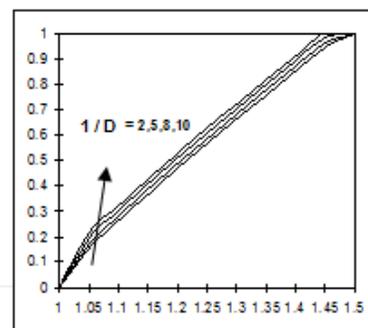


Fig.14 Variation of  $\theta$  with  $D^{-1}$

**Nusselt Number:**

$$s = 0.5, h = 4, Gr = 5, M = 5, D^{-1} = 5$$

$\phi$	$d_p = 40,$ $Q_H = 0$	$d_p = 40,$ $Q_H = 5$	$d_p = 40,$ $Q_H = 10$	$d_p = 20,$ $Q_H = 5$	$d_p = 100,$ $Q_H = 5$
0.02	-1.64838	-2.35051	-2.96791	-2.35512	-2.34821
0.04	-1.64798	-2.29046	-2.86112	-2.29467	-2.28836
0.05	-1.64781	-2.26412	-2.81397	-2.26814	-2.2621

The

variation of Nusselt number for different values of volume fraction ( $\phi$ ),  $d_p$  and  $Q_H$  are depicted in the surface of the outer cylinder. The magnitude of heat transfer decreases as the volume fraction increases on the surface of the outer cylinder. The magnitude of heat transfer increases as the heat source increases. The magnitude of heat transfer decreases with increase in particle size.

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# UNIQUENESS OF AMMENSAL & COMMENSAL MATHEMATICAL MODELS WITH LIMITED RESOURCES IN FULLY WASHED-OUT STATE

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## ABSTRACT

*Ammensalism and Commensalism are having diversity in nature. Both interactions are quite opposite. But there are some rare limitations. In this presentation, the paper aims to discuss the similarities between the mathematical models of Ammensalism and Commensalism with limited resources in one special case. Uniqueness is obtained in Fully washed out state.*

**Keywords:** *Ammensalism, Commensalism, Stability, Normal State, Enemy, Host.*

## I. INTRODUCTION

Ammensalism[2] is a symbiotic interaction in which one population inhibits the other, itself remaining unaffected.

A common example for this is the bread mold penicillium. Penicillium secretes penicillin, a chemical that kills bacteria. Commensalism[16] is a symbiotic interaction between two or more populations which live together, and in which only one of the populations (commensal) is benefited while the other (host) is not affected. It is a special subject of interactions [3-15] in mathematical modeling. Many Mathematicians focused their interest on this subject[1,17-20]

A common example is an animal using a tree for shelter. Tree (host) does not get any benefit from the animal (commensal).

These interactions of Ammensalism/Commensalism between two species

(X and Y) are shown in the table given below:

S.No.	Effect on X	Effect on Y	Type of interaction	Species-Names
1	-	0	Ammensalism	X:Ammensal, Y:Enemy
2	+	0	Commensalism	X:Commensal, Y:Host

## II NOTATIONS ADOPTED

$\chi_1(t)$  : The population of the species  $S_1$  at time  $t$

$\chi_2(t)$  : The population of the species  $S_2$  at time  $t$

$a_i$  : The natural growth rates of  $S_i$ ,  $i = 1, 2$ .

$a_{ii}$  : The rate of decrease of  $S_i$ ; due to its own insufficient resources  
,  $i=1,2$ .

$\mu_i$  : the carrying capacity of  $N_i$ ,  $i = 1, 2(a_i / a_{ii})$

$A$  :  $a_{12} / a_{11}$  is the coefficient of Ammensalism/Commensalism

The state variables and as well as the model parameters  $a_1, a_2, a_{11}, a_{22}, \mu_i$  are assumed to be non-negative constants.

$S_1$  : First Species (Ammensal/Commensal Species).

$S_2$  : Second Species (Enemy/Host Species)

## III. BASIC EQUATIONS

The equation for the growth rate of Ammensal/Commensal species ( $N_1$ ) with limited resources is constituted as

$$\frac{d\chi_1}{dt} = \mu_1 \chi_1 a_{11} - \chi_1^2 a_{11} - A \chi_1 \chi_2 a_{11}$$

Here negative/positive sign occurs before  $A$  in the case of Ammensalism/commensalism respectively.

The equations for the growth rate of enemy species ( $N_2$ ) with limited resources is constituted as

$$\frac{d\chi_2}{dt} = \mu_2 \chi_2 a_{22} - \chi_2^2 a_{22}$$

## IV. EQUILIBRIUM POINTS

The system under this investigation has four equilibrium states:

i)  $\bar{\chi}_1 = 0; \bar{\chi}_2 = 0$  [Fully washed out state].

ii)  $\bar{\chi}_1 = 0; \bar{\chi}_2 = K_2$  [Ammensal / Commensal only is washed out state].

iii)  $\bar{\chi}_1 = K_2; \bar{\chi}_2 = 0$  [Only Ammensal / Commensal survives state]

iv)  $\bar{\chi}_1 = \mu_1 \mp A \mu_2; \bar{\chi}_2 = \mu_2$  [Co-existent state or normal steady state]

## V. UNIQUENESS OF AMMENSAL/COMMENSAL MODELS IN FULLY WASHED OUT STATE :

After linearization, we get  $\frac{dU_1}{dt} = a_1 U_1$  and  $\frac{dU_2}{dt} = a_2 U_2$

The characteristic Equation is  $(\lambda - a_1)(\lambda - a_2) = 0$

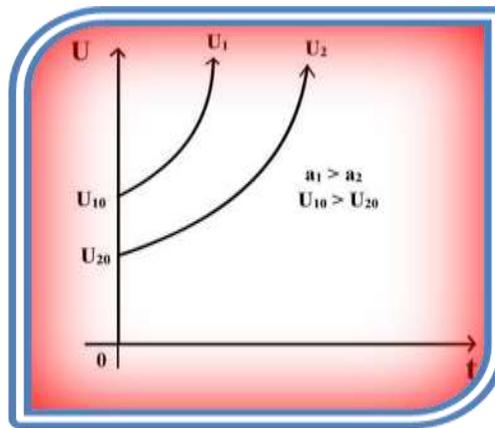
whose roots  $a_1, a_2$  are both positive. Hence the steady state is unstable.

By solving the equations, we get  $U_1 = U_{10}e^{a_1 t}$  and  $U_2 = U_{20}e^{a_2 t}$

where  $U_{10}, U_{20}$  are initial values of  $U_1, U_2$  respectively. The solution curves are illustrated in the following four cases.

#### VI.UNIQUENESS IN AMMENSAL/ COMMENSAL MODELS

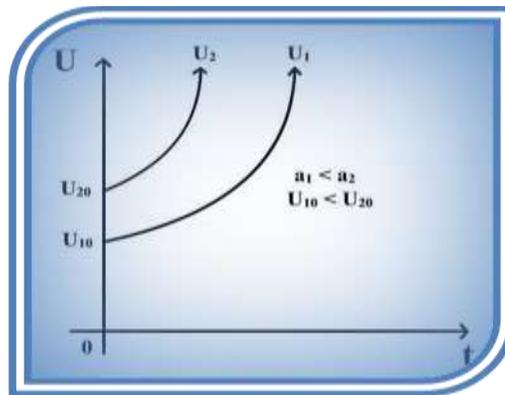
**Case 1:  $a_1 > a_2$  and  $U_{10} > U_{20}$**



**Fig.1**

the Ammensal/Commensal ( $S_1$ ) in this case dominates over the other species: Enemy/Host ( $S_2$ ) in natural growth rate as well as in its initial population strength. Both the domain species have the nature of flourishing throughout in the period of time interval, increasing their strengths gradually to cause for instability of the system. Both are diverging from the equilibrium point shown as in Fig. 1.

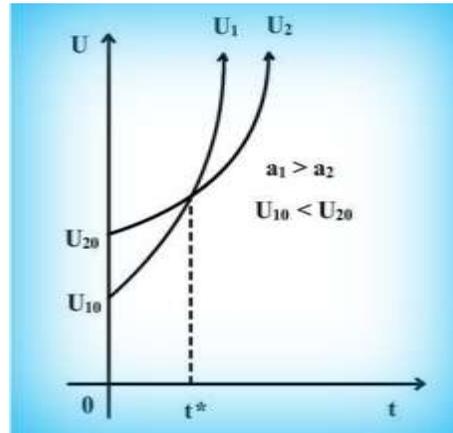
**Case 2:  $a_1 < a_2$  and  $U_{10} < U_{20}$**



**Fig.2**

The Enemy/Host ( $S_2$ ) species is dominating the Ammensal / Commensal ( $S_1$ ) species with sufficient energies in the natural growth rate as well as in its initial population strength. The enemy/ host species is stronger than the Ammensal /Commensal species. The enemy/host continues throughout it's growth and also it is noticed that both the species are going away from the equilibrium point shown as in Fig.2

**Case 3:  $a_1 > a_2$  and  $U_{10} < U_{20}$ :**



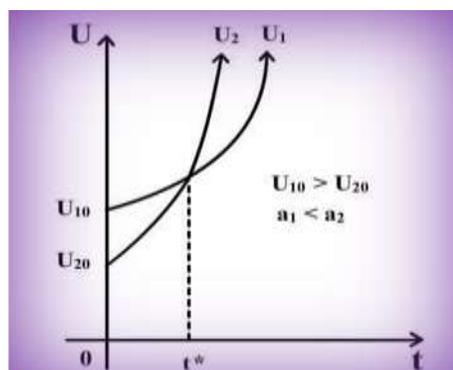
**Fig.3**

The Ammensal/Commensal( $S_1$ ) species dominates over the Enemy/Host( $S_2$ ) species in the natural growth rate but it's initial strength is less than that of the enemy species. The enemy/Host outnumbers the Ammensal/ Commensal till the time-instant( $t^*$ ) after that the Ammensal/ Commensal out-numbers the enemy shown as in Fig.3.

$$\text{here } t^* = \frac{1}{a_2 - a_1} \log \left( \frac{U_{10}}{U_{20}} \right)$$

In this case, the enemy/host species is stronger than the other species i.e Ammensal/ Commensal Species up to some period of time. The first species( $S_1$ ) loses it's initial strengths after  $t^*$ . The dominance will be reversed.

**Case 4:  $a_1 < a_2$  and  $U_{10} > U_{20}$**



**Fig.4**

The enemy ( $S_2$ ) species dominates over the Ammensal ( $S_1$ ) species in the natural growth rate but its initial strength is less than that of Ammensal species. The Ammensal outnumbers the enemy till the time-instant ( $t^*$ ) after that the enemy outnumbers the Ammensal shown as in Fig.4. In this case, the enemy/host species is weaker than the other species i.e Ammensal/ Commensal Species up to some period of time. After  $t^*$ , they will be strengthened. The first species ( $S_1$ ) increases its initial strengths than the second species after  $t^*$ . The dominance will be changed after  $t^*$ .

**VI. TRAJECTORIES OF PERTURBED SPECIES:** Further the trajectories in the  $U_1 - U_2$  plane are given by

$$\left(\frac{U_1}{U_{10}}\right)^{a_2} = \left(\frac{U_2}{U_{20}}\right)^{a_1}$$

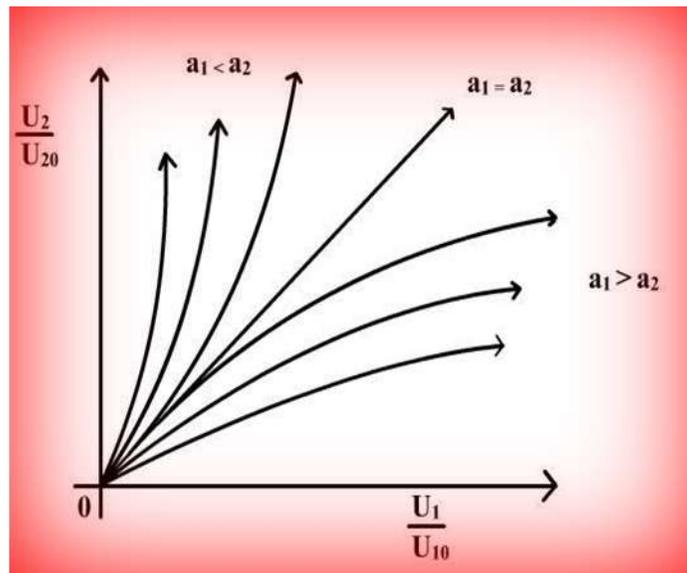


Fig.5

## VII. CONCLUSIONS FROM TRAJECTORIES

On over all observations with the help of Trajectories, some conclusions can be classified as below:

$a_1 < a_2$ : The growth rates are in flourishing in exponential rate and rapid strengths will be obtained.

$a_1 = a_2$ : Steep and uniform growth rates are observed. The growth rates will be converging towards to maximum possible extinct.

$a_1 > a_2$ : The growth rates are in gradual rate and moving towards in the direction of equilibrium state. But both diverge from equilibrium point.

