

Gesture Recognition Using 3D MEMS Accelerometer

Akhila Denny¹, Annmary Cherian², Athira V Nair³, Anitta Thomas⁴

Graduate Students, Department of Electronics and Communication Engineering, Viswajyothi College of Engineering and Technology, Vazhakulam, Kerala, India^{1,2,3}

Assistant Professor, Department of Electronics and Communication Engineering, Viswajyothi College of Engineering and Technology, Vazhakulam, Kerala, India⁴

ABSTRACT:Using the MEMS technology assistance can be provided to physically handicapped people who are deprived of the usage of their limbs to move or to control things around them. Dumb people can be provided with modalities to communicate with people without having to depend on sign language. In this paper a low cost device will be designed that uses MEMS accelerometers to recognize different gestures made by people. Once recognized these gestures can be used to do various functions. When the person moves his hand the accelerometers produce analog voltages corresponding to the acceleration experienced by it various axes. The microcontroller is pre-programmed with the signals corresponding to certain gestures. When the gesture made by the user matches any of the gestures made by the user, the microcontroller generates a certain code uniquely identifying the gesture. The control module has a RF receiver, which can receive the code from the user module. The RF receiver is in turn connected to a microcontroller, which is programmed with specific functions that can be done for the corresponding unique gesture code. The function that is done could be decided depending on the nature of the user.

KEYWORDS:MEMS Accelerometer, Hand Gestures.

I. INTRODUCTION

Over the years transportation for the common man has become more and more easy and convenient. But one section of the society has gone largely ignored from this development; the physically challenged people. For the physically challenged there has been not much development or improvement in the way of transportation. The main aim of this paper is to provide an aid to such people. The MEMS technology used in this paper aims at helping physically handicapped and dumb people. The physically handicapped, who are deprived of their use of limbs or even the partially paralysed with the ability to move their arms can make use of this system to control the devices or pick the objects around them without moving around. Dumb people can make use of this system to communicate with the people around with them more easily, without having to resort to sign languages and the resulting ambiguity.

This paper is an attempt in the direction of trying to make the lives of physically challenged people easier. The proposed system provides them with a low cost device to take care of all these things without much effort using simple gestures. The system makes use of accelerometers, which convert acceleration into voltages. Each gesture produces different voltages and this is used to drive different modules.

The proposed system consists of three modules; a user module, a home automation-voice module and a robotic control module. The user module is used by the person to make the desired gesture. The home automation-voice module is used to control the devices and also to generate the desired voice clip. Using the robotic control module, the user can pick up various objects around them without moving.

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II. LITERATURE SURVEY

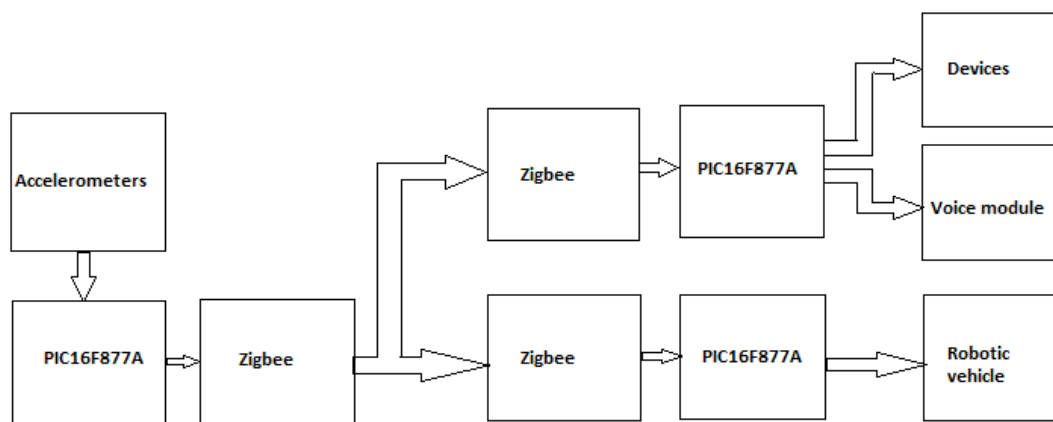
Existing Systems: Most of existing systems in the gesture recognition follows image-based approaches. It requires sophisticated image processing platforms. Mostly cameras were used as input devices. Object needs to be present in front of the cameras for capturing gestures, which limits the mobility. Power consumption is a challenging one. Several other existing devices can capture gestures, such as a “Wiimote,” joystick, trackball and touch tablet. Some of them can also be employed to provide input to a gesture recognizer. But sometimes, the technology employed for capturing gestures can be relatively expensive, such as a vision system or a data glove. There are mainly two existing types of gesture recognition methods, i.e., vision-based and accelerometer or gyroscope based. Existing gesture recognition approaches include template- matching, dictionary lookup, statistical matching, linguistic matching, and neural network. Three different gesture recognition models, 1) sign sequence and Hopfield based gesture recognition model; 2) velocity increment based gesture recognition model; and 3) sign sequence and template matching based gesture recognition model are also available.

