GESTURE RECOGNITION BY EVALUATING FLUX POINTS WHEN INTEGRATING WITH EM WAVES

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ABSTRACT

With the tremendous increase in the use of computers over the past decade or two, emphasis is laid on Human and Machine interaction commonly referred to as Human Computer Interaction or HCI. Amongst the other HCI features, Gesture Recognition is a field that in itself has many applications whether it be security or gaming. New discoveries in Gesture Recognition have led to better and more accurate results.

All the techniques developed so far are either expensive or require a complex apparatus. There is a need for a cheaper and accurate technique in order to reach to the masses. One such technique discussed by us is through EM Waves. It would certainly be more efficient and would cause less harm to human health.

CERTIFICATE

This is to certify that Karandeep Singh has completed M.Tech dissertation proposal titled "Human " under my guidance and supervision. To the best of my knowledge, the present work is the result of her original investigation and study. No part of the dissertation p r o p o s a l has ever been submitted for any other degree or diploma.

The dissertation proposal is fit for the submission and the partial fulfillment of the conditions for the award of M.Tech Computer Science & Engg.

Date: _____

Signature of Advisor

Name:

UID:

ACKNOWLEDGEMENT

Gratitude cannot be seen or expressed. It can only be felt in heart and is beyond description. Often words are inadequate to serve as a model of expression of one's feeling, especially the sense of indebtedness and gratitude to all those who help us in our duty.

It is of immense pleasure and profound privilege to express my gratitude and indebtedness along with sincere thanks to **Mrs Sandeep Kaur Mam** for providing me the opportunity to work for research on "**Human Computer Interface (Gesture Recognition)**". During the entire research session, I have received endless help from her.

I want to formally acknowledge my sincerest gratitude to all those who assisted and guided me in completing this pre-dissertation report and making my research a memorable experience. I am beholden to my family and friends for their blessings and encouragement.

Karandeep Singh

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DECLARATION

I hereby declare that this thesis is my own work and that is has not been submitted anywhere for any award, where other sources of information have been used, they have been acknowledged.

Signature:

Date:

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CHAPTER 1
INTRODUCTION

1.1 HUMAN COMPUTER INTERFACE

HCI is defined as the interaction between humans and computers. This term was coined by Card, Moran and Newell and the term was first used officially in 1980. Since it involves both the machine and computer interaction hence it requires support from both the ends. On the system/computer end, the following points are involved: Computer Graphics, Operating System and programming languages and on the human end communication theory, graphic and industrial design disciplines, linguistics, social sciences, cognitive psychology are associated. Other terms used for HCI are: HMI (Human Machine Interaction), MMI (Man Machine Interaction). HCI is found to be useful in the following concerns:

- Newer technology is developed with the aim of reducing human efforts.
- As far as society is concerned, HCI is able to increase the accessibility features for deaf and dumb.
- HCI features like speech recognition have accelerated the gaming capabilities and have also lead to development of 3D games.
- At some places like factories or industrial outposts, machines are deployed in order to decrease human efforts. Now these machines have made to work with integration with speech and gesture.
- Security features have been developed that are based on basic HCI features like vision or touch interface.

HCI basically inculcates the following major categories:-

- **Gesture Recognition:** Recognizing human gestures by integration with machines.
- **Speech Recognition:** Recognizing speech in order to enhance the security features or to give vocal commands to machines.

- **Eye Tracking:** It is the technology developed in order to track the motion of the eyeballs. This is significantly used in correcting the eye vision, retina scan for security purposes.

1.2 INTRODUCTION TO GESTURE RECOGNITION

Gesture recognition is a term in Human Computer Interaction. It is defined as the technique of recognizing and interpreting gestures. The gestures mainly originate from the following parts:

- Arm or Hand
- Neck or Head
- Body

However the techniques being developed nowadays mainly focus on the Face and Hand recognition. Gesture recognition has been found useful in bridging the gap between user and machines and have significantly developed GUI (graphical user interface) features.

Gesture Recognition is mainly of following uses:

- **Recognising sign language:** There is a separate provision made for the deaf and dumb persons referring to as sign language that has helped them to a great extent in communicating with other persons. This is known as Sign Language. American society has developed a separate database known as ASL (American Sign Language) dataset that has included nearly all the alphabets.
- **s**useful. Robots developed on a large extent have inculcated all the properties and now they even operate on gestures performed by users.
- **Pointing for directional purposes:** Pointing towards a direction generally means that we either want to move in that direction or we want the other person to move in that particular direction. This feature has helped significantly in reference to road signals.
- **Facial Control:** Gestures that we make by our faces mean a lot whether it be sad expression or happy expression. Controlling the machine through our facial expression is a new field that has helped a lot in

increasing the security features in certain devices.

- **Alternative computer Interfaces:** Alternative computer interfaces have been developed like touch pads or tablets that have the motion sensing abilities. It has helped a lot in advancing in the gaming field.
- **Controlling through Remotes:** Gestures made to machines can also lead to movement in that machine. These commands can be stored in the database and then certain gestures made can lead to controlling the machine through remotes or simply gestures.

Gestures are of several types that have different recognition process.

Some of the categories of gestures are listed as under:

- **Static Gestures:** This category refers to gesture that are positioned at one single point only and are not moving. For example pointing in certain direction would be in this category.
- **Dynamic Gestures:** This category includes gestures whose movement is predefined and follow the specific defined movement only.
- **Static and Dynamic Gestures:** This category involves the properties of both static gestures as well as dynamic gestures. The example of this category would be sign language.

Gesture recognition is done by the variety of methods that have their own pros and cons. Some of the gesture recognition methods are discussed as under:

- **Vision Based Methods:** This technique involves recognition through video cameras or fish lens cameras. In this technique there is a database maintained earlier that carries all the gestures. The gestures captured later are then pre-processed and analysed and match is made.
- **Glove Based Methods:** In this approach wearable sensors are wore by the user in the form of gloves or body suit. This wearable sensor would either record the acceleration or the movement of the hand or other body part like the flexion in the fingers in later converted into electrical signals and are communicated to the system.

Figure1.1 Example of Gloves used in Glove Based Approach

- **Drawing Based Methods:** This approach involves stylus as an input device that is used to communicate with any media and later the gestures are recognised. This approach however is used just for designing purposes or for digital writing.

Generally the recognition of gestures comprises of a series of steps beginning from image capturing to noise removal and to feature extraction. The steps are illustrated with the figure given below:

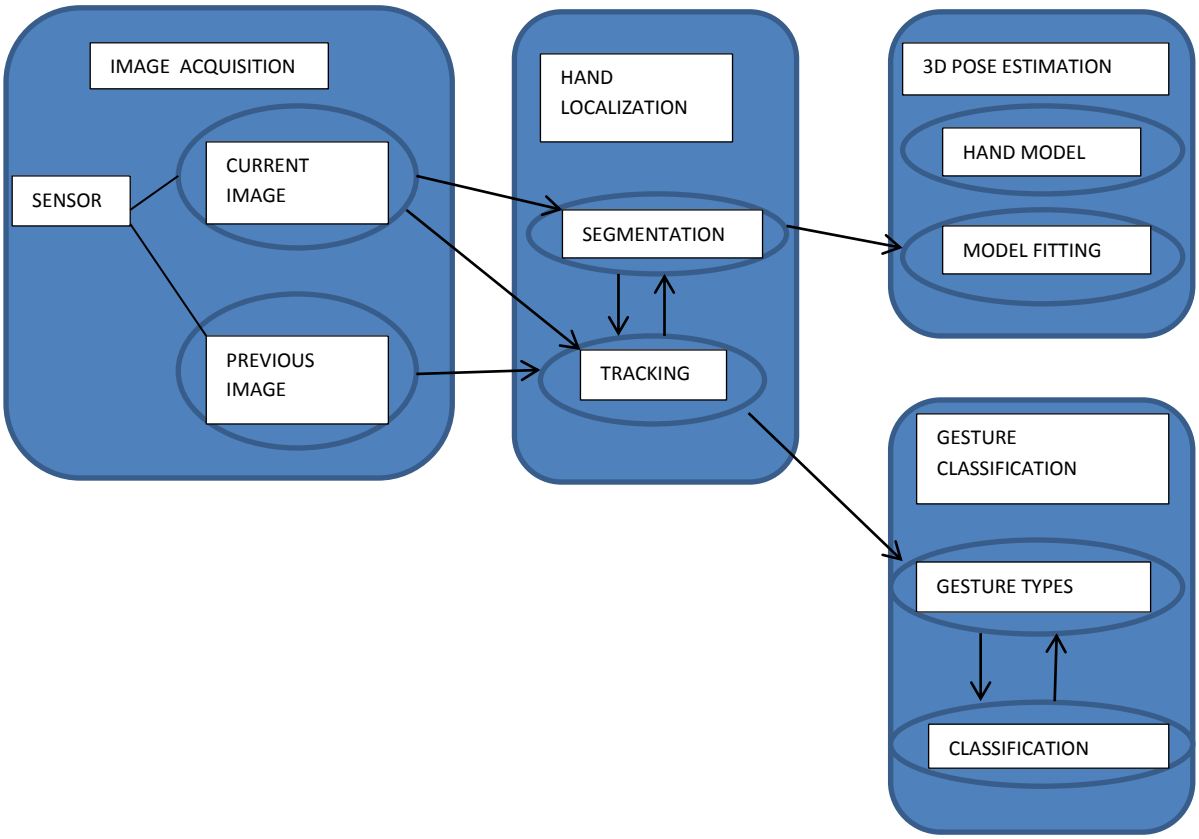

Figure1.2 Steps of feature extraction and recognition

The steps listed above involves three sections. Each of the section is described as under:

- Image Acquisition : This involves a sensor of any kind that detects the current image as well as keeps the track of the previous image. An image sequence comprises of all the images.
- Hand Localisation : This section includes two major parts: Hand Segmentation and tracking. Hand Segmentation refers to partitioning the hand from the rest of the surroundings. The segmentation and tracking fields are interrelated as shown in the figure. Only after

segmenting the hand from the surroundings the movement of the hand can be traced.

- 3D Pose Estimation and Gesture Classification : Pose Estimation feature consists of Hand Model and Model Fitting. Here an earlier prepared model of the hand is stored in the database and the next time any gesture is performed, it is matched with the stored model. A classification algorithm is applied to classify and plot the gestures in the proper category which comes in the Gesture Classification section.

All the methods listed above are based on some algorithms and formulae. Each approach has its own advantage and disadvantage. Some of the advantages and disadvantages of the approaches listed above are discussed in the next section.

CHAPTER 2

LITERATURE REVIEW

Paper on ALPHABET RECOGNITION OF AMERICAN SIGN LANGUAGE by Nachamai.M in 2013[3] suggested that gestures hold great importance in our day to day life whether they are simple or complex, they have got the ability to communicate much more than what words can do. Over the period gestures have given significant importance as it enhances the communication abilities for deaf and dumb as suggested by the paper on Alphabet Recognition for Sign Language. Gestures can be of several types such as:

- Hand and arm gestures
- Head and face gestures
- Body gestures

Gestures are further classified into several categories such as static gestures, dynamic gestures and static and dynamic gestures.

- Static Gestures : These gestures are stationed at one point .
- Dynamic Gestures: In this category of gestures the gesture movement is predefined
- Static and Dynamic Gestures: This category includes those type of gestures that Patterns of both Static and Dynamic Gestures.

A research has been conducted in America that has accelerated the use of sign language and they have developed ASL (American Sign Language) and have created a database for the Same including 26 English alphabets that helps in their identification and matching. Gesture Recognition is a complex procedure and involves several steps. The following are the steps Required for Gesture Recognition:

Pre-processing: Before recognizing any gesture it is needed that the gesture recorded by any medium be it Vision Methods or Hand Glove Methods or simply Drawing Gestures, are processed and required gestures are extracted from the surroundings captured. Noise is removed and location of the gesture is estimated. These steps are necessary as without these Successful identification cannot be made.

Extract Features: From the recorded gestures, it is important to extract only such features Those are needed to identify the gestures

Find Key points: The second important step in pre-processing is finding key points. Key points are nothing but all the pixel values greater than zero. The key points are then stored In an array.

Create Signature: After storing the key points, a specific signature is generated for each gesture and all the signatures are distinct in nature to avoid confusion.

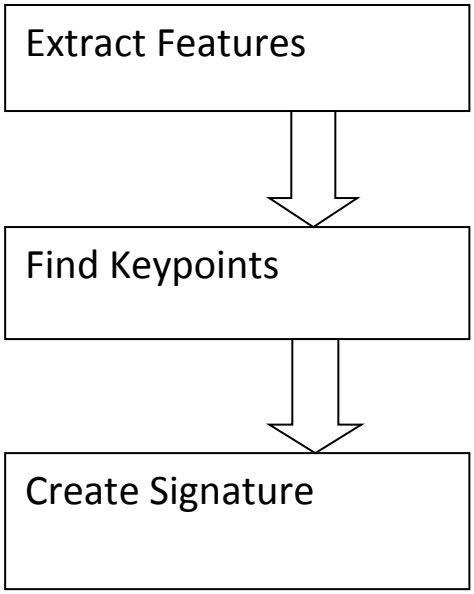

Figure2.1 Sequence of steps in vector composition

Further in this paper certain variances are listed like : Scale Invariance, Rotation Invariance, Illumination Invariance, Perspective Invariance, Affine transformations. Each variance holds its importance when image projection is concerned. This paper particularly focuses on the Scale Variance and introduces SIFT (Scale Invariant Feature Transform) Algorithm. The handling of this variance is done by the steps listed above. Scale Invariance is done with the help of DOG (Difference of Gaussian) i.e the difference between two Gaussian Surfaces is calculated. The algorithm discussed here states that whenever any image is encountered, its key points are stored in the database and the respective DOG values are also determined.

Next time whenever a match has to be made, the keypoints are compared with the earlier stored values and accordingly the match is made. MATLAB tool is used for successful matching of the data values.

One disadvantage that I came across in this algorithm is that DOG values may be same in the case the key points lie on the same set of plane coordinates but still the gesture could be different. In that case a successful match cannot be made. In above listed both the cases if the angle is neglected and only plane difference has to be considered, it would certainly be same in both the cases but the gestures are different. This disadvantage can be solved with the technique of angle matching where angle of each gesture is saved and the match is made.

Paper on HUMAN COMPUTER INTERACTION USING VISION-BASED HAND GESTURE RECOGNITION by Haitham Hasan And Sameen Abdul Kareem in 2013[4] presented a review paper, the paper lists down all the ways available for recognising gestures and their pros and cons. Gestures hold the great importance in the non verbal communication and is being implemented widely by interfacing with the computer systems. Computer Games, machinery replacement or mouse replacement, gestures have several uses in our daily life. Gesture when integrated with computer systems after successful match is referred to as Gesture Recognition. As discussed in the previous paper, gestures are made using various body parts but the most effective and widely used is the gesture made by hand.

