AN IoT BASED SMART GLOVE

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***Abstract*- Internet of Things (IoT) has bought in a new era of smart and portable devices. IoT lays the foundation for futuristic communication standard and integrates various microcontrollers, sensors and all types of communication protocols, enabling "Human-Things Interaction".**

The aim of the project is to highlight the futurism in Internet of Things (IoT) and in addition to this, an Infinity Glove-An IoT based smart wearable gadget capable to perform various tasks like controlling the devices via gesture recognition, removing the communication barrier between the specially-challenged people and the normal people by providing them an interface and to perform custom tasks according to your needs, has been proposed.

The name "Infinity" determines the infinite possibilities that we can achieve using the smart glove.

Infinity Glove is a glove that can be integrated in the field of automation where one can automate things without getting in direct contact of the machines/appliances that are to be automated or controlled.

Infinity Glove is implemented in such a way that it is energy efficient and is a solution to the need for automation.

Keywords- IoT, Gesture Recognition, Bluetooth, Accelerometer sensors, Microcontroller, Glove, Sign language, Specially-challenged.

I. INTRODUCTION

IoT technology has bought transformation to the way we live life every day and will bring much more drastic changes in the automation world. From the consumer point of view, new IoT products like wearable devices and home automation devices are evolving and IoT technology is also giving lots of benefits even to disabled people. [9]
Sensors provides the basis to connect the things and enabling things to share information so that data can be stored, processed and presented in easy understandable form, in an IoT environment. IoT facilitates smart connectivity and context-aware computing via network resources.

Earlier, wired gloves were invented to capture hand gestures and motions. The gloves used optical or resistance sensors or flex sensors to measure the bending of joints. Those gloves had "difficult to handle/use" setup, limiting the applications to research purposes. In the coming years, there is a need to create accurate and lightweight wired gloves. IoT platform also provides a suitable environment to connect the hardware devices through users and the cloud. Considering the huge potential of IoT Technology current and undergoing development, a novel IoT based wearable Gadget- Infinity Glove based on Arduino microcontroller integrated with Bluetooth module(HC-05) and GY-61 3-axis accelerometer sensors, is being proposed.

The glove comprises largely of two main modules, one is for IoT automation and the other is to curb the communication barrier between the normal people and the specially challenged people.

II. LITERATURE REVIEW

All the reviewed literature describe the existing systems and the problems that we have to overcome, some of them are discussed here:

S. Mitra and T. Acharya [1] provide a survey on gesture recognition with particular emphasis on hand gestures and facial expressions. Applications involving HMM, particle filtering and condensation, FSM, optical flow, skin color, and connectionist models are discussed in detail.

Walter and Jones [2] applied the Peak Testing recognition technique to control virtual instruments and investigate how users respond to this interaction. It locates force peaks in continuous force data and then cancels any peaks which are not meant for input.

Barinder Pal [3] analyzes the scope and applications of various gesture recognition technologies in employing human gestures for device control in the paper.

Pallavi Verma [5] developed a microcontroller based cost effective system that receives its instruction from gesture recognition system using flex sensors to recognize gesture and convert into coded form so that it can be displayed if code matches with predefined codes. Normal person can text their message using keyboard.

Priya Matnani [6], proposed a technology which is mainly glove and accelerometer based systems to interact with computers and other physical devices using hand, body and facial gestures. Gestures can be of mainly two types: static and dynamic gestures [1]. In accordance to the input device, the gesture recognition technique can be divided into 3 categories: [4]

- **Glove-data based :-**

Glove-data based gesture recognition systems require users to wear gloves and other wearable devices to record the gesture alignment [4].

- **Vision-based :-**

The performance of vision-based systems relies heavily on the background or lighting condition i.e., the operating environment. They face the problem of low sampling rate issue.

- **Accelerometer based :-**

The accelerometer-based gesture recognition has become increasingly relevant nowadays due to the rapid development of micro–electro-mechanical system technology (MEMS) [2] and already shows its use in many IoT applications.

SoapBox is defined as Sensing, Operating and Activating Peripheral Box. It is a small box that has low power consumption. It is equipped with 3-axis accelerometer, an illumination sensor, an electronic compass and an optical proximity sensor. It is wireless with RF technologies for communication purpose.