Proposed System: To overcome the limitations such as unexpected ambient optical noise, slower dynamic response, and relatively large data collections/processing of vision-based method, and to strike a balance between accuracy of collected data and cost of devices, a Micro Inertial Measurement Unit is utilized in this paper to detect the accelerations of hand motions in three dimensions. The proposed recognition system is implemented based on MEMS acceleration sensors. Since heavy computation burden will be brought if gyroscopes are used for inertial measurement, our current system is based on MEMS accelerometers only and gyroscopes are not implemented for motion sensing.

The sensing device (MEMS accelerometer) senses acceleration in three axes. Those sensed signals are conditioned and given to the controller circuit. The controller compares the incoming signal values with the pre-stored values. Commands for each gestures are used to control different modules.

III. METHODOLOGY

To help handicapped people we incorporated three modules namely a home automation-voice module and robotic module. Home automation module helps them to control different appliances like bulb, fan, etc. Voice module is used to help speech impaired people to communicate with others. Robotic arm helps to pick objects near them. The block diagram of the system as a whole is given below.



The user module consists of a PIC 16F877A microcontroller, two accelerometers (ADXL 335), power supply connections and a switch. The two accelerometers are placed on both arms of the patient. The accelerometers are connected to the ADC port of the microcontroller. Initially the voltage values corresponding to different x, y, z positions of each accelerometer were determined. These values are used as the reference values. When the switch is in

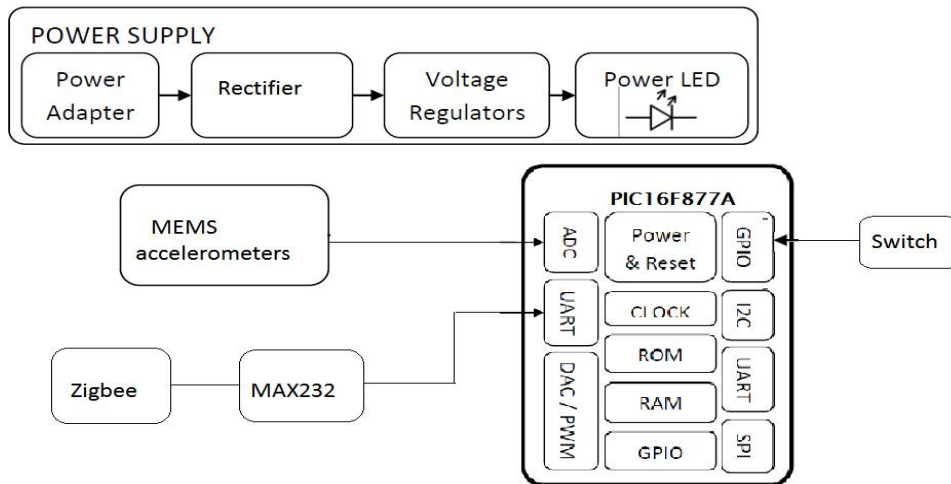
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ON condition one accelerometer is used to control different devices and another accelerometer is used to play voice clips using the voice module. When the switch is in OFF position one accelerometer is used to control the robotic arm and the other is used to control the robotic wheel. When the switch is in ON condition then according to the positions of the accelerometers different voltage values are generated. These voltage values are converted to digital values and are compared with predetermined reference values. If a match is found a certain code is transmitted. The codes are received in the home automation – voice module. Zigbee technology is used for transmission. These received codes are matched with predetermined codes. If match is found either home appliances are controlled or voice clips are played. The following shows the user module.