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# DESIGN OF VISION BASED INSPECTION SYSTEM FOR WASHERS

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## ABSTRACT

*Inspection is a quality evaluation technique which is most widely used in industries to obtain best quality products with specified requirements. Traditionally manual inspection may lead to loss of material, labour, time for production and inaccuracy in measurement. Thus automated inspection technique can be effectively implemented to overcome the above discussed aspects. This paper presents a brief explanation about implementing automated inspection technique in quality control process of washer using machine vision. The manufactured washers may have defect like variation in dimensions. Thus each washer is checked for perfectness in dimension using machine vision. Machine vision processes discussed in this paper include capturing of image of the washer, image processing, determination of area of washer material and actuation of ejector mechanism. By machine vision technique defective washers can be eliminated accurately and comparatively reduces the time for inspection.*

**Keywords:** *Automated inspection, Go and No-Go Gauge, Image processing, Machine vision*

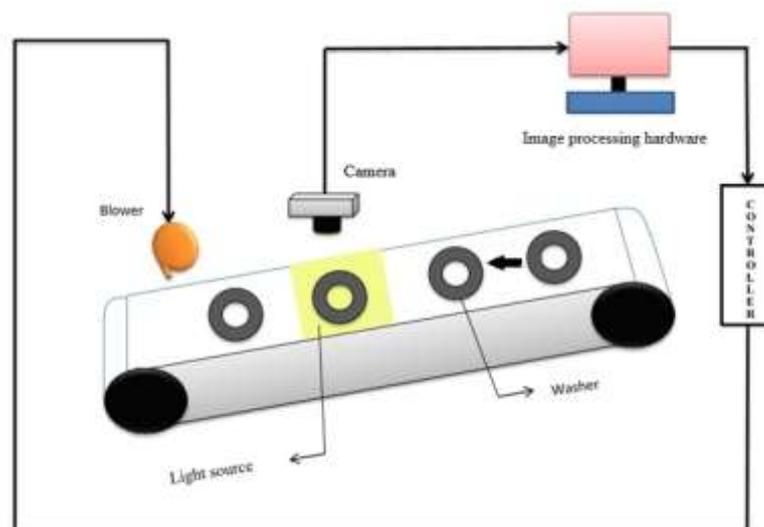
## I INTRODUCTION

Inspection is a quality evaluation technique which is most widely used in industries [1]. Inspection is defined as the critical appraisal process which involves in measurement, examination, analysis and comparison of manufactured part. Inspection may be manual or automatic. Automated inspection includes the use of electrical, electronic and mechanical devices to reduce the workload on human and to increase the effectiveness of quality control. Thus it is viable to replace the manual inspection by automatic inspection method in order to increase accuracy and to decrease the inspection time. Automated inspection techniques are implemented for inspection of food products [2,3], textile fabrics [4,5], tile surface [6], biscuit colour [7] etc. Large scale production industries like washer manufacturing industry follow 'Batch inspection' using "Go/No-Go gauge". Batch inspection method involves in the random selection of a washer from a particular batch and it is subjected to inspection using Go/No-Go gauge. Go/No-Go gauge is a quality control tool which is used to result a state which should be either acceptable or the unacceptable. The Go/No-Go gauge for washer consists of two ends, in which an acceptable washer must pass through one end and should not be able to enter the other end. In traditional manual batch inspection, defect in a single product of the batch leads to the rejection of that particular batch as a whole and it will result in waste of material, labour and time for production. Thus to overcome the defects of manual batch inspection, automated inspection using machine vision can be implemented. Machine

vision is a technology used to provide imaging based automatic inspection and analysis. A machine vision system consists of one or more cameras, analog to digital converter, micro controller, conveyor and a pneumatic blower. As the manufacturing process gets completed, the washer gets collected one by one on top of the conveyor. The washer while reaching the view area of the camera, image of the washer is captured. The captured image can be converted into suitable digital form with the help of analog to digital converter. The converted digital image can be compared with the desired dimensions of washers. The washers with acceptable dimensions will be allowed to pass through. On the other hand the washers with defect will be recognised and the micro controller operates the pneumatic blower and it is eliminated from the conveyor.

## II PROPOSED DESIGN

Design of this visual inspection technique is quite simple with an arrangement of a camera placed vertically over the path of conveyor which carries the part to be inspected. Inspection process includes the usage of back light technique in order to illuminate the part through the transparent conveyor. The light source will be in line with the camera as shown in figure below. The image that is captured by the camera is processed using image processing software using computers. The processed image is compared with the standard image of that size by using the same software. The end output data thus obtained as a result of comparison is fed as input to the micro controller. Elimination of defective part is achieved by use of pneumatic blower connected to the output terminal of the controller. Actuation of pneumatic blower depends on the comparison data which is given as input to the controller. The pneumatic blower should also be a controlled in such a way that its blowing effect should not affect the next coming washer.



**Fig.1. Design layout of the system**

The following are the components of the proposed system:

- Camera
- Light source

- Transparent conveyor
- Image processing hardware
- Controller
- Pneumatic Blower

### **2.1 Camera**

Camera is the most primary component of inspection technique which is used to record the still image of the constantly moving washer and then transmit it to the image processing hardware through cable. Camera is positioned at the top of the conveyor with its lens facing downwards as shown in Fig.1. The shutter speed of the camera relies on the speed of conveyor motor and the distance between two consecutive washers. High resolution cameras are used in order to increase the accuracy of the process.

### **2.2 Light Source**

Light source used here is light emitting diode placed below the transparent conveyor as shown in Fig.1 in line with the camera. White LED light is used to illuminate the part. White LED has many advantages over cold light or fluorescent tubes, which makes them ideal for most machine vision technique. LEDs provide uniform and constant light with less expense and have longer life of over 1,00,000 hours.

### **2.3 Transparent Conveyor**

Conveyors are used to move object from one place to another in production line. Conveyor belt which is used in this method should be transparent in order to illuminate the washer image. The speed of the conveyor motor should be optimum so that there is a little time gap between the consecutive inspection and rejection.

### **2.4 Image Processing Hardware**

Image processing hardware is nothing but a computer in which the image processing software is installed to it. The image processing software enables the comparison of image of the part to be inspected with the standard part image in terms of pixel areas. Data thus obtained after comparison is fed to the controller.

### **2.5 Controller**

Controller forms the heart of this automatic inspection technique. They are used to control the action of entire system by means of program that is already stored in ROM (read only memory). By the nature of data obtained from the computer it controls the actuation of blower.

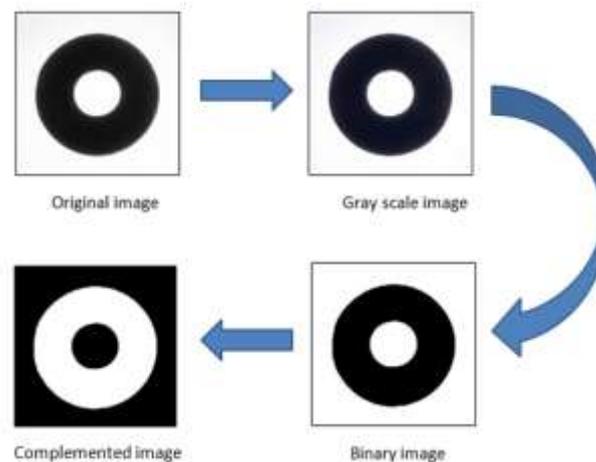
### **2.6 Pneumatic Blower**

A blower is nothing but a pneumatic valve actuated by a solenoid. It is connected to the output terminal of the controller. The solenoid is actuated only if the inspected part does not match the standard part.

## **III IMAGE PROCESSING ALGORITHM**

For the purpose of obtaining the standard dimensions, a washer with perfect dimensions is placed in the field of view of the camera. Backlighting technique is used to capture the image using a camera, which involves in the usage of light source placed under the transparent conveyor. Thus when the washer reaches the view area, the washer blocks the light and appears dark whereas the region which is not covered by the washer will allow the light to be received by the camera and appears bright. The captured image will be converted into gray scale image in which the colours will appear in different intensities of gray. Now the gray scale image will be

converted into binary image. In binary image the region allowing the light will appear white and the washer material area which blocks the light will appear black. For the purpose of calculation of area of the washer, the binary image is complemented which will convert the washer material region into white and the remaining to black. Now the area of the white region is determined and it is stored in the memory as the reference range (36,000 to 40,000). The various images obtained during the process is shown in Fig. 2.



**Fig.2. Various images obtained during processing**

#### **IV WORKING ALGORITHM**

After the manufacturing process, the washers get collected one by one on the conveyor. The washer while reaching the field of view of the camera, the controller triggers the camera to capture the image. The captured image is processed by image processor using the above explained image processing algorithm which results in the determination of washer material area from the complemented image. The determined area of the washer is compared with the reference value using 'if-else' conditional statement. The washers within the reference range (36,000 to 40,000) will be allowed to pass through. If in case the controller detects a washer which fails to possess area within the reference range, the controller triggers the blower which results in the elimination of that particular washer from the conveyor. Further, the washer with lesser area than the reference can be eliminated from the main conveyor and can be collected in different conveyor. Similarly the washer with greater area can be eliminated and collected in another conveyor. Thus only the washers with acceptable dimensions will pass the inspection.

#### **V CONCLUSION**

This paper discusses the design of an inspection system for washers. This system uses simple 2D vision algorithm to inspect the dimensions of the washer. The algorithm was tested and was found to be an effective replacement for Go and No-Go Gauges used in industries. Machine vision technique when implemented in large scale manufacturing industry following batch production, it will eliminate the risk of rejection of whole batch of final product and improve the quality and effectiveness of inspection.

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# DEVELOPING A SUGARCANE FEEDING SYSTEM FOR JAGGERY MAKING PLANTS FOR RURAL INDIA

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## ABSTRACT

*Sugar industry in India is one of the largest types of industry after textile. Making Jaggery from sugarcane is among the major agro processing industries found in rural India. Nearly 50% of total sugarcane produced in the country is used to manufacture about 8 million tonnes of Jaggery. Jaggery making plants are generally small units run by villagers in different parts of India. Most of the Jaggery making plants use two roller sugarcane crushing machine in which the sugarcane is fed manually. This paper discusses the development of a sugarcane feeding system which will save the labour cost and increase the overall efficiency of the Jaggery plant.*

***Keywords: Jaggery, Labour Cost, Sugar Industry, Sugarcane Feeding***

## I. INTRODUCTION

Jaggery is a typical Indian product with several uses in daily food preparations. This is a product majorly manufactured in the states like Maharashtra, Karnataka, UP, Gujarat, Bihar, Jharkhand etc. [1] Jaggery is manufactured from sugarcane juice and is very widely used not only in individual households but also in many eateries, restaurants, clubs and hostels. [2] Manufacture of sugar involves many technical aspects and the capital investment is also on the higher side. Compared to this, production of Jaggery is very simple and the capital cost is also very limited. Due to its wide applications, the market for Jaggery is continuously growing.[3]

## II. JAGGERY MANUFACTURING PROCESS

Jaggery manufacturing is done on a small scale by a group of farmers. The juice is extracted from fresh sugarcane by crushing it using a two roller machine. Then it is filtered and boiled in wide, shallow iron pans with continuous stirring. While boiling, brownish foams come at the top which are continuously removed to get golden yellow colour of Jaggery. The consistency of the juice becomes thick and then it is poured into the small to medium sized iron or aluminum cans where blocks of Jaggery are formed after cooling. Size of the blocks can vary from 1 kg to 10 kg. Finally, these blocks are packed in gunny bags. It has been observed that from 100 kg of sugarcane, around 10 kg Jaggery is made.[4,5,6]

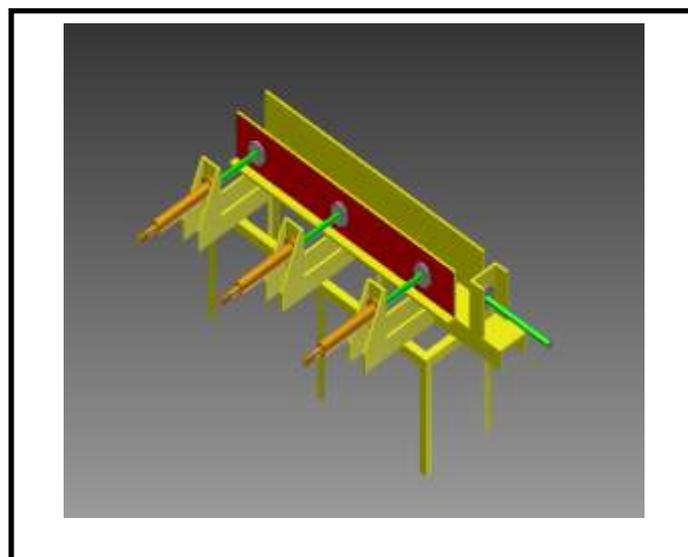
### III. PROBLEM DEFINITION

We took survey of 20 Jaggery production owners in the Kolhapur & Sangli District of Maharashtra State which is famous for Sugarcane as the main agricultural crop. During the survey, it was strongly realized that sugarcane feeding process to the two roller crushing machine to extract the sugarcane juice is the bottleneck in the entire Jaggery making process as it largely depends on the availability and efficiency of the labour. In traditional method the feeding of sugarcane is mostly done manually which requires more number of labours and hence it is more time consuming and involves higher cost. Also Manual feeding of sugarcane results in low efficiency. The cost of operation require for feeding process is high. Manual feeding of sugarcane is complicated process because it requires lot of concentration and hard work while feeding. Many times, there had been incidents of accidents in which labour may lose their finger in feeding process which increases the risk factor.