The process of gesture recognition with accelerometer based device. The process consists of 3 phases. A filtering process is applied on data for simplification purpose before the major 3 phases. Firstly, we have the quantizer that is responsible to cluster the data using a k-means algorithm. Then, a discrete Hidden Markov Model (HMM) is used to train/recognize characteristic patterns for distinct gestures [12]. Finally, a "Bayes classifier" is used to select the appropriate gesture.

Kanika Rastogi and Pankaj Bhardwaj [8], proposed a review to test all the various existing technologies in the data glove or the attempts that have been made in the past to recognize the hand gestures. There are 4 types of existing smart glove technologies that are as follows:-

- Using CMOS Camera
- Leaf Switch based Glove
- Copper Plate based Glove
- Flex sensor based Glove

A. Using CMOS Camera

They transmit image data via UART serial port. The UART performs serial-to-parallel conversions on data received from a peripheral device (CMOS camera) and parallel-to-serial conversion on received data from the CPU (Microcontroller). Hand gestures were detected using CMOS camera by the 3 steps as follows:

- Capturing the image of the gesture
- Edge detection of that image
- Peak detection of that image

Disadvantage: Highly expensive, latency and each image occupies 50KB of memory.

B. Leaf switch based glove

Leaf switches are designed in such a way that when pressure is applied on the switch, the two ends come into contact and the switch will be closed. The two terminals of the switch should come into contact when the finger is bent, hence the leaf switches are placed on the fingers of the glove.

Disadvantage: The switch instead of being open when the finger is straight, it will be closed resulting in incorrect or improper transmission of gesture data due to prolonged use.

C. Copper Plate Based Glove

In this technology, a copper plate is fixed on the palm as ground. In rest position, the copper strips indicate a voltage level of logic 1. The voltage associated with copper strips is drained when they come in contact with the ground plate and thus, they indicate a voltage level of logic 0.

Disadvantage: The use of copper plate makes the glove bulky which makes it unsuitable to use it for a long time.

D. Flex sensor based glove

Flex Sensor is a resistive sensor changing its resistance according to the change in bend or curvature of the finger into analog voltage. This is a haptic based technology using flex sensors to take in physical values for processing.

Disadvantage: It is bulky and inconvenient to use.

All these old technology innovations have motivated us to enhance the advancement in technology. They have their limitations of recognition rate and time which will be overcomed with our proposed glove.

Anand Nayyar and Vikram Puri [9] have proposed a Data Glove, capable of performing various tasks like temperature monitoring, ambient light detection and gesture control. It is equipped with various sensors like LM35, Ambient, 3-Axis Accelerometer and Arduino IDE Serial Monitor for capturing the sensor data.

Santiago, Andrés and Sebastián [10] describe the novel design of a communication tool for individuals with hearing disabilities and speech disorders. Morse code is the base over which this new technology is proposed with a robust functionality and an ergonomic design.

Meri Awaaz [11] smart glove is an electronic gadget that acts as an auxiliary device to make interpretation of communication via gestures into content or discourse as indicated by American Sign Language. This glove has been implemented using flex sensors, accelerometer and Arduino Uno.

III. OBJECTIVE

The objective is to develop a smart glove which can be integrated in the field of automation where one can automate things without getting in direct contact.

1. Add & perform custom tasks using gestures
2. Control machines/appliances that are to be automated using Gesture Recognition technology using various sensors in a wearable IoT based glove.
3. Enable communication between differently-abled (deaf and dumb) person and a normal person who does not have the knowledge of sign language.

IV. SMART GLOVE

Infinity Glove is equipped with sensor attached to the top of the glove taking the gesture input and automation takes place by gesture recognition algorithm.

The sensors that will take the input data will be GY-61 3-axis accelerometer. The accelerometer will help in plotting the gestures in 3-axis graph. The Bluetooth module that is, HC-05 will transfer the data from the sensors attached on the glove to the Android application.

The application of the project is powered by Android, which is a mobile operating system developed by Google, based on the Linux kernel and designed primarily for touchscreen mobile devices such as smartphones and tablets. The application will perform the tasks according to the gestures mapped by the microcontroller.