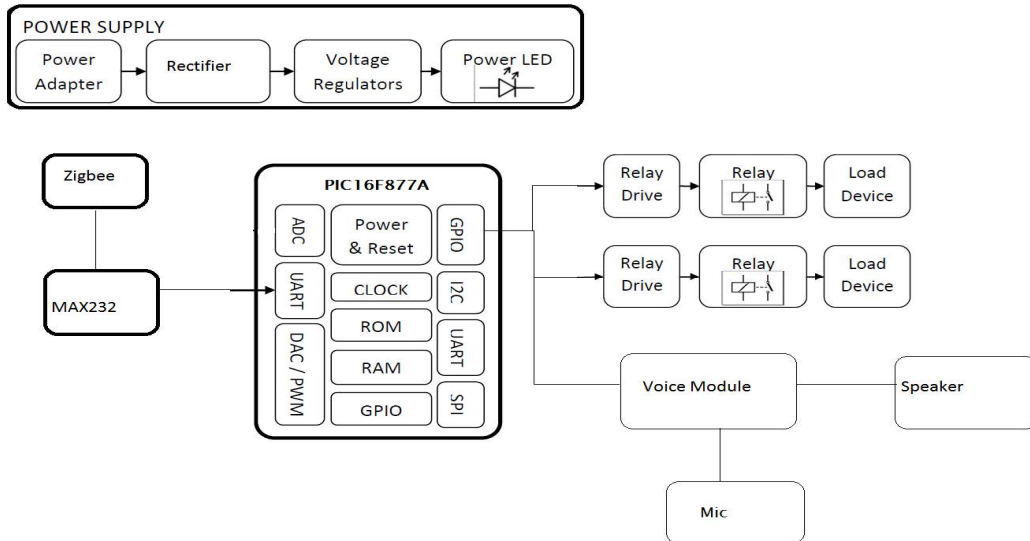
The home automation and voice module sections are connected to the same microcontroller. In home automation section multiple bulbs are switched ON and OFF. While in voice module section different predefined voice clips are played according to the gesture made by the user. The code transmitted by the user module is received by the PIC microcontroller. Operations that have to be performed corresponding to different codes are predetermined. When the codes are received it is compared with predetermined ones. According to the result, bulbs are controlled or voice clips are played. Here the movement of one accelerometer is used to control home appliances and the movement of other accelerometer is used to control the voice module. Relays are used to turn the bulbs ON and OFF. The voice module used is a 5 input channel voice module. Hence a total of 32 voice clips can be played. Here we have used only two input channels for four voice clips. The voice module has got options for recording, playing and deleting the voice clips. A speaker is connected to the voice module to play the clips and a microphone is used to make the recordings. The following shows the home automation and voice module.

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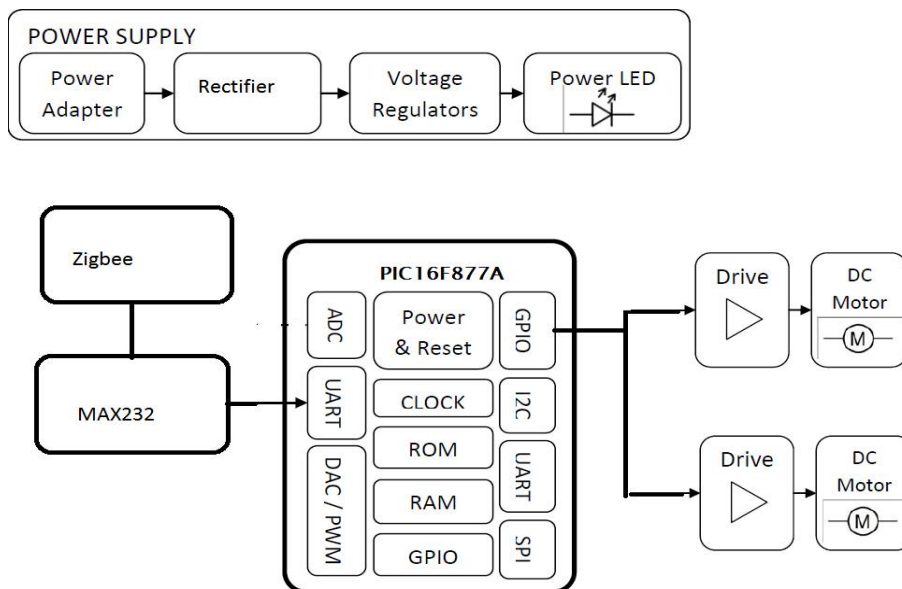
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Robotic module used consists of a robotic wheel and a robotic arm mounted on it. The robotic module is used to pick things around the patient. The robotic module is powered by DC motors. L293 driver IC is used to enhance the output of the microcontroller which is connected to the DC motors. When the switch used in the user module is in OFF state the two accelerometer positions can be used to control the robotic module: one for robotic wheel and the other for robotic arm. The following shows the robotic module.