### IV. EXISTING TWO ROLLER SUGARCANE CRUSHING MACHINE:



**Fig. 1: Two roller sugarcane crushing machine**



**Fig. 2: Proposed feeding system to sugarcane crushing machine**

## V. PROPOSED SUGARCANE FEEDING SYSTEM

The proposed sugarcane feeding system involves developing an automatic sugarcane feeding system as shown in the diagram 2. The base plate or Bed of the system will be required to be loaded with around 20 number of sugarcanes at a time which will be the only manual process required. Once the sugarcane sticks are placed on the bed, the moving plate will start its motion due to simultaneous forward stroke exerted on it by the three hydraulic cylinders. Due to the high impact received from the hydraulic cylinders, the sugarcanes will start getting crushed between the moving plate and the fixed plate. The bed will be in the form of a perforated stainless steel sheet through which the juice extracted due to compression will get collected at the bottom side. The compressed sugarcane will be pushed into the two roller crushing machine where again it will be crushed to extract the juice further.

## VI. ACTUAL FABRICATED SYSTEM



**Fig. 3: In Process fabrication of feeding system to sugarcane crushing machine**

## VII. EXPECTED OUTCOMES

This process reduces human efforts and also it is intended to extract 10-15% more sugarcane juice than the conventional crushing. This sugarcane feeding system increases efficiency & effectiveness of production. Also cost of operation is reduced as no labour is required to feed it. The project expectation is to make it more simple and effective process.

## VIII. CONCLUSION

Non-availability of manpower for feeding of sugarcane in the Jaggery making plants is a major problem for most of the small scale Jaggery makers in the rural India. Also the cost involved with the labour is also very huge. Hence, as this project work is intended to reduce the human efforts and indirectly the labour cost, the success of this project will give a cost effective solution to the small scale Jaggery makers.

#### IV. ACKNOWLEDGEMENTS

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# A CRITICAL REVIEW OF FRICTION STIR WELDING ON METAL MATRIX COMPOSITE

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## **ABSTRACT**

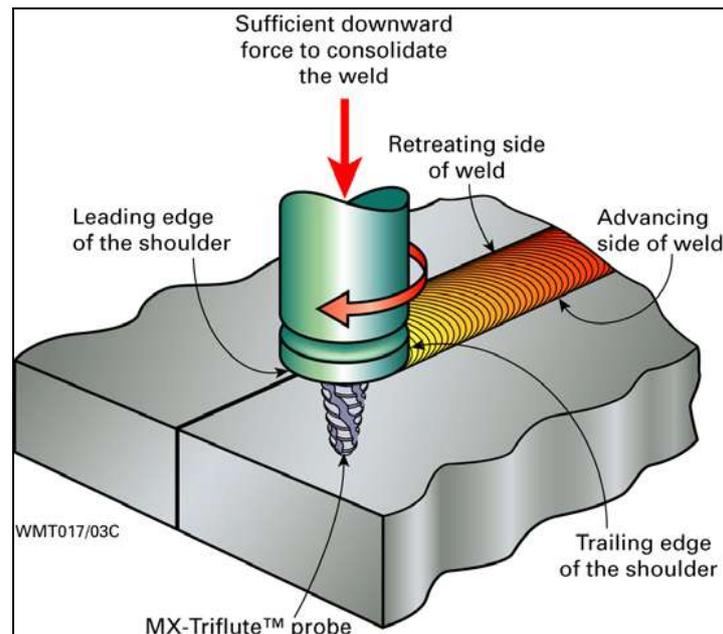
*Friction Stir Welding (FSW) is a novel solid state welding process for joining materials. The process is widely used because it produces sound welds and does not have common problems such as solidification and liquefaction cracking associated with the fusion welding techniques. Metal Matrix Composites have gathered wide acceptance in the fabrication of light weight structures requiring a high strength to weight ratio, temperature resistance and wear resistance. Metal Matrix Composites (MMCs) consist of a metal alloy reinforced with ceramics and have a very high strength to weight ratio, a property which makes them attractive for use in aerospace applications. This review presents a detailed description of the mechanical characteristic and micro structural evaluation as well as tool geometry approaches.*

***Keywords: FSW, Mechanical Behaviour, Microstructure, MMCS, Tool Geometry***

## **I INTRODUCTION**

Friction Stir Welding (FSW) was invented by Wayne Thomas at TWI (The Welding Institute), and the first patent applications were filed in the UK in December 1991. Welding of such relatively strong alloy materials by fusion welding techniques has certain difficulties such as (i) chances for cracking due to wide freezing range, (ii) incipient melting & cracking of eutectic phase at the fusion boundary & (iii) amount of micro-porosity leading to a weaker joint or loss of joint-strength. As a matter of fact, all these problems can be solved by using an innovative method of welding called 'Friction Stir Welding' (FSW). Friction Stir Welding can be used to join different metal sheets like a range of aluminium alloys, magnesium alloys, titanium, copper, stainless steels and nickel alloys plates without filler rod or shielding gas. Material can be welded with thickness of 0.5 to 65mm from one side at full penetration, without any porosity or inner voids [1]. MMCs are dual phase materials which consist of a ceramic reinforcement surrounded in a metal alloy (the matrix). They are classified according to the type of reinforcement such as Silicon Carbide or Aluminium Oxide, but may be in the form of either particulates or fibers. Metal Matrix Composites are beneficial because their very high strength to weight ratio, temperature resistance, wear resistance, and fatigue life [2]. The FSW process takes place in the solid-phase at below the

melting temperatures point of the material, and it does not occurrence problems related to resolidification such as porosity, embrittlement and cracking [3]. FSW is performed by a rotating non-consumable tool which is plunged into the material to be welded until the shoulder touch the top surface of the plate; the tool is then traversed along the joint line to generate a solid phase weld as shown in (Fig. 1). The material around the tool becomes softened and highly plasticised from the frictional heat generated during the process and is passed around the tool so that there is complete mixing of material from the two plates. [4]



**Fig. 1 Principle of the friction stir welding process [8]**

## II EMERGING TREND IN FSW

The FSW process takes place in the solid phase below the melting point of the materials to be welded which are difficult to fusion weld. Other advantages are as follows:

- Low distortion, even in long welds.
- Excellent mechanical properties as proven by fatigue, tensile and bend tests.
- No fume, porosity and spatter.
- Low shrinkage.
- Can be operating in all positions.
- Energy efficient.

The repeatable quality of the solid-phase welds can be improve existing products and go ahead to a number of new product designs previously not possible. The highest welds quality can be achieved by friction stir welding. The crushing, stirring and forging action of the FSW tool produces a weld with a greater microstructure than the parent material [5]. As compared to the conventional welding methods FSW consumes considerably less energy,

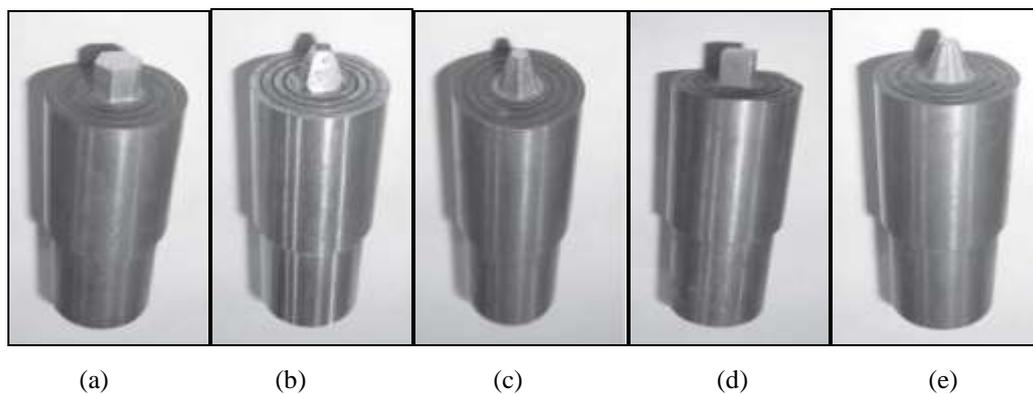
no consumables such as a cover gas or flux, and no harmful radiation are produced during welding. The FSW process is environmentally friendly. In FSW does not requirement of filler metal because there is no melting, any Metal Matrix Composites can be joined without worry for similarity of composition or solidification cracking issues related with fusion welding [6].

### III RELATED STUDIES ON FRICTION STIR WELDING OF METAL MATRIX COMPOSITE (MMC)

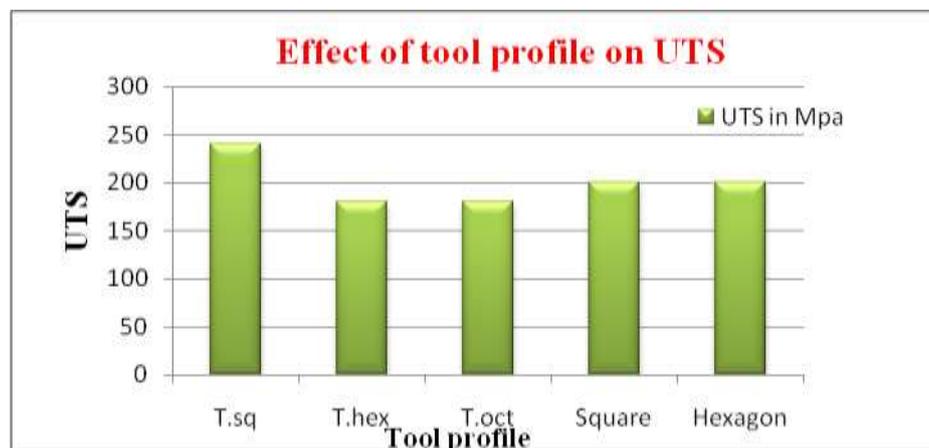
#### 3.1. FSW Tool Geometry for MMC

Tool geometry is a very important factor for producing sound welds .The tool serves two primary functions: (a) heating of work piece, and (b) movement of material to produce the joint. The heating is accomplished by friction between the tool and the work piece and plastic deformation of work piece. [7] Furthermore, B. Ashok Kumar et al. (2014) fabricated FSW tool pin profile without draft from High Carbon High Chromium (HCHCr) steel material with pin diameter 6mm and 5.7mm length with square pin profile. They found that a square profile tool pin gave better joint strength for AA6061-T6/AlNp composite.[9] Mohsen Bahrami et al.(2014) used the friction stir welding tool which was machined out of H13 hot working steel and heat treated to 58HRC and successfully welded a 6 mm thick 7075-O aluminum plate with SiC nano-particles. The tool had threaded taper pin profile, shoulder diameter of 16 mm and pin height of 5.7 mm.[10] P. Vijayavel et al.(2014) used non consumable tool with Plain taper pin profile of 7.2 mm length and 5.5-7.2 diameter and 22mm tool shoulder diameter made of super high-speed steel for joining LM25AA-5% SiC (MMCs) plates (200× 100 ×12 mm).[11] H.R. Akramifard et al.(2014) successfully welded Cu/SiC composite(100 mm ×70 mm × 5 mm)by the Bohler shoulder tool with a cylindrical cone pin shape with 3mm length and 4mm diameter and 16mm shoulder diameter. The tool was tilted 3° from the plate normal direction.[12] Belete Sirahbizu Yigezu et al.(2014) used The FSW tool with a flat cylindrical shoulder with a 7 mm diameter probe of having anticlockwise thread of 1 mm pitch. Tool shoulder diameters were selected as 18 mm, 20 mm and 22 mm to weld for Al + 12%Si/10 wt%TiC in situ composites. They were used flat shoulder tools because they were found that concave shoulder surface did not produce clearly considerable weld.[13] D.R. Ni et al.(2013) successfully welded SiCp/AA2009-T351 by A cermet tool with a concave shoulder 14 mm in diameter and a cylindrical pin 5 mm in diameter and 2.7 mm in length with a triangular tip.[14] Qiang Liu et al.(2013) were used the fixed pin tool with 12 mm in diameter and 7.8 mm in length, The shoulder diameter was 26.8 mm, and a tilt angle of 2° to joining the multi-walled carbon nanotubes (MWCNTs).[15] D. Wang et al.(2013) were joined 6 mm thick plates of 15 vol.% SiCp/2009Al composite by an ultra-hard material tool with a shoulder diameter 20 mm and a cylindrical pin diameter was 8 mm and length 5.8 mm was used.[16] N. Murugan et al.(2013) successfully joined AA6061/AlNp composite butt joint of 100 mm ×100 mm×6 mm size by square pin profile without draft from high carbon high chromium (HCHCr) steel material with shoulder diameter 18 mm and a cylindrical pin diameter was 6 mm and length 5.7 mm was used[17] S. Soleymani et al.(2012) were used a tool made of H-13 steel with a shoulder of 20 mm diameter and a pin of 6 mm length and 2.8 mm height with a tilt angle of 3° for joining Al5083 rolled plates of 3 mm thickness with a nominal composition of 4.3Mg–0.68Mn–