The two modules which come under the IoT glove are as follows:-

- IoT Automation
- Specially Challenged people

A. IoT AUTOMATION

This module was proposed to highlight the futurism in Internet of Things (IoT). An Infinity Glove- an IoT based smart wearable gadget which is capable of performing various tasks like controlling the devices via gestures and to perform custom tasks according to your requirements.

In the age of automating everything, a touch-less, natural user interface (NUI) is critical for everyday users to engage with the intelligent devices and environments. Carefully designed interfaces and sensors that can recognize common user gestures will greatly enhance the user experience, productivity and safety in designing smart buildings.

B. SPECIALLY-CHALLENGED PEOPLE

The project can be beneficial for the differently-abled (deaf and dumb) community. As disabled people have their own kind of communication language which might not be easily understood by normal people. Normal people, such as us, use verbal communication as our primary mode of communication i.e. we can convey directly everything and anything which comes in our mind by speaking it. And the means of communication that disabled people say deaf-dumb, uses is sign language. It is a communication skill that uses gesture instead of sound to convey one's thought. Well, to minimize the depth of this barrier we came up with a smart glove that can easily communicate by just making the ASL gestures that are recognized by the microcontroller then results in different expressions/commands in text and audio format on laptop or any android smartphone via an app, enabling specially challenged people (deaf and dumb) to communicate easily with others who do not have any knowledge about sign language.

Sign language recognition-

As ASL (American Sign Language) is the most commonly used sign languages, we will be incorporating it in our gesture recognition module. The way to measures orientation in a three dimensional space depends on the referential system. For the working of Infinity glove, we observed that the Euler coordinate system was the most suitable for the gesture recognition. This system represents an orientation with three angular values- yaw, pitch and roll which are used to describe the orientation and altitude of the hand movements.

The 3D motion can be detected by the three angular values with reference to the orthogonal axes are as follows:-

- **Roll** indicates rotation along the front-to-back axis of the plane.
- **Pitch** indicates rotation along the side-to-side axis of the plane.
- **Yaw** indicates rotation along the vertical axis.

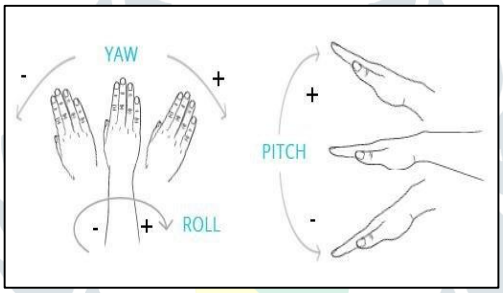

Fig. 1

V. IMPLEMENTATION

The following is the overall implementation of the smart glove: -

1. The glove is attached with basically a GY-61 3-axis accelerometer, Arduino microcontroller and HC-05.
2. The accelerometer sensors collect the gesture data and convert it into gesture input.
3. The gesture input is sent to the microcontroller i.e., Arduino.
4. The microcontroller matches the gesture input from the sensors with the stored gestures.
5. The microcontroller transfers the data to the Android application on the smartphone via a Bluetooth module i.e., HC 05 and also displays it on the 16x2 LCD attached to the glove.
6. If the gesture input matches with any stored gesture, then the respective objective is performed related to the gesture.

Real world implementation(Prototype):