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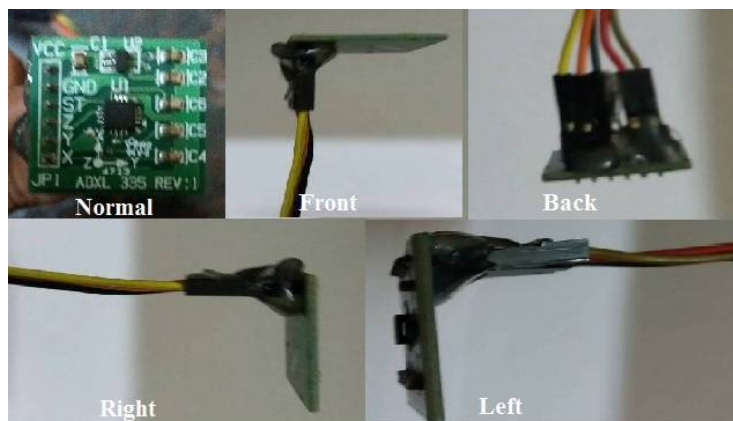
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IV. EXPERIMENTAL RESULTS

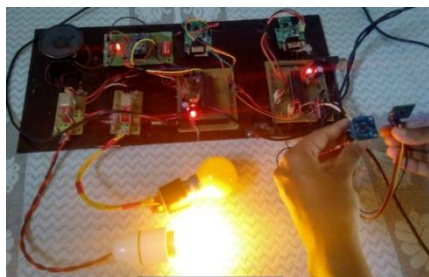
Initially the voltage levels corresponding to the different positions of accelerometer were determined. The positions taken are front, back, right, left and normal. The following figure shows the different positions of accelerometer.



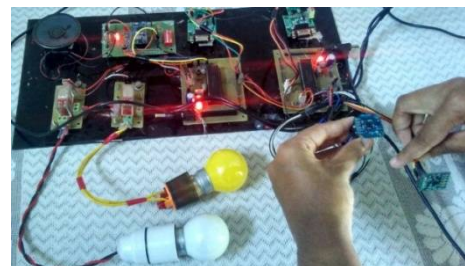
The switch provided was used to select either home automation – voice module or robotic wheel module. When the switch was turned ON, one of the accelerometers controlled the home appliances and the other one controlled voice module.

The figures below shows the different actions performed on different positions of the accelerometer.

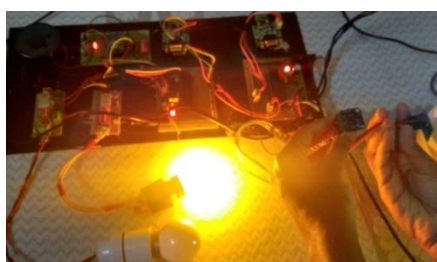
Figures (a) and (b) show the turning ON and OFF of the first bulb and figures (c) and (d) shows the ON and OFF of the second bulb.



(a)



(b)



(c)



(d)

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The second accelerometer was used to play different voice clips. An alarm sound was played when the accelerometer was kept in forward direction. When it was kept in backward direction the clip 'thankyou' was played. When the accelerometer was kept in right position the voice clip 'can you give me a glass of water' was played. When kept on left position the voice clip 'can you help me' was played.

When the switch was turned OFF both accelerometers were used to control robotic module. When the first accelerometer was kept in the forward position the robotic vehicle moved forward. When that accelerometer was kept in the backward position the robotic vehicle moved backward. When it was kept in right position the vehicle turned towards right and when it was kept in left position the wheel turned towards left.

When the second accelerometer was kept in forward position the robotic arm moved downwards. When it was kept in backward position the arm moved upwards. When the second accelerometer was kept in right position the robotic arm closed. When it was kept in left position the arm opened.

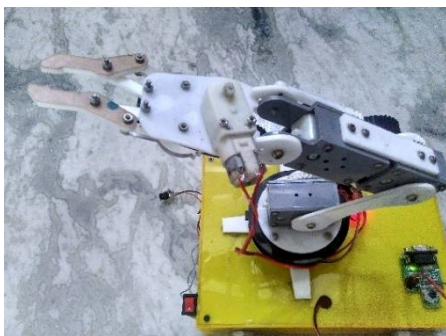
The figures (a) and (b) shows the robotic arm moving up and down when the accelerometer is kept in positions forward and backward. The figures (c) and (d) shows the robotic arm being closed and opened when the accelerometer was kept in the positions left and right respectively.



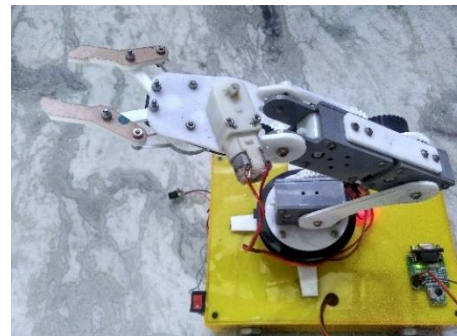
(a)



(b)



(c)



(d)

V. CONCLUSION

The success of the project lies in how accurately the accelerometer voltages can be predetermined corresponding to each accelerometer x, y, z positions. In order to get fast responses the accelerometer voltages predetermined should be accurate. The project can be a low cost and efficient one to control different home appliances and perform other tasks like playing voice clips and picking up objects.



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