0.15Si-bal.[18] A. Dolatkah et al. (2012) used FSP tool which is made from H13 hot worksteel; heat treated and hardened up to 52 HRC for joined Al5052/SiC metal matrix composite plate. It had square pin profile, shoulder diameter of 18 mm, pin height of 3 mm and excircle diameter of 6 mm shown in fig 5. [19] Mehdi Zohoor et al. (2012) successfully joined AA5083 aluminum alloy with reinforced layers using copper particles by H13 steel tool with shoulder diameter of 16 mm. The tool pin used with pitch height of 1 mm, diameter of 6 mm and with pin height of 3.2 mm. [20] Tool profiles such as taper square, taper hexagon, taper octagon, square, and hexagon as shown in (Fig. 2) are used. Taper square tool profile has more significant effect on tensile strength. The weld joint produced using taper square tool offers maximum joint efficiency as shown in (Fig. 3). [21]



**Fig. 2 Tool pin profiles used in FSW: (a) hexagon, (b) Taper square, (c) Taper hexagon, (d) square, and (e) taper octagon [21]**

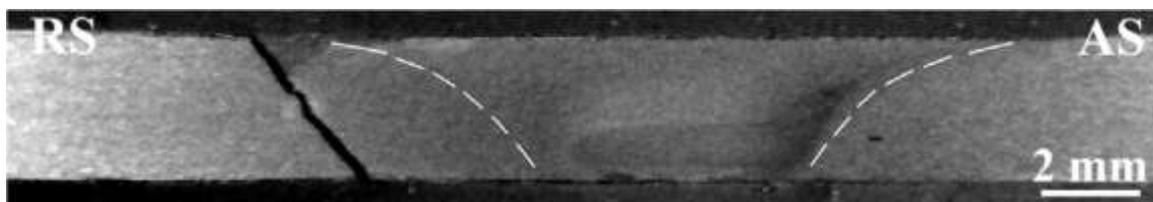


**Fig. 3 UTS of welded joint differ due to different tool pin profiles [21]**

### 3.2. Mechanical Characterization

B. Ashok Kumar et al.(2014) concluded Friction Stir Welding (FSW) is one of the most suitable welding process to weld the Aluminium Matrix Composites (AMCs) unbreakable with particulate form of ceramics without failing its greater mechanical properties.[9] Mohsen Bahrami et al.(2014) found that Due to the presence of SiC nano-particles, ultimate tensile strength (UTS) and percentage of elongation were improved by 31% and

76.1%, respectively at 1250 rpm and 40 mm/min, On the other hand, at 1250 rpm and 40 mm/min, SiC-included specimen showed superior ductility to SiC-free specimen. They also obtained the average hardness of as 7075-O aluminum is 66HV. The fracture morphologies were in good consistency with related ductility results.[10] P. Vijayavel et al.(2014) concluded that at lower D/d ratio, less amount of heat is generated which is not enough for the better material transport on LM25AA-5% SiC (MMCs) plate. At higher D/d ratio, excess amount of heat is generated which leads to unsteady type of material flow which results in the phenomenon of defects in the processed zone. Therefore, optimal heat generation and successive material flow yields the superior tensile strength. [11] H.R. Akramifard et al. (2014) obtained that hardness value in SZ is much superior to BM of Cu/SiC composite surface. In this study Advancing Side (AS) shows a better distribution of SiC particles with compare to Retreating Side (RS). Thus, the hardness of AS is higher than that of RS. They were also concluded that Cu/SiC composite shows higher hardness and better wear behaviour than pure Cu. [12] Belete Sirahbizu Yigezu et al.(2014) investigated that the effect of the FSW process parameters on the micro-hardness of Al + 12%Si/10 wt%TiC composite weld joints that the micro-hardness increases consistently with the increase in tool shoulder diameter. In this study three shoulder diameters (18 mm, 20 mm and 22 mm) were used and found that the tool with 20 mm shoulder produced maximum percentage elongation. [13] D.R. Ni et al. (2013) investigated that the FSW composite joint is higher hardness in all characteristic regions than the FSW 2xxx Al alloy joints, due to the subsistence of the SiCp. The hardness profile of FSW heat-treatable aluminium alloys greatly depends on the sudden distribution and only slightly on the grain and interruption structures. The fracture of the FSW joint occurred in the HAZ on the RS (Fig. 4). [14]



**Fig. 4 Optical micrograph showing failure location of FSW SiCp/AA2009 joint [14]**

Qiang Liu et al. (2013) were concluded that the tensile strength increases with the increasing multi-walled carbon nanotubes (MWCNTs) content in the composite but on the opposite, the elongation decreased. They also found that when 6 vol. % MWCNTs were added then the maximum ultimate tensile strength reached up to 190.2 Mpa, and this value was two times greater than aluminum matrix. [15] D. Wang et al. (2013) achieved the strength of the SiCp/2009Al composite plates joint was only 321 Mpa and Due to the low strength of hot rolled temper the joint was failed in the BM (base metal) zone. So, they were decided T4-treatment on the plates and after T4-treatment the strength of the joint increased up to 521 Mpa. [16] S. Soleymani et al. (2012) found the average hardness of composites increased about 102 HB for SiC sample as the highest. Hybrid composite showed the highest wear resistance amongst all samples. SiC sample with the highest hardness (Fig. 5) developed in the third position of wear resistance after hybrid and MoS<sub>2</sub> samples. [18] A. Dolatkhan et al. (2012) investigated that Micro hardness value of Al5052/SiC metal matrix composite was improved up to 55% and wear rate was reduced about 9.7 times comparing with as-received 5052 aluminum with Addition of reinforcing SiC particles. [19] Mehdi Zohoor et al. (2012) were found that tensile properties of the specimens

with nano-sized Cu particles are significantly increased in comparison with the base metal. They showed that the specimens with micro and nano-sized particles present fine grains and higher level of hardness. [20]



Fig. 5 Weight percent of Fe particles resulted from EDAX analysis of wear debris of samples. [18]

### 3.3 Microstructural Evolution

Based on microstructural characterization of grains and precipitates, three distinct zones, stirred (nugget) zone, thermo-mechanically affected zone (TMAZ), and heat affected zone (HAZ), have been identified as shown in (Fig. 6). The microstructural changes in various zones have significant effect on post weld mechanical properties. Therefore, the microstructural evolution during FSW/FSP has been studied by a number of investigators. [7]



Fig. 6 Cross-sectional macrostructure of FSW SiCp/AA2009 joint [12]

B. Ashok Kumar et al. (2014) found that various defects in AA6061-T6/AlNp composite after the friction stir welding. They were used different process parameters like the tool rotational speed, welding speed and axial force for that macrostructure analysis and they obtained Tunnel defect at  $N = 1000$  rpm,  $S = 55$  mm/min,  $F = 5$  KN, Worm hole at  $N = 1400$  rpm  $S = 55$  mm/min,  $F = 5$  kN. And Piping defect at  $N = 1200$  rpm,  $S = 25$  mm/min,  $F = 5$  kN. After optimize these Fsw parameters using generalized reduced gradient (GRG) method and they were solved these problem at  $N = 1217$  rpm  $S = 51.81$  mm/min and  $F = 5.08$  kN.[9] Mohsen Bahrami et al. (2014) concluded that with increase in traveling speed, resulted in larger grain sizes at 800 rpm. This result suggests the key role of stirring action in controlling the grain size. On the opposite, finer grains are achieved at higher traveling speeds at 1250 rpm. This amount reflects the control of heat input factor to stirring action of the pin. At 1000 rpm, grain size values have not any particular connection with traveling speed. This behavior is recognized to the ability of heat input factor and stirring action of the pin. [10] P. Vijayavel et al.(2014) used five different shoulder diameters to pin diameter (D/d) ratio for processing the composite material for LM25AA-5% SiC (MMCs) and they were studied the macrographs of the processed zone for five different D/d ratios( 2,

2.5, 3, 3.5, 4). They observed that tunnel defect in the retreating side (RS) was present with the D/d ratios of 2, 2.5, 3.5 and 4 and there was no defect found with D/d ratio of 3. [11] H.R. Akramifard et al. (2014) observed SEM micrographs of different regions of Cu/SiC composite they were found that SZ has fine and equiaxed grains and distribution of SiC particles in the matrix is nearly uniform. Intermetallic compound was not produced after FSP. In XRD patterns of SiC powder and Cu/SiC composite, it can be seen that SiC was present in the composite. while the volume fraction of Cu is higher than that of SiC, SiC peaks in Cu/SiC composite appear weak.[12] Belete Sirahbizu Yigezu et al.(2014) were found that the matrix and reinforcements in HAZ and the metal matrix and reinforcement in TMAZ are presented in Al + 12Si/10 wt%TiC in situ composite. They have been also observed that uniformly distributed refined in situ reinforcements in the grain refined metal matrix in the weld nugget zone. [13] D.R. Ni et al. (2013) found that the shape of nugget zone or dynamically recrystallized zone (DXZ) in SiCp/AA2009-T351 is exhibited essentially a basin shape (Fig. 2) and also studied that there are no onion rings, which are the classic feature observed in the NZ of FSW aluminium alloys, were detected in the NZ of the present FSW composite. In the SEM microstructures they were found that in the BM, SiC particles showed a polygonal morphology and were equivalently distributed in the matrix with the long axis similar to the rolling direction [14] Qiang Liu et al.(2013) have been taken the sample of 4.4 vol.% MWCNTs(multi-walled carbon nanotubes) for macrostructure analysis and they were examined four different regions like unaffected base metal (BM), friction stir zone (FSZ), shoulder deformation Zone (SDZ), and thermo-mechanically affected zone (TMAZ).they were found that the grain size of the FSZ is much better-quality than the BM. In the FSZ, grains are produced uniform and superior equiaxed, which is qualified to the dynamic recrystallization of highly deformed grains during process. [15] D. Wang et al. (2013) examined the macrograph of the FSW SiCp/2009Al composite plate and they found that No defects presented in the joint. they were also studied the OM microstructure and found that The SiC particles were uniformly distributed on the cross section perpendicular to the rolling direction.[16] S. Soleymani et al.(2012) were carried out the microstructure of base metal specimen and they found the mean grain size of material is 45  $\mu\text{m}$ . After performing the FSP the evaluation shows that the mean grain size has been decreased to about 16  $\mu\text{m}$ . SEM micrograph shows the surface composite layer appears to be very well bonded to the Al alloy substrate without any void formation. [18]A. Dolatkah et al. (2012) were examined stirred zone and they found that during friction stir processing, extreme rise of temperature and Sever plastic deformation leads to formation of a fine equiaxed in microstructure. Best results were gained with nano-sized SiC powder. [19] Mehdi Zohoor et al. (2012) studied the macrographs of Al–Mg/Cu composites and indicated that the basin-shaped nugget zone was generated in tool rotation rate of 750 rpm, whereas at tool rotation rate of 1900 rpm elliptical nugget zone was obtained. They also conclude that Shape of the SZ depends on the processing parameters, tool geometry, workpiece temperature and thermal conductivity of the material. [20]

#### IV APPLICATIONS

Current markets for MMCs are primarily in military and aerospace applications. Experimental MMC components have been developed for use in aircraft, satellites, jet engines, missiles, and the National Aeronautics and Space Administration (NASA) space shuttle. The first production application of a particulate-

reinforced MMC in the United States is a set of covers for a missile guidance system. The most important commercial application to date is the MMC diesel engine piston made by Toyota. This composite piston offers better wear resistance and high-temperature strength than the cast iron piston it replaced. The first successful application of continuous-fiber reinforced MMC has been the application of BORON/Al tubular struts used as the frame and rib truss members in the mid-fuselage section, and as the landing gear drag link of the Space Shuttle Orbiter (Fig. 7).[22]



**Fig. 7 Mid-fuselage structure of Space Shuttle Orbiter showing boron-aluminum tubes (Photo courtesy of U.S. Air Force/NASA) [22]**

## V CONCLUSION

FSW process is an eco-friendly solid state joining technique and consumes considerably less energy; no consumables such as a cover gas or flux, and no harmful radiation are produced during welding compared to the conventional welding techniques. The properties of MMCs like strength, fatigue life and wear resistance represent a significant improvement over both Magnesium and unreinforced Aluminum alloys. Welding parameters, including tool rotation rate, traverse speed and tool geometry are most influence factor to produce sound and defect-free weld. Furthermore, effect of shoulder diameters to pin diameter ( $D/d$ ) ratio is important parameter for processing the composite material. The less amount of heat is generated with lower  $D/d$  ratio which is insufficient for the better material transport. Whereas, the excess amount of heat is generated with higher  $D/d$  ratio which results in the occurrence of defects in the processed zone. Thus the optimal  $D/d$  ratio is identified as the better tool dimensions which yielded defect free microstructure in FSP region and yielded a maximum tensile strength.

