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Human Movement Recognization using Radars

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Abstract— Human Movement recognization or gesture recognization via mathematical algorithm is attracting great attention in recent years mainly because of its applications the key element of such system is smart user interface which can actually recognizes the gestures or the movement and convey the same message. Which is actually quite challenging because of its various parameter? In this paper I am try to work on this challenge of traditional sensors and improve the interaction between machine and sensing system by usage of radars to detect the gestures.

Index Terms— *Human Movement recognization*

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I. INTRODUCTION

A gesture is a form of non-verbal communication in which visible bodily actions communicate particular messages, either in place of, or in conjunction with, speech. Gestures include movement of hands, face, or other parts of the body. Humans use gestures in their everyday communication with other humans, not only to reinforce the meanings that they convey through speech, but also to convey meaning that would be difficult or impossible to convey through speech alone. Gestures are considered as the most natural expressive way for communications between human and computers in virtual system.Gestures have been used as an alternative form to communicate with computers in an easy way. Human gestures constitute a space of motion expressed by the body, face, and/or hands. In the recent years there has been gargantuan development in the area of gesture recognition. Many different systems have been designed for gesture sensing. They are broadly classified as follows; Hand Gesture Recognition, Face Gesture Recognition and Body Gesture Recognition.

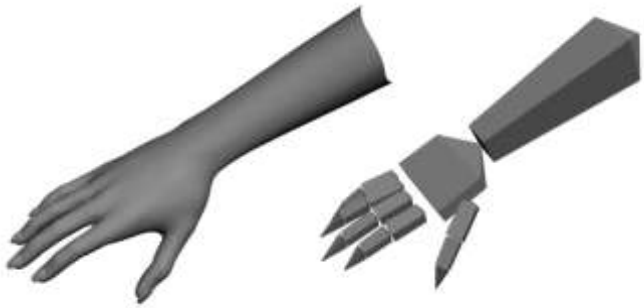
Gesture recognition is a topic of computer science and language technology with the goal of interpreting human gestures via mathematical algorithms. Gesture recognition can be seen as a way for computers to begin to understand human body language, thus building a richer bridge between machines and humans than primitive text user interface or even GUIs (graphical user interfaces), which still limit the majority of input to keyboard and mouse. Gesture recognition enables humans to communicate with the machine (HMI) and interact without any mechanical devices. Using the concept of recognition, it is possible to point a finger at a computer screen so that the cursor will move accordingly.

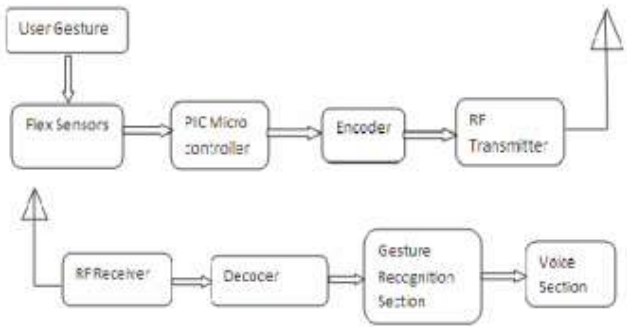
Hand Gesture Recognition:

Hand gestures are a means of communication, similar to spoken language. Hand gestures are the most commonly used gestures in our day to day lives. A simple hand gesture can enhance or improve the message being conveyed. Any form of machine input that can recognize hand gesture and process is used to hand gesture recognition.Hand gesture recognition system can be used for interfacing between computer and human using hand gesture. This kind of human-machine interfaces would allow a user to control a wide variety of devices through hand gestures. Hand gesture recognition is further classified as follows; Glove-based Hand Gesture Recognition and Vision-based Hand Gesture Recognition

- Glove-based Hand Gesture Recognition:

A glove-based system uses neural network approach where they use neurons inspired by the biological nervous system. The system consists of components which collect, send, process and then take action just like our human nervous system. The glove acts as a receptor and the sensors placed on the gloves collect the data and send it to the processing unit via electric signals. The processing unit then compares and calculates the correct result. Glove based approach is preferred due to drawbacks in the vision based systems. A glove-based system requires the user to be connected to the computer. Even wireless systems currently offered in the market require the user to wear a glove. In glove-based systems data gloves are used which can archive the accurate positions of hand gestures as its positions are directly measured. The Data-Glove based methods use sensor devices for digitalizing hand and finger motions into parametric data. The other sensors help in collecting hand configuration and movement.





Block diagram of glove-based hand gesture recognition

User Gesture: Data glove is implemented to capture the hand gestures of a user.

Flex Sensors: The data glove is fitted with flex sensors along the length of each finger and the thumb. The flex sensors output a stream of data that varies with degree of bend. The analog outputs from the sensors are then fed to the PIC microcontroller.

PIC microcontroller: It processes the signals and perform analog to digital signal conversion.

Encoder and RF Transmitter: The resulting digital signal is encoded and transmitted through RF system.