Gesture Analysis is further of many types including:

- Glove-based analysis: In this type gloves carrying sensors are wore by the user. The sensor converts the finger flexion into electrical signals which to used to determine hand posture. Further the relative position of the hand is determined by an additional sensor that is magnetic or acoustic attached to the glove.
- Vision-based analysis: It is based on how humans perceive information about their surroundings. Gestures are captured using cameras and later palm orientation and joint angles are estimated. By these parameters gesture classification is done.

- Analysis of drawing gestures: This category involves analysis of drawing gestures leading to recognition of written text. This involves Stylus as an input device.

The disadvantages of both type of gestures are listed below:

- Disadvantages of Glove based or static gesture is reliability, accuracy and Electromagnetic noise.
- Disadvantages of Vision Based Gesture is it leads to many problems in machine vision like removal of unwanted background, location estimation of hand.

Table2.1 Comparison of Contact and Vision based approaches

Criteria	**Contact based devices**	**Vision based devices**
Cooperation of user	Yes	No
Precision	Yes/no	No/Yes
Configure flexibility	Yes	No
Usability	No	Yes
Health problems	Yes(no)	No

Gesture recognition is further classified into mechanical, haptic, ultrasonic, inertial and magnetic devices. There are some challenges in vision-based gesture recognition:

- There is a large variety if gestures and recognising each of them requires many degrees of freedom, huge variability of 2D appearance depending on the camera viewpoint and many resolutions for the temporal dimension.
- Vision based analysis is dependent on background and lighting conditions. Improper lighting or background conditions lead to failure in effective matching.

- Low recognition rates and complex implementation.

In the vision based gesture representation, the 3D model based gesture defines the 3D spatial description of a human hand for representation. This automation consequently divides the characteristics of a gesture into three phases: the preparation or prestrike phase, the nucleus or stroke phase, and the retraction or post stroke phase. Further the appearance based gestures are divided into two major subcategories, the 2D static model-based methods and the motion- based methods. The following listed are the commonly used 2D models:

- **Based Models:** It uses the body markers to track and identify the motion of body or body part
- **Silhouette Geometry-based Models:** These models use the geometric properties like elongation, convexity, surface, centroid and orientation to recognize hand gestures.
- **Deformable Gabarit-based Models:** Used in generally the deformable contours. Snakes are used to analyze gestures and actions for video indexing.
- **Motion-based Models:** These are used to recognizes an object or its motion based on the motion based on the motion of the object in an image sequence.

Paper on STATIC GESTURE RECOGNITION COMBINING GRAPH AND APPEARANCE FEATURES by Marimpis Avraam in 2014[5] The main aim of gesture recognition as we know is to identify gestures that are performed by the users. These gestures are performed by body parts mainly hands. This paper on static gestures combining with graphs mainly focuses on the features that are extracted in the process of gesture recognition. SGONG algorithm is used to create an approximation of the hand topology. Particularly methods are developed to detect and process canny edges. There is a proposed method to perform the system, the same is discussed in the following points:

- **Image Pre-processing:** Before analysing any image it is necessary to segment the particular body part from the rest of the background. This is done so that the background doesn't conflict with the hand. Now

since image has to be analysed properly, certain variances are removed for example: rotation variances, scaling variances. All the images for this purpose are resized to 256*256. Now before applying the canny edge detector, Gaussian Blur kernel is used to blur the image in order to high lighten the edges.

- **Appearance Based Features:** Before applying the canny edge detector algorithm, Gaussian filter is used in order to reduce its susceptibility to noise. Finally the magnitude and gradient are calculated and edges with lower values are suppressed.
- **Graph-induced features:** Since Neural Gas Algorithm failed to define explicitly a neighborhood. To overcome this issue an enhanced version of Neural Gas was proposed integrating with Competitive Hebbian Learning (CHL). This technology helped in preserving topology of the image.

Further in the paper the Neural Gas with CHL Algorithm is discussed. The algorithm works in the following steps:

- Number of neurons are created and random positions are assigned to them with no connections between them.
- X is projected to the network.
- Nodes are sorted based on their istances from x.
- Nodes position vectors are adapted.
- Two closest are connected, if already connected the database is refreshed.
- The age of the edges is increased by 1, this applies to all the edges connected with the best matching unit.
- The old edges are checked and are removed from the graph if their age is increasing the threshold. This is decided by the following formula:

$$\alpha(t) = \alpha_{initial} \left((\alpha_T)/\alpha_{initial}\right)^{1/Tmax}$$

Now since this approach is significant in case of Sign Language Recognition (SLR), American Sign Language is being analysed by this by storing 36 American Signs in the dataset each one of which is performed by five different persons. In

order to extend the dataset, the original authors of the dataset rotated each image in different scales resulting into 2425 images. This approach was applied to ten different gestures, each one of gesture counting from zero to nine. The results of this paper are shown in the table below:-

Table2.2 Bayes Classification

GESTURE CLASS	ACCURACY SCORE
0	93%
1	86%
2	73%
3	65%
4	100%
5	93%
6	86%
7	80%
8	86%
9	69%

Paper on MEMS ACCELEROMETER BASED ON NON SPECIFIC USER HAND GESTURE RECOGNITION by RUIZE.XU, SHENGLI ZHOU, AND WEN J.LI in 2012[6], the advancement that this paper achieved was in respect to gesture recognition with the help of a significant new technology. This was with the help of MEMS Accelerometer. Accelerometers were introduced earlier. These are defined as the instruments that detected the acceleration by which a hand moves. Now since every individual would have different ways of moving his hand. Hence only eight gesture codes were extracted and were matched with the values stored in database. This model was efficient in recognising seven hand gestures like:

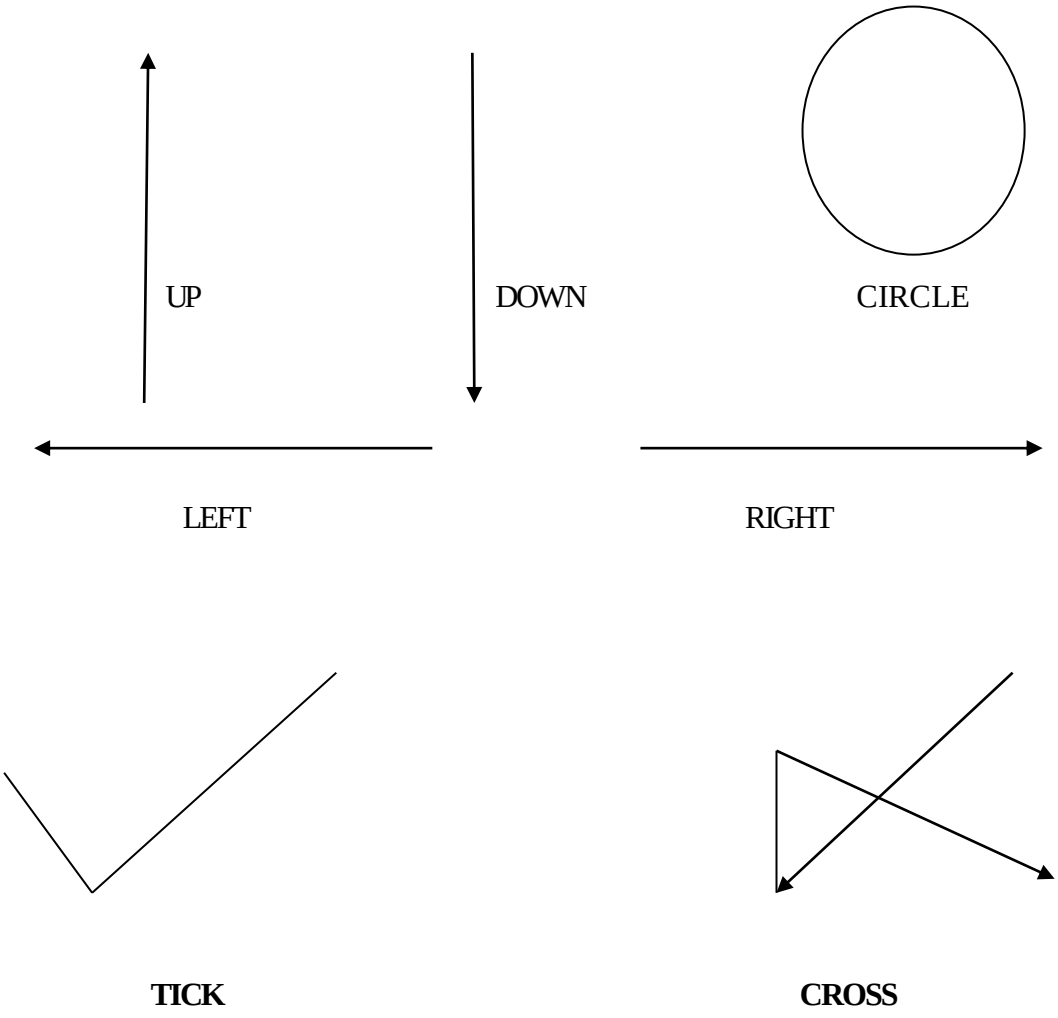

Figure2.2 Seven Hand Gestures

The acceleration is recorded by the three accelerometers placed on hand. These signals are transmitted to a PC via wireless medium. Before recognizing any gesture the recorded gestures are pre-processed by removing noise and performing segmentation. The purpose of segmentation is to find terminal points of each gesture. The features are extracted each time any gesture is analyzed. The following are the rules for each gestures:

- "1 1" represents positive sign;
- "-1 -1" represents negative sign
- "1 -1" represents zero

The three models discussed above have their various accuracy rates. The

accuracy of the three models are discussed in the table listed below:

Table2.3 Accuracy of various gestures

Up	**Down**	**Left**	**Right**	**Tick**	**Circle**	**Cross**	**Mean**
Model 1 95.0	86.0	91.0	84.0	64.0	75.0	61.0	79.0
Model 2 87.0	19.0	63.0	94.0	25.0	0.0	88.0	54.0
Model 3 94.8	91.1	96.7	100	94.4	97.7	94.4	95.6

Paper on WHOLE-HOME GESTURE RECOGNITION USING WIRELESS SIGNALS by QIFAN PU, SIDHANT GUPTA, SHYAMNATH GOLLAKOTA AND SHWETAK PATEL[7] suggests the technology that was significant enough to start a new field of research since it introduced gesture recognition by EM (Electromagnetic Waves). In this technique a reflector was connected with the hand of an individual and on the other side a receiver was installed. Now, the waves that were emitted by the emitter installed at some distance were received at some distance and were later integrated and amplified and were interpreted for the corresponding gestures. The reflected Electromagnetic wave was later compared with the inference wave already present in the environment. Now since when the hand is moved, there would be a corresponding change in the reflected EM wave and when compared with inference wave, the movement of hand shall be evaluated and accordingly matched with the enteries of movements in database. Hence appropriate results are drawn.

In this paper a new sensor (Homodyne sensor) is introduced that works as an wave interferometer by comparing the reflection of a transmitted wave against a local(phase reference) wave. This sensor was found effective in capturing the gestures performed on a larger extent. The major disadvantage is the health hazard that can be caused by the electromagnetic waves that are caused by the emitters attached to the hand.

The EM waves emitted by the emitter may interfere with the EM waves already present in the atmosphere that may cause ineffective recognition. Yet another paper focuses on providing an alternative to the previously developed 2 basic approaches : Vision based approach & wearable sensors based approach through the wireless signals technique. The gestures are recognized if we consider the Doppler shift. Now in order to understand this theory, we need to understand Doppler effect.

Doppler effect can be defined as the change of frequency of a wave as the source moves relatively with receiver. Doppler effect holds not only for sound waves but also for EM waves. This technique is applied here with the Doppler shifts occurring when user moves his hand towards or away from the receiver. Only challenge is that human hand gestures result in very small Doppler shifts.

i.e max Doppler shift is :

$$(2\ f\ v)/c$$

Secondly the problem arises pertaining to presence of more than one human being in home. In that case the MIMO capability is adopted in this. It focuses on recognizing gestures from any particular user. Further like in Kinect and Xbox , some specific gestures are associated with a particular user that acts as his preamble and the next time he wants to access, he would have to perform the similar gestures. To extract the Doppler shifts from wireless signals, the technique used is based on the arrival of crests and troughs of the reflected signals that appear at a faster rate when object moves towards the receiver and vice versa.

Paper on SPEECH ARTICULATOR AND USER GESTURE MEASUREMENTS USING MICROPOWER, INTERFEROMETRIC EM-SENSORS by J.F. HOLZRICHTER AND L.C. NG IN 2001[8] suggested that the EM sensors can also measure fringe motions as reflected waves are interfaced with a local i.e homodyne reference wave. This experiment was found useful for a wide range of applications starting from speech coding synthesis and recognition, speaker or object identification , noise cancellation. It shows that larger motions of a user's body parts are also being measured by using multiple fringe counting , together with the fractional techniques that are appropriate for homodyne radar like sensors. In this paper homodyne sensors are discussed.

Homodyne Sensors

This sensor works same as EM wave interferometer by comparing the reflection of a transmitted wave against a local wave. When the reflecting surface of the system moves, the phase of the reflected wave varies with respect to the stationary local wave. Hence the detection system measures position changes versus time, within the specific frequency range.

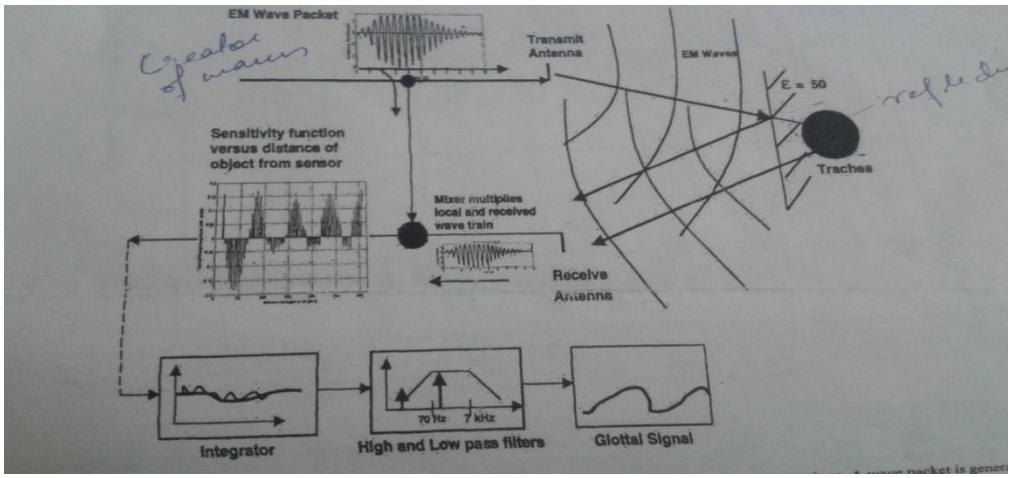

Figure2.3 Reflection of Transmitted Wave

CHAPTER 3

PRESENT WORK

EM fields are found everywhere, some spectrums are visible to naked eye and some are not. These waves if distorted at particular points would generate a pattern, if successfully recognized and traced would enable successful gesture recognition. Introducing EM field theory for detecting gestures not only reduces extra cost for wearable or vision based sensors but would also account for a wide range of area. In our work, we would propose a theory that works with the transmission of EM wave detected at various points that results in appropriate gesture.