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# CLUSTER FORMATION ALGORITHM FOR LIFE TIME MAXIMIZATION IN HETEROGENEOUS WIRELESS SENSOR NETWORKS

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## **ABSTRACT**

*Typically, a wireless sensor network (WSN) is a new technology about acquiring and processing information from environment. Wireless sensor network contains an important number of inexpensive power constrained sensors, which collect data from the environment and transmit them towards the base station. Sensor networks have limited and non-rechargeable energy resources. Saving energy and therefore, extending the wireless sensor networks lifetime, imposes a great challenge. The clustering technique is a kind of key technique used to reduce energy consumption. Many clustering protocols had designed for the characteristic of heterogeneous wireless sensor networks. In this paper we propose energy efficient cluster formation algorithm for heterogeneous wireless sensor network. Our technique differs from DEEC protocol in cluster formation phase. In our technique the member node join that cluster head which has minimum distance between member node to cluster head and minimum distance between cluster head to base station. Simulation result shows that our technique will increase the network lifetime around 25% and number of packet sent up to 10%.*

***Index Terms: Base Station, Clustering, Heterogeneous Wireless Sensor Network.***

## **I. INTRODUCTION**

Sensor nodes are often left unattended e.g., in unapproachable environments, which makes it difficult or impossible to re-charge or replace their batteries. This necessitates devising novel energy-efficient solutions to some of the conventional wireless networking problems, such as medium access control, routing, self-organization, so as to prolong the network lifetime. Since, sensor nodes are power-constrained devices, frequent and long-distance transmissions should be kept to minimum in order to prolong the network lifetime [1], [2]. Thus, direct communications between nodes and the base station are not encouraged. One effective approach is to divide the network into several clusters, each electing one node as its cluster head [3]. The cluster head (CH) collects data from sensors in the cluster which will be fused and transmitted to the base station. Thus, only some nodes are required to transmit data over a long distance and the rest of the nodes will need to do only short-distance transmission. Then, more energy is saved and overall network lifetime can thus be prolonged.

Adaptive Clustering can be done in two types of networks, homogeneous and heterogeneous networks on the basis of energy. Homogeneous are those in which nodes have same in terms of initial energy, memory and link. While heterogeneous networks are those in which nodes have different initial energy, memory and link. In this paper the discussion is to be done only energy heterogeneity. Many Clustering algorithms have been proposed for homogeneous wireless sensor networks such as LEACH [3], PEGASIS [7], and HEED [6] which does not perform well in heterogeneous networks. SEP [9] uses two types of nodes normal and advanced nodes. Advanced nodes have more energy than normal ones. It prolongs the stability period of the network lifetime. The main problem in SEP is that it does not fit for networks having more than two types of energy.

DEEC [11] is clustering-based algorithm in which cluster head is selected on the basis of probability of ratio of residual energy and average energy of the network. In this algorithm, node having more energy has more chances to be a cluster head. It prolongs the lifetime of the network. Our proposed protocol follows the same concept of DEEC but differ in cluster formation phase in our protocol clusters are form on the criteria of cluster head distance to base station and node distance to cluster head. Simulation result shows that our protocol improves the performance of network.

## II RELATED WORK

For homogeneous wireless sensor networks Heinzelman, et. al. [3] introduced a hierarchical clustering algorithm for sensor networks, called Low Energy Adaptive Clustering Hierarchy (LEACH). LEACH is a cluster-based protocol, which includes distributed cluster formation. LEACH randomly selects a few sensor nodes as cluster heads (CHs) and rotates this role to evenly distribute the energy load among the sensors in the network [3]. PEGASIS [7] is a chain based protocol which avoids cluster formation and uses only one node in a chain to transmit to the BS instead of using multiple nodes. PEGASIS and LEACH are designed for homogeneous Wireless Sensor Networks. In homogeneous WSN, all nodes are same type. But in heterogeneous WSN includes different types of sensor nodes. When we apply LEACH or PEGASIS to heterogeneous WSN, they not perform well. Because in heterogeneous WSN nodes having different type of energy so low energy node will die more quickly.

SEP [9] uses two types of nodes normal and advanced nodes. Advanced nodes have more energy than normal ones. It prolongs the stability period of the network. SEP performs poorly in multi-level heterogeneous networks and when heterogeneity is a result of operation of the sensor network

To improve the SEP performance, the DEEC (Distributed Energy-Efficient Clustering)[11] algorithm was designed for multi level heterogeneous WSN. In DEEC cluster head is selected on the basis of probability of ratio of residual energy and average energy of the network.

Our Energy Efficient cluster formation algorithm scheme is based on DEEC. The difference between DEEC and our protocol is mainly in cluster formation phase in our protocol the member node join that cluster head which has minimum distance from member node and minimum distance from base station

### III Energy Efficient Cluster formation Algorithm

Our algorithm is based on DEEC scheme, where all nodes use the initial and residual energy level to define the cluster heads. To avoid that each node needs to have the global knowledge of the networks, DEEC and MDEEC estimate the ideal value of network lifetime, which is use to compute the reference energy that each node should expend during each round.

#### 3.1 Network model

In this section, we consider a network with  $N$  nodes, which are uniformly dispersed within an  $M \times M$  square region. The node always has data to transmit to a base station, which is often far from the sensing area. The network is organized into a clustering hierarchy and the cluster-heads (CHs) do aggregation function to reduce correlated data produced by the sensor nodes within the clusters. The cluster-heads transmit the aggregated data to the base station directly. To avoid the frequent change of the topology, we assume that the nodes are micro mobile or stationary.

We consider the multi-level heterogeneous networks for our protocol operation. In multi-level heterogeneous networks; initial energy of sensor nodes is randomly distributed over the close set  $[E_0, E_0(1+a_{\max})]$ , where  $E_0$  the lower bound is and  $a_{\max}$  determines the value of the maximal energy. Initially, the node  $n_i$  is equipped with initial energy of  $E_0(1+a_i)$  which is  $a_i$  times more energy than the lower bound  $E_0$ . The total initial energy of the multi-level heterogeneous networks is given by:

$$E_{total} = \sum_{i=1}^N E_0(1+a_i) = E_0(N + \sum_{i=1}^N a_i) \quad (1)$$

#### 3.2 Radio Model

We use similar energy model and analysis as proposed in [3]. According to the radio energy dissipation model [3] in order to achieve an acceptable Signal-to-Noise Ratio (SNR) in transmitting an  $l$ -bit message over a distance  $d$ , the energy expended by the radio is given by:

$$E_{tx}(l, d) = \begin{cases} l * E_{elec} + l * E_{fs} * d^2 & \text{if } (d < d_0) \\ l * E_{elec} + l * E_{mp} * d^4 & \text{if } (d \geq d_0) \end{cases} \quad (2)$$

$E_{elec}$  is the energy dissipated per bit to run the transmitter circuit. Here both the free space ( $d^2$  power loss) and the multipath fading ( $d^4$  power loss) channel models were used, depending on the distance between the transmitter and receiver  $d_0$ . is given by following formula.

$$d_0 = \frac{E_{fs}}{E_{mp}} \quad (3)$$

Energy spend in receiver circuit is given by

$$E_{rx} = E_{elec} * l \quad (4)$$

### 3.3 Cluster Head Selection Method

Our protocol uses the initial and residual energy level of the nodes to select the cluster-heads same as DEEC. To avoid that each node needs to know the global knowledge of the networks, our algorithm estimates the ideal value of network life-time, which is use to compute the reference energy that each node should expend during a round. the probability of cluster head selection for normal mode and advance mode is as follows.

$$P_{normal}(i) = \left\{ \frac{P_{opt}}{1 + \alpha * m} \frac{E_i(r)}{E(r)} * \frac{\overline{D_{BS}}}{D_{BSi}} \right.$$

$$P_{advance}(i) = \left\{ \frac{P_{opt}}{1 + \alpha * m} (1 + \alpha) \frac{E_i(r)}{E(r)} * \frac{\overline{D_{BS}}}{D_{BSi}} \right. \quad (5)$$

$$\overline{D_{BS}} = \frac{1}{N} \sum_{i=1}^N D_{BSi}$$

This means that the nodes with more energy will have more chances to be the cluster-heads than the nodes with less energy. Thus the energy of network is well distributed in the evolving process.

Threshold for cluster head selection in our protocol calculated as:

$$T(S_{nm}) = \begin{cases} \frac{p_{nm}(i)}{1 - p_{nm}(i) * r \bmod \frac{1}{p_{nm}(i)}} & \text{if } S_{nm} \in (G') \\ 0 & \text{otherwise} \end{cases} \quad (6)$$

$$T(S_{adv}) = \begin{cases} \frac{P_{adv}(i)}{1 - p_{adv}(i) * r \bmod \frac{1}{P_{adv}(i)}} & \text{if } S_{adv} \in (G^n) \\ 0 & \text{otherwise} \end{cases}$$

Our technique implements the same strategy for estimating the average energy in the network as proposed in DEEC [6]. Since the probabilities calculated depend on the average energy of the network at round  $r$ , hence this is to be calculated. This average energy is estimated as

$$\bar{E}(r) = \frac{1}{N} E_{total} \left(1 - \frac{r}{R}\right) \quad (7)$$

Where  $R$  denotes the total rounds of the network lifetime can be calculated as:

$$R = \frac{E_{total}}{E_{round}} \quad (8)$$

$E_{round}$  is the energy dissipated in the network in a round.

The total energy dissipated  $E_{round}$  is given by

$$E_{total} = l(2NE_{elec} + NE_{DA} + kE_{mp}d_{toBS}^4 + NE_{fs}d_{toCH}^2) \quad (9)$$

Where  $k$  is the number of clusters,  $N$  nodes are distributed uniformly in an  $M \times M$  region  $E_{DA}$  is the data aggregation cost expended in the cluster-heads.  $d_{toCH}$  is the average distance between the cluster members and the cluster-head.  $d_{toBS}$  is the average distance between the cluster-head and the base station.

$$d_{toCH} = \frac{M}{\sqrt{2\Pi k}}, \quad d_{toBS} = 0.765 \frac{M}{2} \quad (11)$$

By calculating the derivative of with respect  $E_{total}$  to  $k$  to zero we get optimal number of clusters as

$$k_{opt} = \frac{\sqrt{N}}{\sqrt{2\Pi}} \sqrt{\frac{E_{fs}}{E_{mp}}} \frac{M}{d_{toBS}^2} \quad (12)$$

Thus we can compute the lifetime R substituting these equations.

### 3.4 Cluster formation method

After election of cluster head, each HEAD node broadcasts the HEAD\_AD\_MSG across the network, this message consists head ID and energy of that cluster head. All normal nodes receive that message and calculate the cost function according to following formula

$$Cost = E_j * (1 / D_{ij})$$

## IV RESULT AND DISCUSSION

We evaluate the performance of our proposed protocol and DEEC protocol using MATLAB. Both methods simulated in multi level heterogeneous network. The basic simulation parameters for our model are mentioned in Table 1. The environment consists of 100 nodes; randomly deployed a field with dimensions 100×100. The sink is located at position. The energy of each node is distributed between  $[E_0 \ 2E_0]$  where  $E_0 = 0.5$

In WSNs, there are a lot of parameters to evaluate a clustering algorithm. In this paper, the number of nodes alive and number of data packet sent is chosen to compare the performance of our algorithm with DEEC. Without considering other external factors, if a node's energy is less than zero, we define it as a dead node.

Fig.1 Shows the results of the case with  $m = 0.1$  and  $a = 2$ , and It is obvious that the stable time proposed method is prolonged compared to that of SEP and LEACH. Because in our proposed method the node which have more residual energy and less distance to base station have more chances to become cluster head. And normal node joins that cluster head which has more energy and less distance to base station. The performance of SEP protocol is better than LEACH because in SEP protocol advance node becomes cluster head more frequently. We also observe that the first node die of LEACH when  $m=0$  and  $a=0$  and LEACH  $m=0.1$  and  $a=2$  almost same time this shows that LEACH cannot able to take advantage of heterogeneity. The reason of this is in LEACH the cluster head election is random so normal node die more frequently and advance node dies very slowly member join to cluster having minimum distance between member node to cluster head and distance between cluster head to base station distribute the load, so that makes network clustering more reasonable, saves energy, effectively prolongs the life cycle of the entire network.