RF Receiver and Decoder: RF receivers receive the signal and fed to the gesture recognition section through the decoder.

Gesture Recognition Section: In this section the gesture is recognized and the corresponding text information is identified.

Voice Section: Text to speech conversion takes place in the voice section and play out through the speaker

Advantages of using glove based system is that we can achieve a higher accuracy and it is not affected by any vision impairing factor such as low light, noise, faulty camera and line of sight. There are certain disadvantage of this system, it gets complex and for it to function the user has to wear gloves while using the system. Gloves have to be safe to wear and easy to handle with all the electronics and wires being involved.

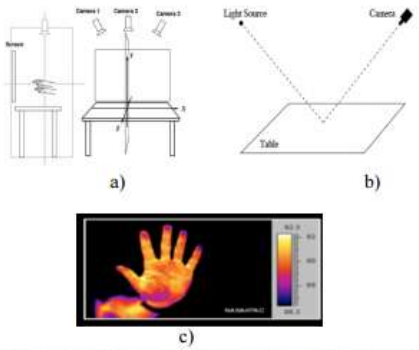
- Vision-based Hand Gesture Recognition:

In vision based methods, computer camera is the input device for observing the information of hands and fingers. It uses one or more camera to record images of human hand gestures and lighting conditions that enhance gesture classification accuracy. There are different types of Vision-based Hand Gesture Recognition such as:

Infrared-camera Based

Mono-camera Based

Multi-camera Based



a) Multi-camera, b) Mono-camera and c) Infrared-camera based Gesture Recognition

Figure: Vision Based Sensor

The production and perception of gestures can thus be described using a model commonly found in the field of spoken language recognition. An interpretation of this model, applied to gestures.According to the model, gestures originate as a gesturer's mental concept, possibly in conjunction with speech. They are expressed through the motion of arms and hands; the same way speech is produced by air stream modulation through the human vocal tract.

Also, observers perceive gestures as streams of visual images of gesturers which are acquired by one or more video cameras and interpret using the knowledge they possess about those gestures.

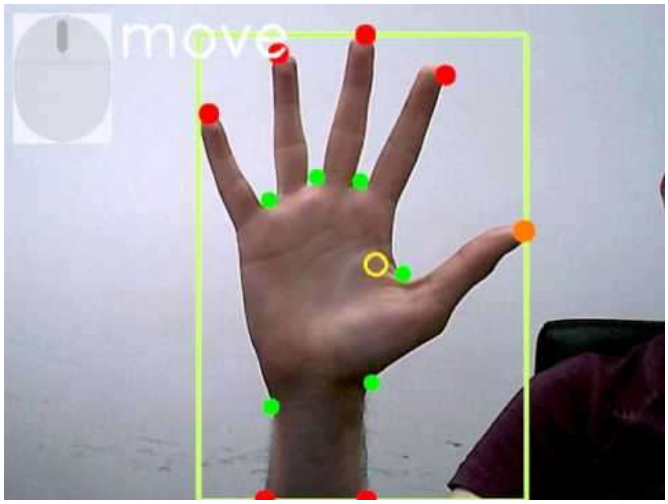


Figure : Hand recognition using rays

The vision based system uses a three layer model. The three layers are: detection, tracking and recognition. The detection part is made very precise involving multiple cameras and multiple shots to give the best result. Cameras take the picture of the gesture performed and using multiple techniques the image is processed and enhanced to remove any kind of noise. Tracking is the process where the perfect shot is taken from a series of photos which reflects the best output. Recognition layer uses the pre defined data along with the algorithm used to identify a certain gesture.

II. WORKING

By eliminating the use of optical signals to approximate the moment and decipher the gesture performed from the data collected. The system we are proposing in this article uses radars instead of optical sensors to overcome the drawbacks of the present optical sensors used in gesture sensing, as mentioned above. Radars are predominantly used for long range detection of objects but in this proposed system we will use them for short range detection of anomalies.

The sensors using radars would be more accurate and would be able to provide better communication interface between the user and the machine. The radar would allow the user to comfortably talk to the system without any limitation of the cone of sight of the device.

The human body, as we think of it is made up of many particles, these vibrate at their own rate and this also differs from one person to another. Thus when radar is used to detect these anomalies, the same gesture by different persons will slightly wary. This difference can be used to train the system to perform certain task when the gesture is performed.

As per above the system proposed consists of the following blocks:

- Signal Generation Module
- Transceiver Module
- Signal Processing Module
- User Interface Module
- Task Initiation Module

Signal generation module: In order for the system to detect anomalies we must first radiate energy into the surroundings for it to reflect back. Thus the signal generator module generates a pulse modulated energy signal to be radiated by the antenna.

Transceiver module: The signal to be radiated and the reflected signal will be detected by this unit.

Signal processing module:The received signal consists of a different frequency component when compared to transmitted signal. The processor is to basically filter out this component and compare it with trained sample to put forth the correct results to the Task initiation module.