This theory would be useful in following ways:

- This technique would be cheaper than other approaches introduced earlier.
- Since EM fields are found everywhere, the range would be comparatively wider.
- The devices and tools required involved for the implementation would be simple.
- Unlike wearable sensors, the apparatus involved in this approach would not cause any harm to human body.

Since the need of HCI has increased to a much extent, such a technique needs to be devised that does not depend on Vision or Wearable sensors approach as they had the following disadvantages:

DISADVANTAGES OF WEARABLE SENSORS

- Wearable sensors need to be wore in hand or arm for the Gesture Recognition.
- Wearable sensors like accelerometers are expensive.

DISADVANTAGES OF VISION BASED SENSORS

- They are not very accurate.
- Environmental factors like brightness or same color contrast may hinder the gesture recognition.

3.1 OBJECTIVES OF THE STUDY

An alternate and efficient approach to the existing techniques is EM field detection approach. This would require only an EM field transmitter and a detector or receiver. Our aim here is to refine this approach and examine its testing in practical. The generated EM wave can be detected using a detector. The apparatus used for the same has an energy source that would travel in the circuit and would generate an EM wave that would be transmitted through the transmission line. Our proposed theory is that, if the apparatus is attached with the human hand and the gestures are performed, the detector would detect the EM waves at various gesture points forming a grid. Then the proper gesture can be extracted out of it. Electromagnetic waves are of several spectrums classified on the basis of frequencies. The chart of electromagnetic spectrum is given as under:

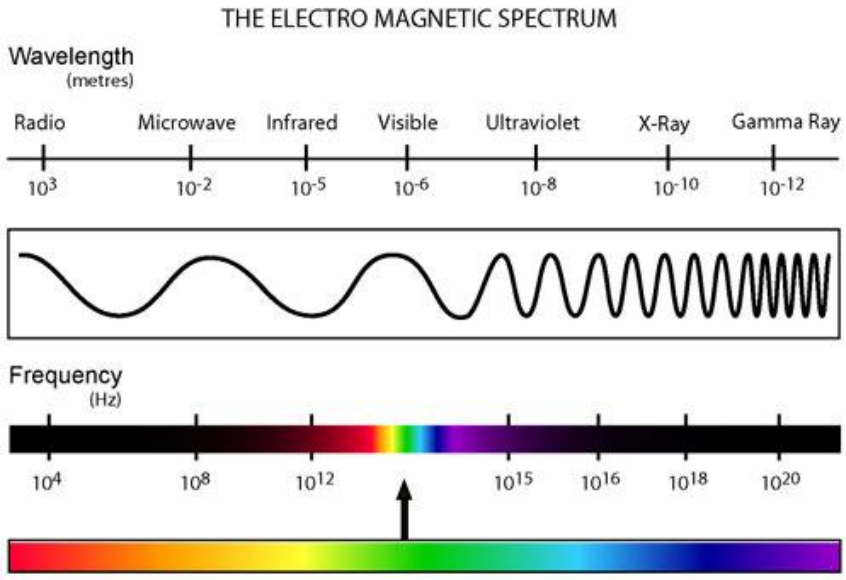

Figure3.1 EM Wave Spectrum[2]

Different spectrums can be used for gesture recognition. Electromagnetic waves or EM waves is simply the wave having both electric and magnetic fields. EM waves are present in atmosphere in many forms, some are visible to naked eye and some are not. Now discussing how the EM waves are produced. When the current is made to flow outside the conductor (mainly in rotation) then the EM waves are produced that can be plot on a machine when interfaced with computer system.

A simple apparatus to generate an EM wave is shown as under:

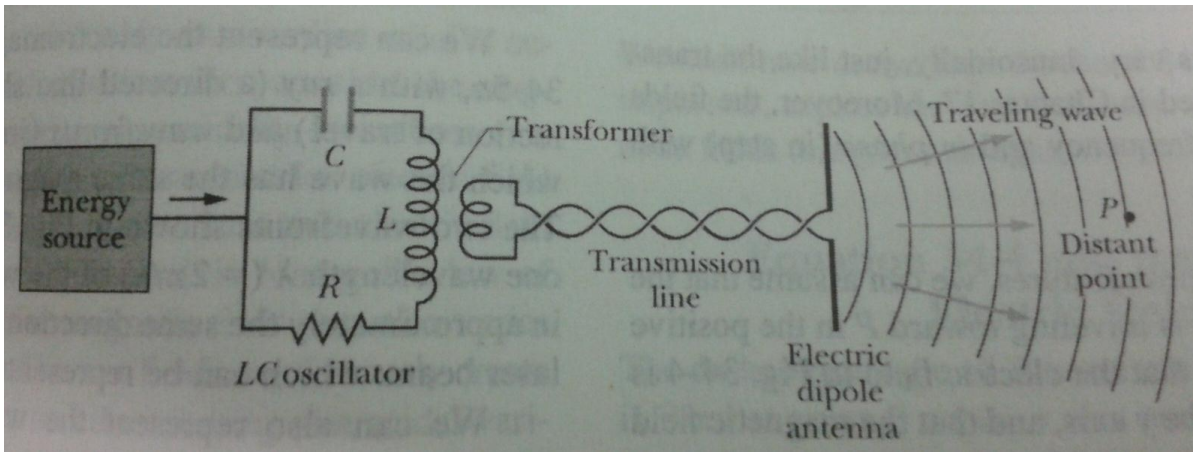

Figure: 3.2 EM Wave Generators [1]

Second approach to Gesture Recognition through EM Waves is through simple laser light. The light emitted by a laser light is also a form of EM wave. This light can be sensed using light sensor which precisely estimates the location of the light and the intensity of the light beam. An example of laser light and light sensor is illustrated as under:

Figure3.3 Beam transmitted by laser light device

Figure3.4 Light Sensor

3.2 RESEARCH METHODOLOGY

The demonstration of the methods discussed above are illustrated with the help of Macromedia Flash Player. In the first demonstration the laser light is intended to be targeted towards the light sensor. The light sensor is a device that tells about the intensity of the light and the estimated location of the light. Now the intensity being constant in this case the changing location would help predicting the gesture. Once the light sensor senses the light, the noise filter would filter the extra light of the surroundings. In the next step, the connection would be made to the PC where the gestures would be interpreted and further matched with the set of gestures. In the animation below the steps of recognition is displayed:

In the first layer only the laser beam appears, keeping the second and third layers as constant