Fig. 2 Figure 5.4 shows that rounds first node dead and half node dead of our protocol, LEACH and SEP. We see that the first node dead in our protocol is 1443 rounds is highest. Means in our protocol the network is full connected till 1443 rounds..SEP has FND at 1171 which is greater than LEACH. Because in SEP the cluster head election probability is according to initial energy of nodes. Thus advance nodes become cluster head more number of times than normal nodes. the FND of LEACH with  $m=0$  and  $a=2$  is almost same because in LEACH there is no criteria that advance node becomes cluster head frequently in LEACH the cluster head election is random. So LEACH cannot take advantage of energy heterogeneity

Similarly the half node dead (HND) of our protocol is 1539 which is greater than LEACH and SEP. SEP has HND at

1373 which is greater than LEACH. LEACH  $m=0, a=0$  and LEACH  $m=0.1, a=2$  has almost same HND at 1158 and 1192

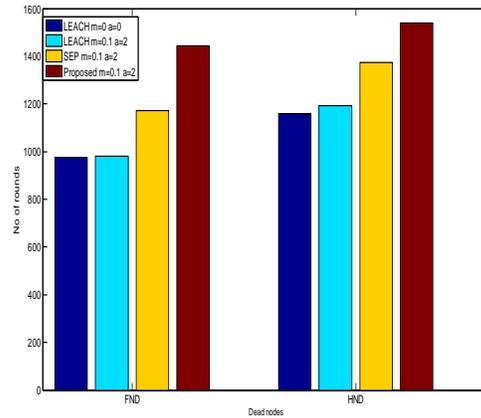
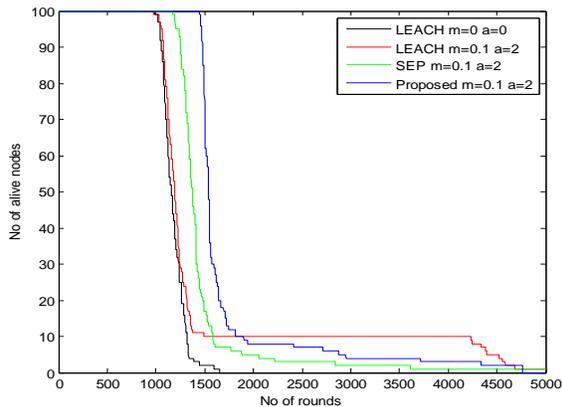


Fig.1 number of node alive vs. number of rounds. (m=0.1)

Fig.2 FND and HND when m=0.1

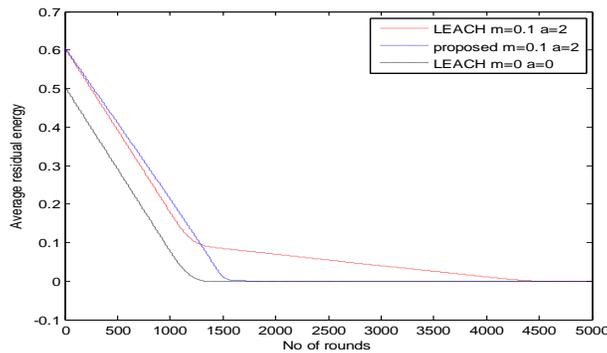


Fig.3 Average residual energy in LEACH and proposed when m=0.1

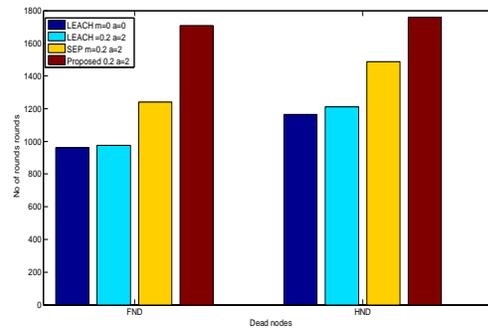
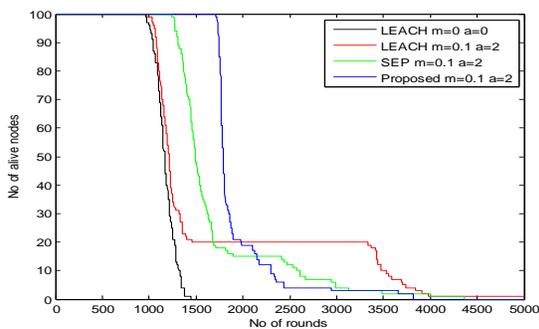
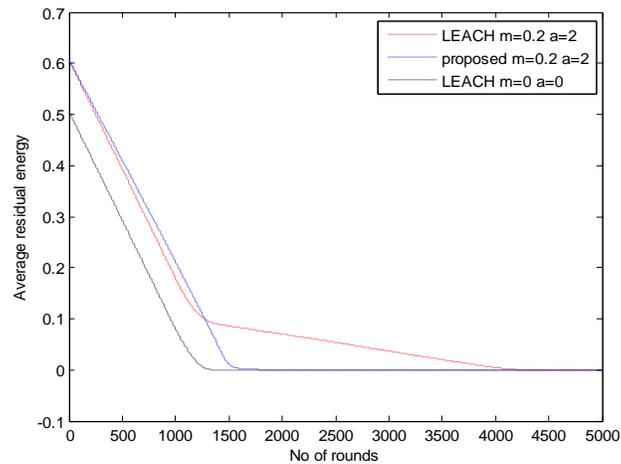


Fig.4 Alive nodes vs. rounds when m=0.2

Fig. 5 FND and HND of LEACH, SEP and proposed method when m=0.2



**Fig.6 Average residual energy in LEACH and proposed method when m=0.2**

Fig.3 shows the average residual energy comparison of LEACH and proposed protocol when  $m=0.1$  and  $a=2$ .simulation result shows that our proposed method has more average residual energy at stable region as comparison to LEACH. Fig.4 shows the results of the case with  $m = 0.2$  and  $a = 2$ , and It is obvious that the stable time (the first node die) in proposed method is prolonged compared to that of SEP and LEACH. Fig. 5 shows that rounds first node dead and half node dead of our protocol, LEACH and SEP. when  $m = 0.2$  and  $a = 2$ . Fig.6 shows the average residual energy comparison of LEACH and proposed protocol when  $m=0.2$  and  $a=2$ .simulation result shows that our proposed method has more average residual energy at stable region as comparison to LEACH

**TABLE 1**  
**PARAMETERS VALUE**

parameter	Value
Network Field	(100,100)
Base Station location	(50,200)
n (No of sensor node)	100
p	0.1
$E_{fs}$	10nJ/bit/m <sup>2</sup>
$E_{mp}$	0.013 pJ/bit/m <sup>4</sup>
$E_{elec}$	50nJ/bit
$E_{DA}$ (Data aggregation energy)	5nJ/bit/signal
W	0.8

## V CONCLUSIONS

In this paper, the modified method for lifetime maximization for heterogeneous WSNs is proposed. In the proposed method every node select itself as a cluster head based on initial energy, residual energy and distance to base station. The epochs of being cluster-heads for nodes are different according to their initial and residual energy and distance to base station. Means nodes which have more residual energy and less distance to base station has more chances to become cluster head.

Also in our proposed scheme the cluster formation takes place using a cost function. That cost function includes energy of cluster head and distance from normal node to cluster heads. Means normal node joins that cluster head which has more energy and less distance.

The simulation result shows that in our proposed schemes the round when first node die is more that region is known as stable region. In the proposed scheme the network is full connected more number of rounds than LEACH and SEP. And the average residual energy is more in our proposed scheme.

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# REQUEST ROUTING MECHANISM FOR SIMILARITY SERVICE BASED CLUSTER WEB SERVERS

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## ABSTRACT

*Because of the busy work schedule most of the people are not getting the time to do simple personal works like phone recharging, paying bills, shopping etc. So they are depending on the internet services. These days a huge number of services are available on internet. Only the thing that if the services are popular then hit rate on that service increases that causes declining quality of service on internet. To improve the quality of services, we are proposing a content based request routing and load balancing.*

**Keywords:** *Clusters ,Web Servers, Service Wise Request Routing*

## I INTRODUCTION

We are all huge consumers of various services the internet supports. Web Servers have gained an immense popularity these days due to its nature to cater huge number of user requests were any number of users can get service from web based applications. As it comes with global accessibility, servers hosting popular website tends to get massive load which deteriorates its efficiency to provide quality service[11]. Imagine a situation where you are accessing your bank account to transfer funds to a friend's account for an emergency. And the site simply says, ' Sorry, the service is unavailable!'. As end users, we would hate to be in this situation. That you get to call the customer service. This despite having invested in a cluster for a reliable service!

Most businesses happen over the Internet and Enterprises prefer clusters for the reliable services. Critical servers and applications such as database servers, exchange servers etc are hosted in clustered environment for high availability. Further, load balancers are plugged into the network to distribute the load on servers to address the primary need of un-interrupted availability at all times[8]. There are three essential principles driving cluster & load balancing today:

- Send data as efficiently as possible
- Send data as infrequently as possible
- Send as little data as possible

Clustering allows us to run an application on several parallel servers . The load is distributed across different servers, and even if any of the servers fails, the application is still accessible via other cluster nodes. Clustering is crucial for scalable enterprise applications, as you can improve performance by simply adding more nodes to the cluster. Clustering solutions usually provide Scalability, High Availability & Load Balancing.

Cluster has two types of Failovers: Firstly Request Level Failover in which If one of the servers in the cluster goes down, all requests should get redirected to the remaining servers in the cluster. Secondly Session Level Failover in which if one of the servers in the cluster goes down, then some other server in the cluster should be able to carry on with the sessions that were being handled by it, with minimal loss of continuity.

The objective of load balancing that it should distribute the load among the servers in the cluster to provide the best possible response time to the end user. Here we are focusing to perform load balancing based on the content type of service request.

The paper includes following sections of information: Section II provides Related work, Section III: provides Request Routing section IV Experimental Results & Section V conclusion

## II RELATED WORK

While content-aware distribution getting more popular in cluster-based web systems. Most of the researchers using different techniques on clusters to improve the service accessibility. Zhiyong Xu et al[1], propose a novel and efficient content-aware dispatching algorithm. Their approach eliminates the potential bottleneck and the single point of failure problems completely by using totally decentralized P2P architecture. It is scalable, increases throughput linearly with the increased number of servers and it does not introduce heavy communication overhead among back-end servers.

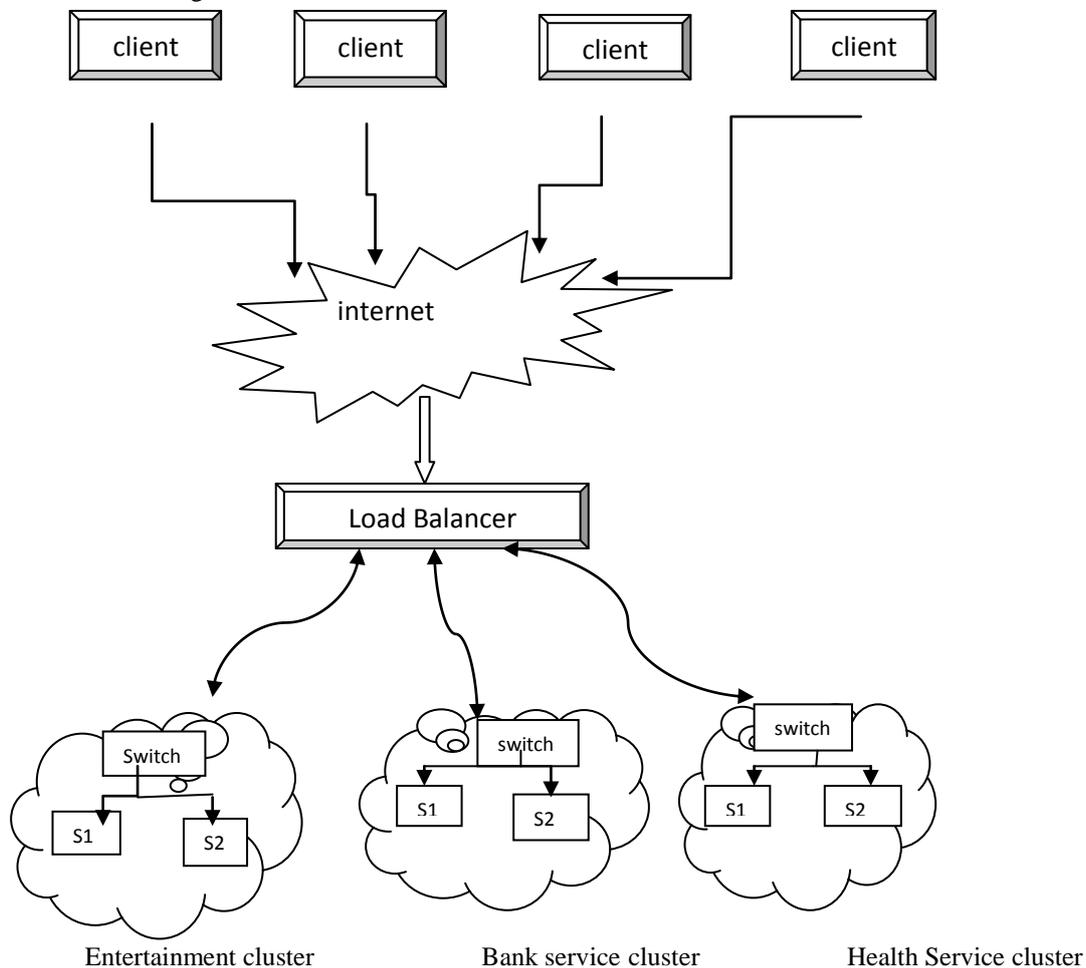
- DU Zeng-Kui et.al[2] they proposed a architecture with dispatching policy named DWARD to achieve scalable server performance. With DWARD, all the server nodes participate in request dispatching on the basis of local access pattern. They developed this policy using HASH function on homogeneous servers. They implemented the test on linux kernel and compare the results with WARD and LARD algorithms. The performance results shows that this method achieves good throughput.
- YunFeng Li, et al[3], considering heterogeneity server performance the authors propose a novel scheduling algorithm for Web switch operating at layer-7 of the OSI protocol stack. A scheduling policy classifies the requests according to their contents on Web servers and estimate the load state of each server. Using a L7 scheduling algorithm, allow the switcher to select randomly two servers from the server pool and calculating the load of the two servers, the request will be dispatched to the lowly loaded server. This method improves the performance but there is a difficulty in classifying the client requests.
- Chun-Wei Tseng,et.al,[4] the authors propose a mechanism that can effectively shield off the effect of code 304 in the server cluster. these authors used two-level dispatching scheme to cooperate for distributing requests. In this method they place a *workload divider* in front of the two clusters to map different clients to different distributors. Implement the algorithms such that it evenly divide the workload to the two clusters. Workload divider can preserve the possible reference locality in the user session because they divide workload on a per client basis. But the time consumption to carry out this method is more.