User interface module: This is an application interface which allows the user to train the system of various gestures and assign them to various tasks as per his fitting. This module allows user to adjust or modify the gesture assignment as per his needs

Task initiation module: This module basically initiates the task assigned to the gesture it received as the input from Signal processing module. In order to interpret the body, motion we are utilising the concept of doppler shift. This is achieved by before mentioned Microwave module HB100 capable to tranceive in the range of 10.520GHz to 10. 530GHz.We have chosen the above module as it has a doppler frequency detection capability in the neighbourhood of 70Hz.

In order to process the received signal, we must first record the analog data from the sensor. This will be achieved by a python script running on Raspberry Pi.The data recorded contains the doppler shift data also. Thus in order to decipher this shift the data will be processed by a matlab script running on the Raspberry Pi as well.

The matlab script consists of the following sub scripts to perform the various signal processing functions on the data - Noise filter, Correlator filter (to remove transmitting frequencies), Low pass filter, Comparator (to compare the doppler shift with saved samples)

III. COMPONENTS USED

1. RASPBIAN OS:

The Raspberry Pi primarily uses Linux kernel-based operating systems. The new OS allows better use of the Raspberry Pi 's floating point hardware and allows for faster web browsing. Also, there is an omxplayer accelerated media player that comes preinstalled with this image. (Omxplayer is a video player specifically made for the Raspberry PI's GPU,). The most popular OS for the Rasp Pi is certainly Raspbian, a custom version of Debian GNU/Linux specially tailored for the mini-computer. Debian is widely used in server systems, and it forms the basis for several popular desktop distributions, such as Ubuntu. Thanks to the 35,000 packages in the Debian repositories, the user can draw on a huge amount of free software.

2. PYTHON IDE:

Python is a widely used high-level, general-purpose, interpreted, dynamic programming language. Its design philosophy emphasizes code readability, and its syntax allows programmers to express concepts in fewer lines of code than would be possible in languages such as C++ or Java.

It is a multi-paradigm programming language, including object-oriented programming and structured programming are fully supported, and there are a number of language features which support functional programming. The language provides constructs intended to enable clear programs on both a small and large scale.It features a dynamic type system and automatic memory management and has a large and comprehensive standard library commonly cited as one of Python's greatest strengths, providing tools suited to many tasks

3. LINUX:

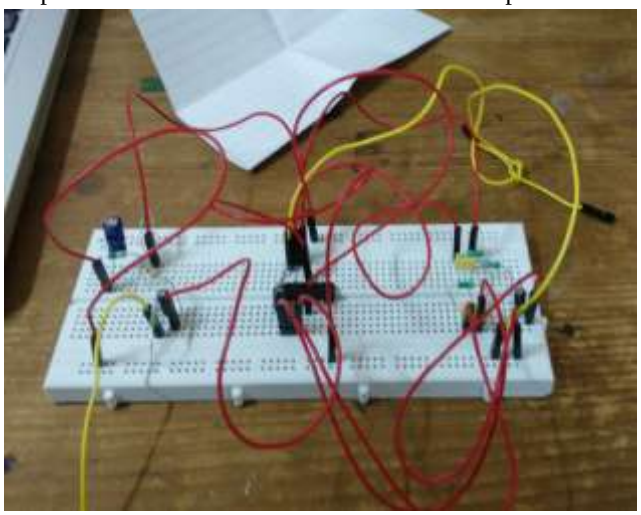
Linux is a free and open source software Unix-like operating system for computers. An operating system is a collection of the basic instructions that manage the electronic parts of the computer allowing running application programs. Free and open source software (FOSS) means that everyone has the freedom to use it, see how it works, change it or share it

4. MATLAB:

MATLAB is a high-level language for numerical computation, visualization, and application development. It is also used as an interactive environment for iterative exploration, design, and problem solvingIt also helps in solving complex mathematical functions for linear algebra, statistics, Fourier analysis, filtering, optimization, numerical integration, and solving ordinary differential equations.With the MATLAB language, you can write programs and develop algorithms faster than with traditional languages because you do not need to perform low-level administrative tasks such as declaring variables, specifying data types, and allocating memory.

IV. RESULTS

The practical result obtained was same as the expected result.



Circuit diagram

Verification of waveform

V. FUTURE SCOPE

With the advancement in the technology these days' mankind is developing new systems and devices to make our day to day life easier. Some of the regions where in it can be used are -

- Home automation – The system can be used to provide a comfortable interface between the user and the technology.
- Automotive automation – The system can be used to provide an easy reach for the driver/pilot so that he can concentrate on the primary tasks.
- Military – The system can be used at multiple places in military system as to provide no distraction combat capability.

Other application may be –

- Controlling lightning systems in an arena with limited manpower.
- Making the smart devices even smarter by providing a no touch interface for very minuscule tasks.
- For developing smart devices for disabled people.

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