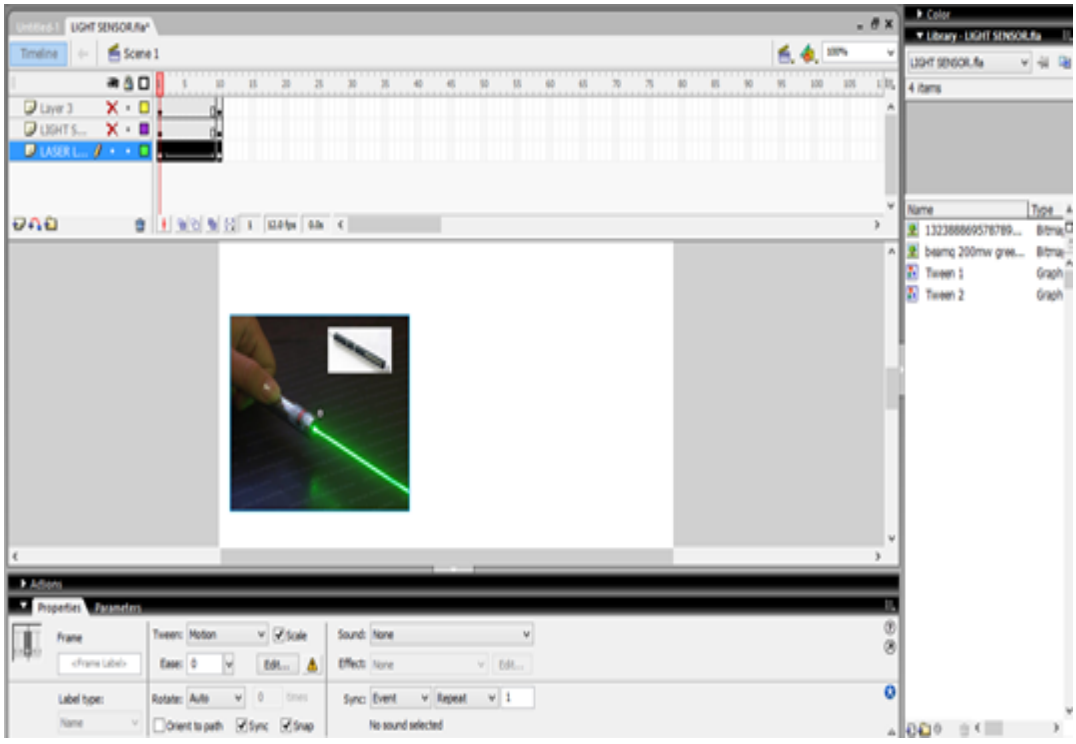

Figure3.5 Layer 1 (Laser Light)

In this layer only the sensor is placed in the layer, keeping the other layers as constant.

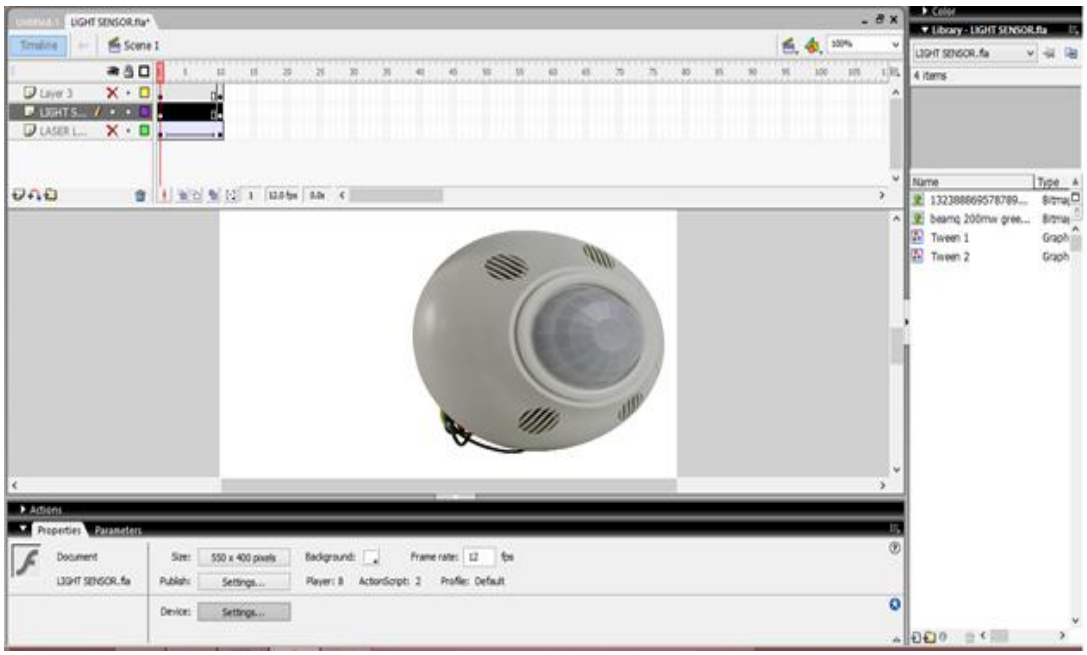

Figure3.6 Layer 2 (Light Sensor)

In this layer only the text portion appears keeping the other layers as constant.

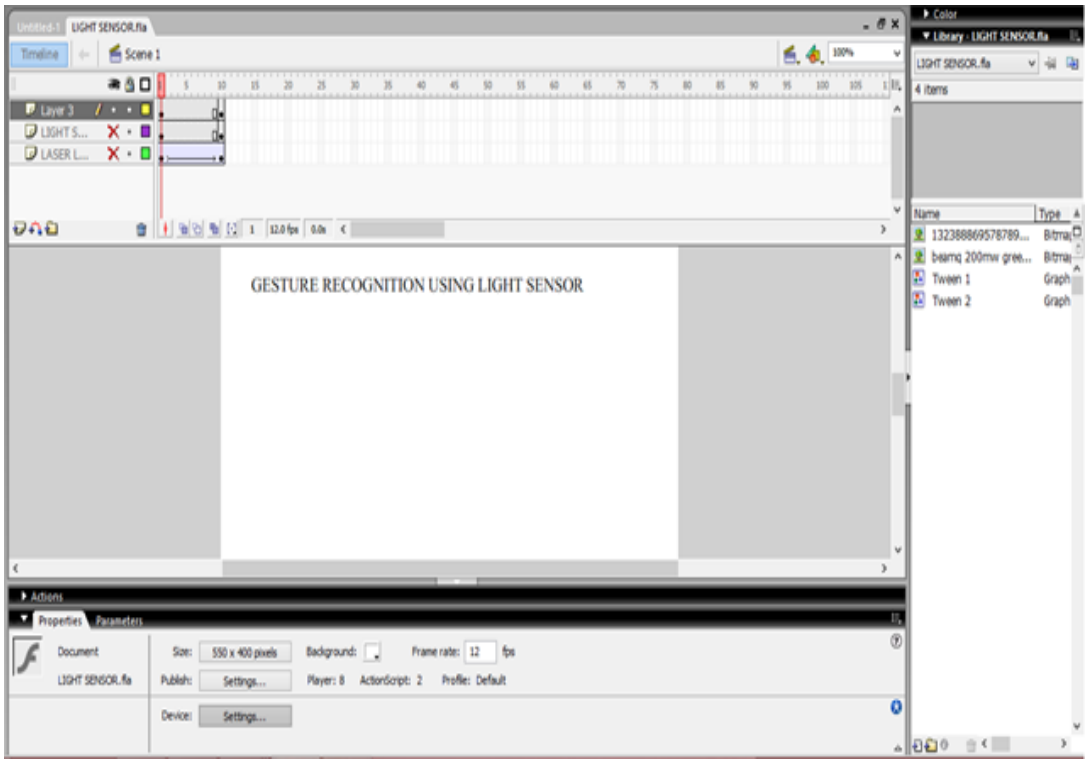

Figure3.7 Layer 3

This is how final animation would appear:

Figure3.8 Final Working

When interfaced with computer system, the following would be the scenario:

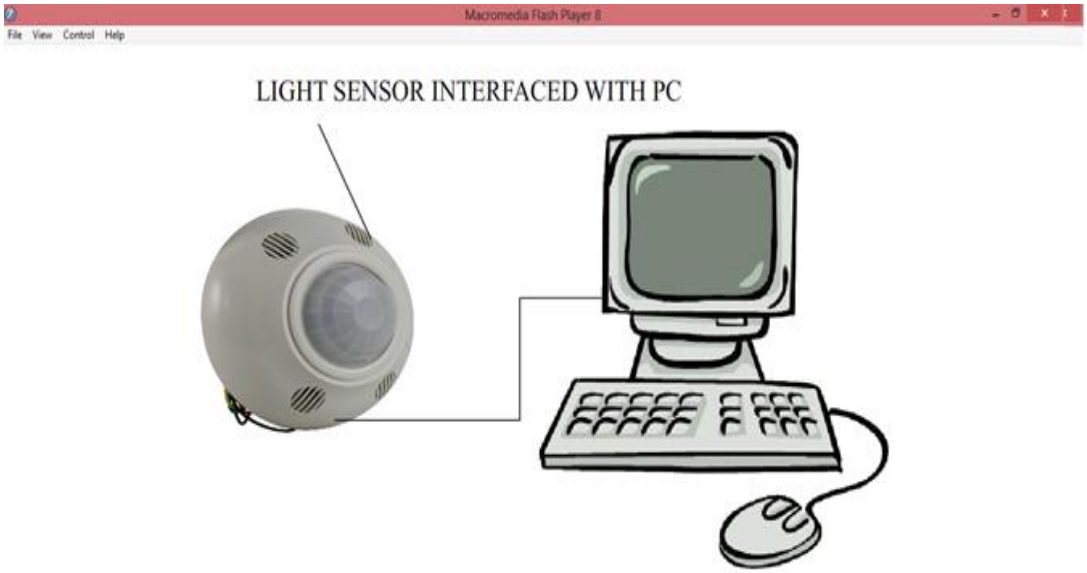

Figure3.9 Sensor interfaced with PC

In the next demonstration, the EM wave generator is attached to hand and as the hand moves, the waves are generated from various points consequently forming the flux points which would therefore help in tracing the trajectory of the gestures. The only difference is that the EM wave generator is attached to the hand and the gestures are performed.

The following figure shows the EM Wave generator circuit:

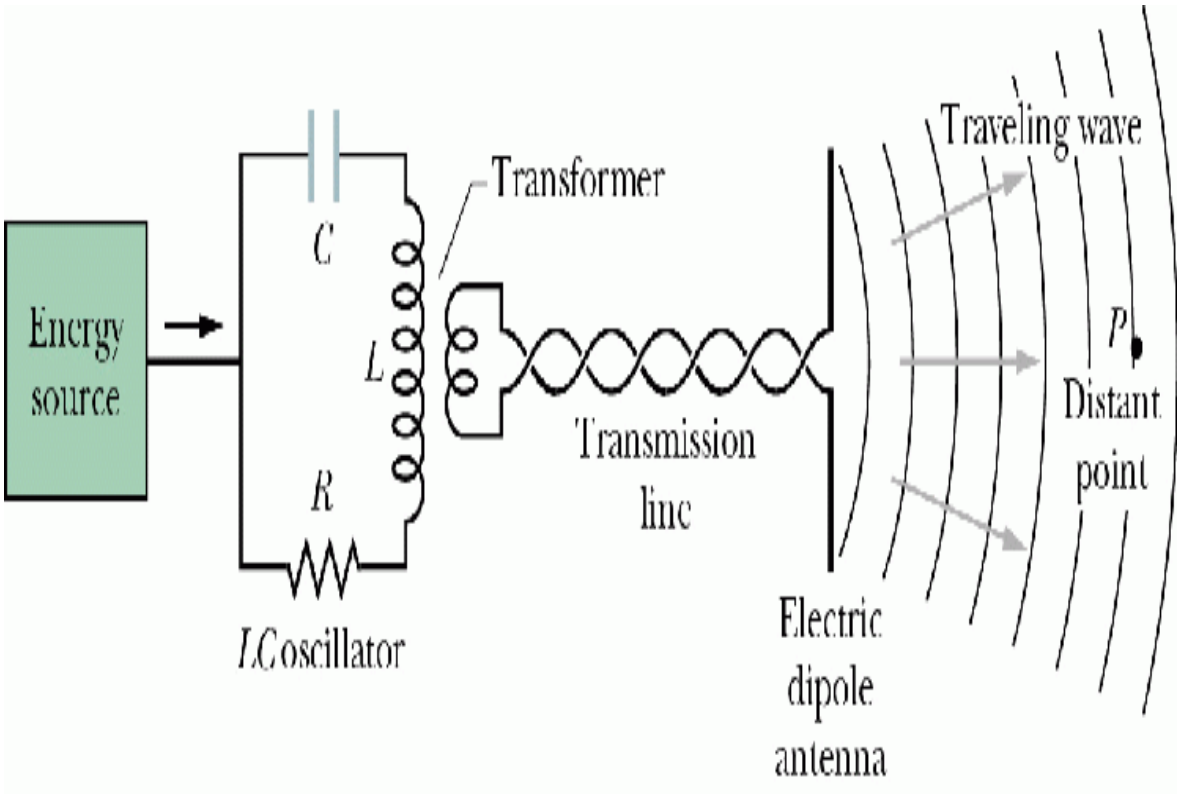

Figure3.10 EM Wave Generator

The figure of EM Wave receiver is displayed below:

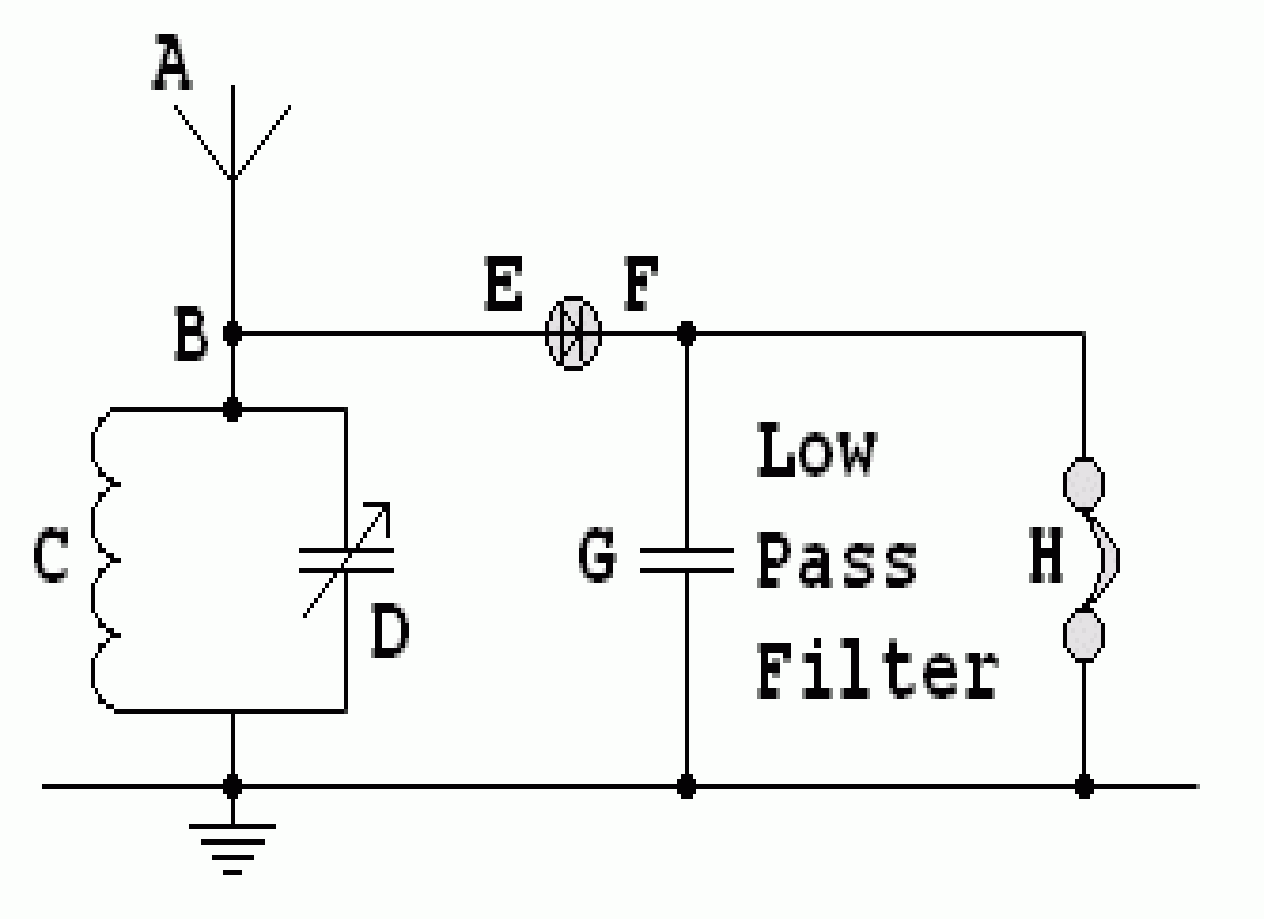

Figure3.11 EM Wave Receiver

CHAPTER 4

RESULTS AND DISCUSSIONS

As discussed in the literature survey, there has been quite a significant development in Gesture Recognition over the past one decade and many new technologies have been devised. Data Gloves or video cameras are used extensively for the same. Due to its complexity and expense, they are avoided to be brought in frequent use.

Recent study on gesture recognition using wireless signals involving Doppler shifts has proved that still there is much scope left in development of techniques involving EM waves. Doppler shifts have the following amplitude frequency dependency and the channel occupancy and classification accuracy dependencies.

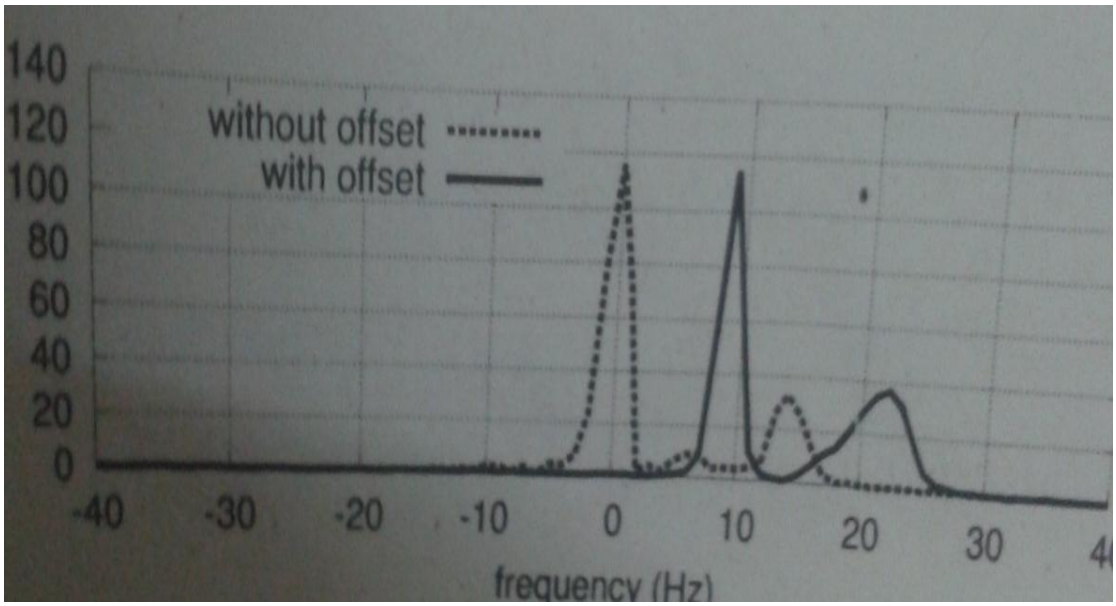

Figure4.1 Amplitude frequency dependency

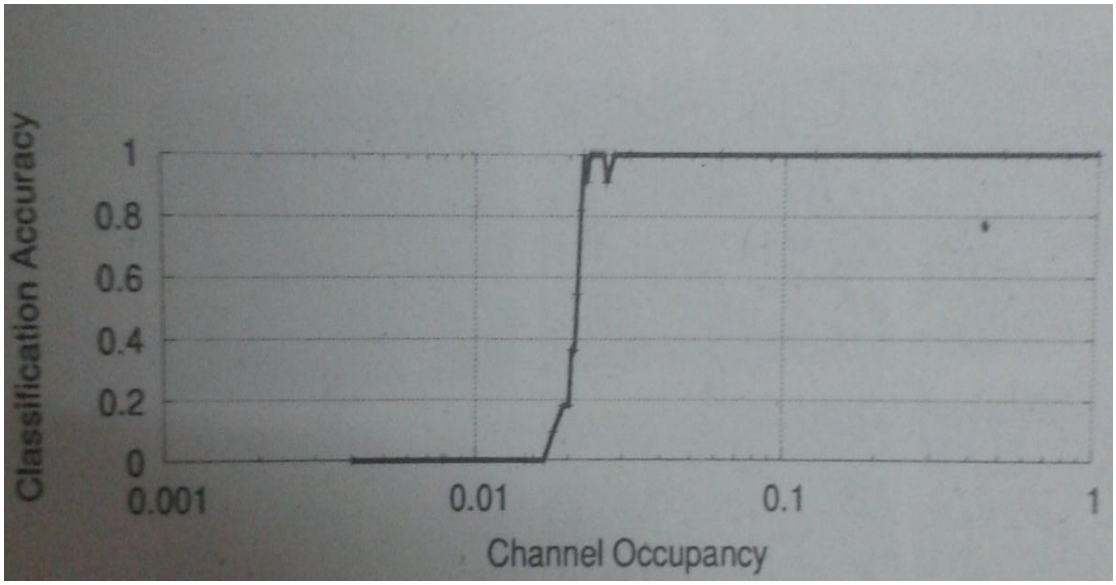

Figure4.2 Channel Occupancy and classification accuracy dependency

CHAPTER 5

CONCLUSIONS AND FUTURE SCOPE

In the scenario of advancements in technology, there is a need to develop HCI to a much greater extent. Gesture Recognition has various applications:

- Better interaction with machines where accuracy in operations is required.
- Robotics mainly man operated robots employ gesture recognition as a sole technique to operate the robots.
- Gaming involves gesture recognition to a much greater extent.
- Gesture recognition gives a way out to deaf and dumb to interact with machines effectively.

Till now many techniques have been employed for gesture recognition. Only need is to devise such a technique that not only gives accurate results but is also cheap and can be easily brought to use. In our research we have proposed the way we can interact with computer over a wider range. Neglecting the noise factor, there would be interruptions in magnetic field lines that would be detected by a detector. This theory would certainly reduce the cost factor and add to the simplicity of the current human computer interactions.

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APPENDIX

TERM	FULL FORM
HCI	Human Computer Interface
HMI	Human Machine Interaction
MMI	Man Machine Interaction
GUI	Graphical User Interface
ASL	American Sign Language
SIFT	Scale Invariant Feature Transform
DOG	Difference of Gaussian
SGONG	Self-Organising Neural Gas
CHL	Competitive Hebbian Learning
EM	Electromagnetic
HMM	Hidden Markov Model
DTW	Dynamic time Warping
LCS	Longest Common Subsequence