### III SERVICE WISE REQUEST ROUTING

An explosion in the number and variety of devices is dramatically changing the world of internet computing. Recently With the increasing availability of the internet on a wide range of these devices the web is emerging as the proffered data delivery mechanism for a number of application scenarios.

There is a rapid movement towards the use of powerful processors. These processors have constraints on the available Processing Power, Network and Storage. Such constraints affect the quality of services on web for the end users. Accessing the services through the cellular network is limited upto 19.2 KB/Secs. The processing capacity of the system varies based on their configurations and memory capacity. These constraints failure to provide effective service expectations to the user.

Cluster based web server system becomes one of the most prevailing mechanisms to satisfy this need. As shown in the figure below



**Fig 1: Proposed Cluster Architecture**

The cluster are formed based on their services using a mathematical model based on Random walk algorithms concepts. Distribution of the users requests over a group of servers is a strategy to achieve scalability. A HTTP is a stateless protocol, So each request may be directed to any host in a distributed server cluster. This may creates un accessibility of service from the servers.

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So we are proposing the service based request dispatching method using mapping table . The load balancer mapping table contains the IP address of the cluster heads , type of service and load state of a cluster . The IP address of the Cluster Head is given by DNS server connected to an Load balancer.

Load of each server  $LS_i = \text{Cpu load} + \text{mem load} + \text{bandwidth usage}$

Average Load on cluster  $L_{avg} = \sum_{i=1}^n LS_i / M$  where  $M =$  number of servers present in an

cluster. we are consider two load states

$L_n < \text{Underload} * L_{avg} =$  underload

$L_n > \text{Upperload} * L_{avg} =$  overload

Load on the servers are identified using following algorithm

```

if(matching(request type)=True) then
{
For (j=1; j<m; j++)
For( i=1; i<n; i++)
If ( cj.si= underloaded)
Allocate the request to si
Elseif(cj.s1 = overloaded)
Search another server in cluster j
}
If( all servers in cj are overloaded) then
Find another nearest cluster providing the same type of service
Allocate request to that cluster
}

```

The request can be dispatched in an two methods :Non Content approach and Content-aware approach.

In an non content based method , the load balancer randomly dispatches the request to one of the cluster server but in case of content based method the requests are dispatched based on request category. We are using content aware request serving concept.

## IV RESULT

To carry out the proposed work we setup a Hardware and Software configurations as stated below.

### Hardware Configuration:

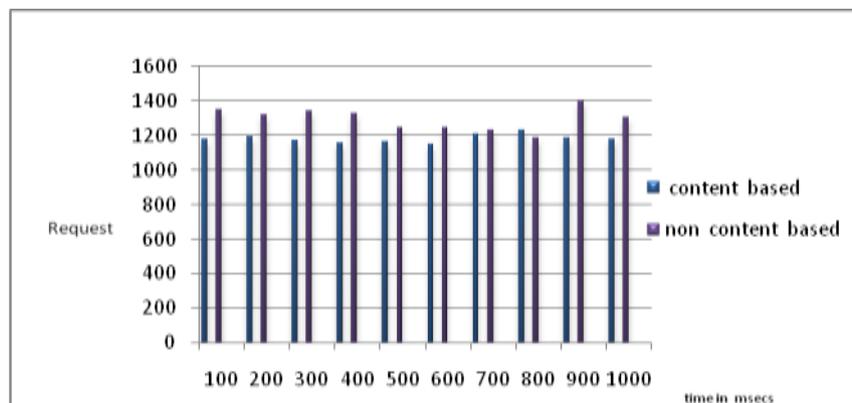
We formed cluster with minimum two Pentium processors ranging from 1GHZ to 2 GHZ with minimum of 512Mb &DDR RAM. Also used different machines with variable processor speeds are as clients.

### Software Configuration:

All the system in the cluster runs windows xp 2007 operating system; we developed experimental test on our proposed model using Jmeter. Jmeter generates load on cluster servers. We vary the loads on the cluster by

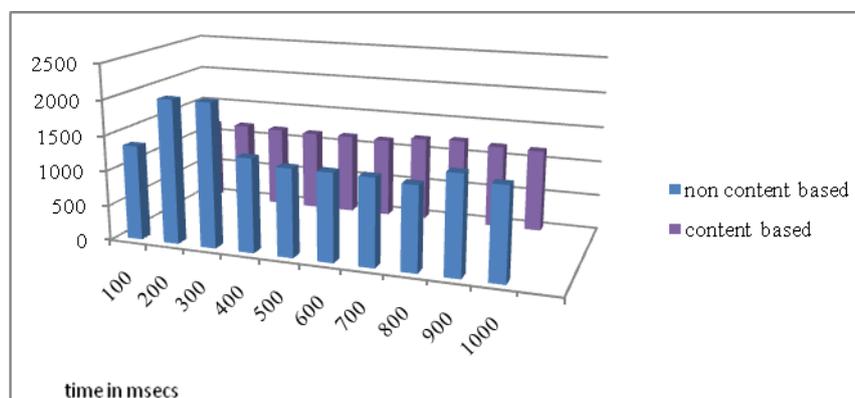
varying the number of concurrent clients. The performance of our work is measured using response time , latency and throughput calculations. We compare our results with non content based concepts.

The following figure 2 indicates the response time of content based and non content based, in which content based method reduces the response time by 7.9 msec compare to non content based method.



**Fig2: Response Time Comparison**

Below figure 3 shows latency comparison where it is shown that the non content based system servers only less number of requests per minute compare to the content based system. From this we may say that 12.4% of improvement from content based .



**Fig3: Latency Comparison**

The following table 1 provides comparative values obtained between the content and non content based methods

Table 1: comparisons between content & non content request routing

Parameters	Content Based	Non Content Based
Number of Requests	9461	9461
Response time	1117ms	1186ms
Latency	1172ms	1296ms
Throughput	3.9ms	2.3ms
utilization	1.30ms	1.04ms

## V CONCLUSION

Web technology which has a very vast potential and is still unexplored. The capabilities of web computing are endless. One of the major issue of web service is load balancing because overloading of a system may lead to poor performance which can make the technology unsuccessful. The increase in web traffic and different services are increasing day by day making load balancing a big research topic. So there is always a requirement of efficient load balancing algorithm for efficient utilization of resources.

In our work the workload is distributed among various other nodes of clustered servers based on content of a request, it improve both resource utilization and job response time. Experimental results suggest that our proposed algorithm can balance the load of web server clusters effectively, make full use of the existing source of software and hardware, highly improve the server's performance, and even make the best use of the web server.

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# COMPARATIVE STUDY BETWEEN DISTRIBUTED AND COLLOCATED TEAMS IN AGILE SOFTWARE DEVELOPMENT

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## ABSTRACT

*The internet world is changing rapidly which has led to the change in the Software Development models. Many SDLC models have been developed like Waterfall Model, Build and Fix Model, Iterative Enhancement Model, Rapid Application Development Model, Evolutionary Process Models but no model is able to satisfy the customers by delivering 100% error free, client satisfactory product. This has led to the development of Agile software methodologies for software development.*

*The meaning of the term Agile is: “**Quick and Well Coordinated in Movement**”. Mostly widely used Agile Methodologies are: Extreme Programming, Scrum , Dynamic System Development Method (DSDM), Adaptive Software Development (ASD).*

*Software development has now become multi-site, multicultural, globally distributed undertaking. More number of organizations are distributing their software development process worldwide to achieve higher profits, productivity, quality and lower cost. This change has profound impact not only on marketing and distribution but also on the way products are conceived, designed, constructed, tested and delivered to customers.*

*Out of the 12 principles of Agile Manifesto, one of the main principles is: “Collocation of team members”. i.e all the team members working on a project should be at the same location. But today many companies have adopted Agile Methodology with their teams distributed in various areas.*

*Collocation of team has positive impact on factors like feedback, performance targets, trust, team identity, conflict management, goal, fun etc, but it has negative impact on factors such as morale, no privacy, lot of noise.*

*Distributed teams face problems in terms of time zones and working hours, cultural and language differences, availability and access to tools, file sharing etc. But these problems can be solved using document management tools, Use of teleconference, videoconferencing facility, Establish centralized wikis and discussion forums*

*This research paper will do a comparison between collocated teams and distributed teams and find the advantages and disadvantages of both and try to find out which one is better.*

***Keywords: Agile manifesto, Agile methodologies, Agile software development, Collocation of teams, Distributed Software Development***

## **1. INTRODUCTION**

The development of any software for example: Railway Reservation System, Online Banking System etc. is referred to as Software Development. There are many types of software applications that can be grouped in eight areas: System Software, Real time software, Embedded Software, Business Software, Personal Computer Software, Artificial Intelligence Software, Web Based Software, Engineering and Scientific Software.[1,2]

Many steps are involved in the development of any software. Various models have been developed for producing good quality maintainable software within reasonable time frame and at affordable price. Some of these models are: Waterfall Model, Build and Fix Model, Iterative Enhancement Model, Rapid Application Development Model, Evolutionary Process Models etc.[1,2]

Instead of the development of so many software models, we cannot find any software to be 100% error free, 100% qualitative, 100% customer satisfactory. To overcome all these problems, *Agile Software Development* came into picture.

Out of the 12 principles introduced in Agile Manifesto, one principle is, “The teams should be collocated.” That is: All the members of a team should develop a project by working at the same place. But today we can see through previous research that Software development has now become multi-site, multicultural, globally distributed undertaking. More number of organizations are distributing their software development process worldwide to achieve higher profits, productivity, quality and lower cost. This change has profound impact not only on marketing and distribution but also on the way products are conceived, designed, constructed, tested and delivered to customers.

Both agile and distributed software developments (GSD) are growing trends as software business requires quicker quality production at a cheaper price. Distributed development is a fact of life for many agile teams. Most of the Agile methodologies (e.g. SCRUM) assume that the team is located in a single room. Unfortunately this principle does not fit in the real scenario where agile teams are also distributed across the globe. *Factors like expanding business to new markets, creating high quality employee pool, reduced costs through outsourcing to regions with cheaper development overheads are the main driving forces for organizations opting for distributed development.*

The purpose of this research project is to make a comparison between both the approaches of Agile Software Development – collocated and distributed and try to analyze which approach is better.

The remainder of the paper is organized as follows. Section 2 gives a brief background and summarizes related work. Section 3 discusses the research methodology and explains different steps of conducting this systematic review. The results of the study are presented in Section 4, and discussion and observations around them are provided in Section 5. Finally, conclusions and future research directions are presented in Section 6.

## II BACKGROUND AND RELATED WORK

In February 2001, 17 software developers met at the Snowbird, Utah resort, to discuss lightweight development methods. They published the *Manifesto for Agile Software Development* to define the approach now known as agile software development. It provides us with the better ways of developing the software.

The way a team works together is much more important than any other process. While a new process can only improve productivity by a fraction, however if a team works effectively as a cohesive unit, it can improve productivity by several times. The key features of agile software development are:

1. If a programmer is very brilliant and is working in an ego rich environment, he can't do the task as much as ordinary programmers working cooperatively as a self disciplined and self organizing team.
2. Customer, one who funds the software development is a valuable and essential team member. Customer is involved in the scope decisions throughout the project. Whereas in traditional approach, developers decide everything about the scope of the project.
3. Agile does not give much importance to documentation, as a document can have plenty of information, but real knowledge is hard to put on paper. The system will get build, but it won't solve the problem like one guided by an expert on daily basis.
4. The biggest problem with software development is changing requirements. Agile processes accept the reality of change versus the hunt for complete, rigid specifications.
5. To improve the optimal working structure, team structure improvement is one method employed to improve software development. An approach known as "radical collocation" has been devised, whereby team members are located in the same room known as the 'team room' for the duration of the project.

Agile software focuses on the below underlined approach rather than the approach followed in previous models:

1. Individuals and interactions over processes and tools
2. Working software over comprehensive documentation
3. Customer collaboration over contract negotiation
4. Responding to change over following a plan

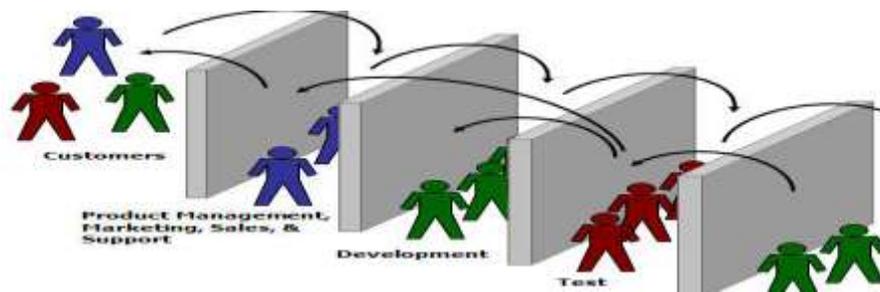
According to Kent Beck, the Agile Manifesto is based on twelve principles:

- Customer satisfaction by rapid delivery of useful software
- Welcome changing requirements, even late in development Working software is delivered frequently (weeks rather than months)
- Working software is the principal measure of progress
- Sustainable development, able to maintain a constant pace
- Close, daily co-operation between business people and developers
- Face-to-face conversation is the best form of communication (co-location)
- Projects are built around motivated individuals, who should be trusted
- Continuous attention to technical excellence and good design
- Simplicity- The art of maximizing the amount of work not done - is essential
- Self-organizing teams
- Regular adaptation to changing circumstances

The meaning of the term Agile is: “Quick and Well Coordinated in Movement”. The processes we describe as Agile are environments for a team to learn how to be Agile.

Cockburn proposes the following points for successful project completion:

1. Communication and Community: Two to eight people in one room.
2. Short and continuous feedback cycles: Onsite usage experts.
3. Short increments: One to three months, allows quick testing and repairing.
4. Unit and functional tests: Fully automated regression tests.



**Fig 1: Pictorial Representation of Agile Software Development**

According to **Highsmith and Cockburn**, “what is new about agile methods is not the practices they use, but their recognition of people as the primary drivers of project success, coupled with an intense focus on effectiveness and maneuverability.”

### III AGILE METHODOLOGIES

They are the procedures, business rules, processes and techniques that developers use to develop software [Roberts, T. et al 1998]. Agile software development methodologies are characterized by iterative development, constant code integration and production of demonstration modules and prototypes. [Roberts, T. et al 1998]

Following are the agile software development methodologies:

- Agile Modeling
- Agile Unified Process (AUP)
- Crystal Clear
- Crystal Methods
- Dynamic Systems Development Method (DSDM)
- Extreme Programming (XP)
- Feature Driven Development (FDD)
- GSD
- Kanban (development)
- Lean software development
- Scrum
- Velocity tracking

According to a research paper, “**Successful implementation of Agile Software Development Methodology**”, most widely used methodologies are: Extreme Programming, Scrum , Dynamic System Development Method (DSDM), Adaptive Software Development (ASD).

Major factor impacting Agile Software Development Methodology are:

1. Training
2. Management involvement
3. Access to external resources
4. Corporate Size

Factors that did not impact the Software Development Methodology are:

1. Using models having an implementation plan
2. *Collocating the development team*
3. Developing software for internet/intranet

### 3.1 Collocation of Teams

Collocation is defined as *“the physical proximity of the various individuals, teams, functional areas, and organizational subunits involved in the development of a particular product or process”* (Rafii, 1995), p.78).

In order to further improve productivity and collaboration, agile teams are known to collocate their team members in a single room known as a “team room”.

Radical collocation is a strategy that involves *“putting an entire project team in one room for the duration of the project”* (Teasley, Covi, Krishnan and Olson, 2000, p.339).

This strategy was developed in response to communication difficulties, such as the time wasted on communication in distributed environments and the regular communication breakdowns that occur on projects. (Teasley et al, 2000).

The concept of war room came into existence in World War II during which major leaders had “special rooms outfitted with key maps and other information as well as the key figures „at hand” wherein they would meet and discuss their strategies (Teasley et al, 2000, p. 671).

### 3.2 Distributed Software Development

Software development has now become multi-site, multicultural, globally distributed undertaking. More number of organizations are distributing their software development process worldwide to achieve higher profits, productivity, quality and lower cost. This change has profound impact not only on marketing and distribution but also on the way products are conceived, designed, constructed, tested and delivered to customers.

There are four different ways to distribute software development. Distribution can be defined by its geographical location and by the control and ownership structure of the project. The control structure can be defined by 2 dimensions: outsourcing means that the company buys the software from some external company and insourcing means that the company provides the services itself through some internal projects.

Geographical location is defined by dimensions: onshore, which means that all company’s development work takes place in the same country where the headquarters and other operations are located and offshore which means that part of the development happens abroad. Onshore distribution is called distribution software development or DSD and offshore distribution is called global software development, GSD.

Both agile and distributed software developments (GSD) are growing trends as software business requires quicker quality production at a cheaper price. Distributed development is a fact of life for many agile teams. Most of the Agile methodologies (e.g. SCRUM) assume that the team is located in a single room. Unfortunately this principle does not fit in the real scenario where agile teams are also distributed across the globe. *Factors like expanding business to new markets, creating high quality employee pool, reduced costs through outsourcing to regions with cheaper development overheads are the main driving forces for organizations opting for distributed development.*

#### IV CASE ILLUSTRATIONS

According to a Research paper – SACJ, No.47, December 2010 “Collocation impact on team effectiveness”, it can be seen that collocation has the positive impact on the following factors:

1. Feedback
2. Performance Targets
3. Trust/Mutual Accountability
4. Team Identity
5. Conflict Management
6. Goal
7. Commitment
8. Resources and Morale
9. Improve in communication and knowledge transfer
10. Fun

However team members have also reported a negative impact of collocation. These are:

1. Roles are less emphasized and sometimes team members are required to do a job that is not part of their job specification.
2. Morale of the whole group is often influenced by individuals. If one team member is feeling down, the whole team is more likely to feel down as well.
3. There is no privacy and there is increased frequency of interruptions.
4. There is a lot of noise and at times reduce the level of concentration.

According to a journal “Distributed Agile Software Development”, *Journal of Computer Science and Engineering, Volume 1, Issue 1, May 2010*

Distribution of software development is becoming more and more common in order to save production cost and reduce the time to market. Large geographical distance, different time zones and cultural differences in distributed software development (DSD) leads to weak communication which adversely affects the project. Using agile practices for distributed development is also gaining momentum in various organizations to increase the quality and performance of the project.

According to the White Paper of Mindtree, “**Distributed agile and offshoring – antagonism or symbiosis?**”

Mindtree has proven experience of over 10 years in agile methodologies. They have executed software development, maintenance and testing projects using agile methodologies with distributed teams as well as collocated offshore teams. Their experience includes:

- 50,00,000+ man hours of experience in agile projects
- 1000+ agile team members
- 100+ ongoing agile projects'

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Their experience in executing projects in onsite-offshore models enables them to apply agile principles and best practices in distributed teams. In order to make this work at an organizational level, they have created subject matter experts and agile coaches. They also facilitate training programs on distributed agile to build agile capabilities in their organization. These are the crucial steps they have adopted to make it work. They promote agile through Mindtree Agile Council and Agile Community. Mindtree Agile Council, a team of agile experts, focuses on nurturing agile capabilities at Mindtree and facilitating competency building programs. Agile Community at Mindtree is a knowledge management community that provides a common platform for all practitioners and promotes knowledge sharing. In addition to these they contribute to external conferences and online media by sharing their success stories, presenting white papers and participating in discussions.

According to White paper, “Distributed Agile – Pointless or Possible by SQS.COM”, Most common challenges faced by the Distributed Development Teams are:

- Time zones and working hours
- Cultural and language differences
- Availability and access to tools
- File sharing
- Team dynamics
- Telephone dynamics

Collocated teams according to them have the highest rate of success as the members of the team communicate face to face. They benefit from communication fidelity – the degree of accuracy between the meaning intended and the meaning interpreted (Petersen,2007):

- 55% of the meaning is conveyed by physical body language,
- 38% is conveyed by culture-specific voice tonality, and
- Only 7% of the meaning is conveyed by words.

Much of the focus around communication and working side by side is about building trust.

The solutions suggested for the problems of Distributed teams are:

- Establish a synchronization and communication plan
- Use interactive communication software with a voice layer to assist in keeping all parties across distributed teams engaged
- Use of teleconference, videoconferencing facility
- Shared drive
- Document management tools
- Establish centralized wikis and discussion forums
- Develop a common low level vocabulary where you understand each other and develop from there
- Onsite coordinator

According to a research paper, “Successful implementation of Agile Software Development Methodology”, Non-collocated (Distributed) teams use software tools such as instant messaging(IM) or e-mail to compensate for the lack of casual interactions associated with collocation[Brush ,A.J., & Borning, A.2003 and Teasley, S.D., & Covi, L.A.2003].A growing number of industries including financial services, technology, and telecommunications business integrate IM as a part of their standard business operating procedures [Isaacs, A. et al 2002, King, J. 2004 and King, J. et al 2003]. Geographically distributed teams use IM and collaboration software to facilitate communication between members and customers and minimize miscommunication [Herring, C. 2001].Collaborative software may support synchronous or asynchronous communications.

Baheti et al [Baheti, P. et al 2002] investigated the effect of providing distributed XP development teams with videoconferencing technology. These researchers assigned programming projects to 37 groups of university students. To provide valid results, a control group of 24 of the teams were collocated and 13 were geographically distributed. The distributed teams were given a videoconferencing tool with multiple cameras and wall-sized image projections. The videoconferencing tool assisted the distributed teams to be as productive as collocated teams and produce code that had the same amount of errors as the code produced by the collocated teams [Baheti, P. et al 2002].

## V FINDING AND CONCLUSION

According to the primary research done by me by getting an Online Survey filled from a Software Company in Noida working under Agile Methodology, I could find the following points:

	<b>Strongly Agree</b>	<b>Strongly Disagree</b>	<b>Agree</b>	<b>Disagree</b>	<b>Neither Agree nor Disagree</b>
<b>Is collocated environment noisier?</b>	1	1	6	8	5
<b>Does collocation decrease productivity?</b>	2	4	3	12	0
<b>Does collocation increase interruptions?</b>	1	3	5	9	3
<b>Does the quality of software suffer if team is collocated together?</b>	0	7	1	12	1
<b>Is communication with the development team better when team is collocated?</b>	10	1	7	2	1
<b>Is knowledge transfer better in collocated environment?</b>	8	1	6	1	5

<b>Is the team coordination same as in collocated teams?</b>	3	0	7	9	2
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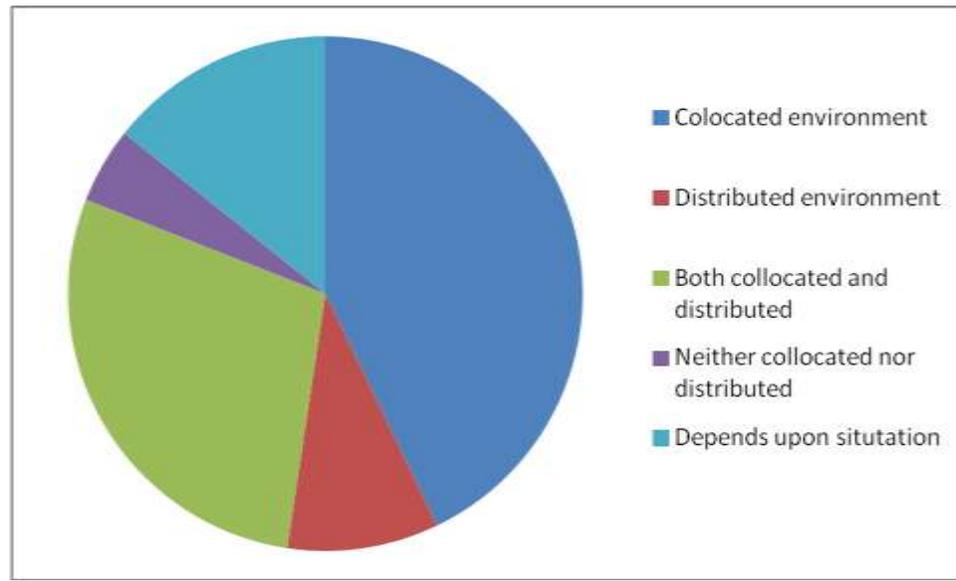
**TABLE 1: Impact of collocation on the effectiveness of Agile Development Teams**

	<b>Strongly Agree</b>	<b>Strongly Disagree</b>	<b>Agree</b>	<b>Disagree</b>	<b>Neither Agree nor Disagree</b>
<b>Is the team coordination same as in collocated teams?</b>	3	0	7	9	2
<b>Does different time zones and working hours has any impact on quality of software?</b>	2	0	8	7	4
<b>Does cultural differences and language a difference has any impact on quality of software?</b>	1	1	6	10	3
<b>Is any problem faced in access to tools and file sharing?</b>	0	1	8	4	5

**TABLE 2: Impact of distributed teams on effectiveness of Agile Development Teams**

<b>Colocated environment</b>	<b>9</b>
<b>Distributed environment</b>	<b>2</b>
<b>Both colocated and distributed</b>	<b>6</b>
<b>Neither colocated nor distributed</b>	<b>1</b>
<b>Depends upon situation</b>	<b>3</b>

**TABLE 3: Which approach is better - team working in a collocated environment or team working in a distributed environment?**



**Fig 2 : Pie Chart of questions asked in TABLE 3**

## VI FUTURE WORK

This research was done for a company using SCRUM methodology of Agile Software Development and the number of respondents who gave response were 21. Most of them have agreed that colocated environment is better, but some of them have also said that it depends upon project and situation which approach is better. In further papers, a detailed analysis of all the different methodologies using in Agile software development can be made which will give a clear picture of which approach is better – working in colocated teams or working in distributed teams.

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