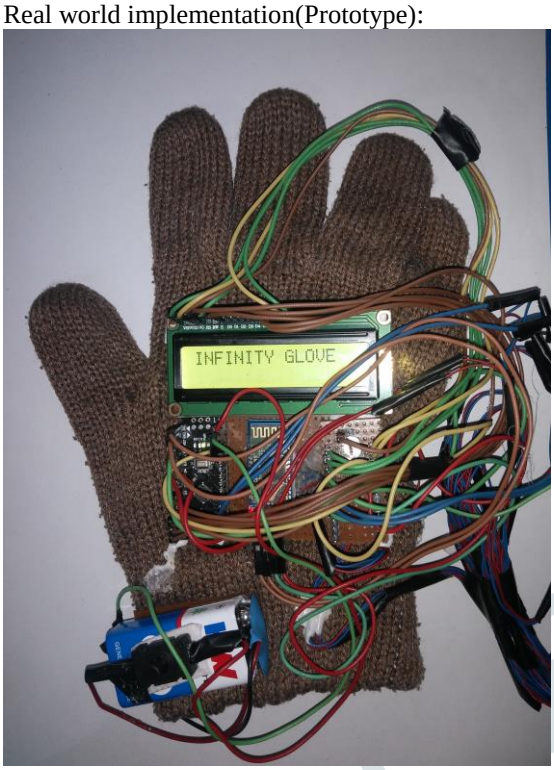

Fig. 2

VI. WORKING AND CALCULATIONS

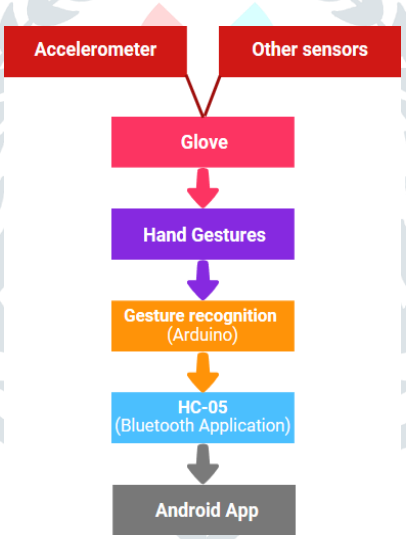

Fig. 3: Data flow diagram of Smart Glove

Arduino Nano R3 has been used in the project model which uses a single 5V output pin. But we need to connect more than one sensor which requires 5V. So here we are using a 1K ohm potentiometer. Potentiometer, a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. With a potentiometer here we are extending the capability of microcontroller to provide multiple 5V and GND pins.

$$V_{\text{out}} = \frac{Z_2}{Z_1 + Z_2} \cdot V_{\text{in}}$$

Z1 = V / I

where I is current draw from Vin when Z2 is 0

Z1 = 10v / 10mA

Z1 = 1K Ω

5v = (Z2 / (1 k Ω+Z2)) * 10v

Z2 = 1K Ω

In 16x2 LCD, though it is an 8 bit mode component but we are using only 4 bits here to save pins.

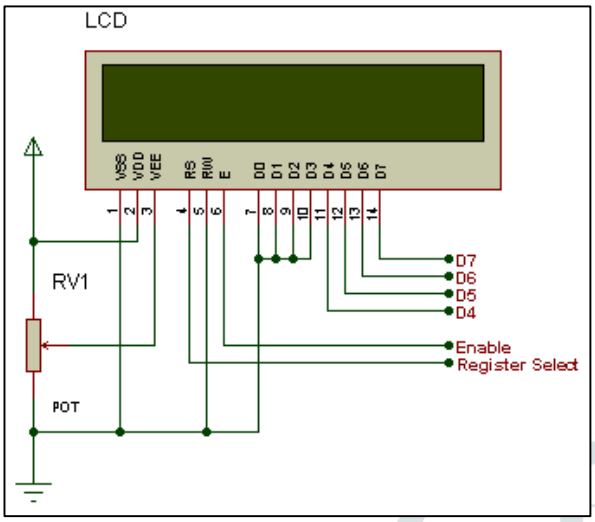

Fig. 4

Here only D4, D5, D6 and D7 data pins are used and D0, D1, D2 and D3 are kept grounded.

4 pins in HC-05 Bluetooth module are used. RW(Receive), TX(Transmit) 5V and GND.

4 pins in GY-61 Accelerometer are used X, Y, 5V and GND.

Sample Data:

You can put the module in 4 directions to determine the min-max-values which are the axis values of x's and y's.

The values ranges from:

(Right) 0° x = 349; y = 341

(Forward) 90° x = 281; y = 345; z = 357

(Left) 180° x = 350; y = 345; z = 288

(Backward) 270° x = 419; y = 341; z = 355

```
if(x_axis > 380)
{
lcd.setCursor(0,0);
lcd.print("gesture 2");
Serial.println("gesture 2");
}
```

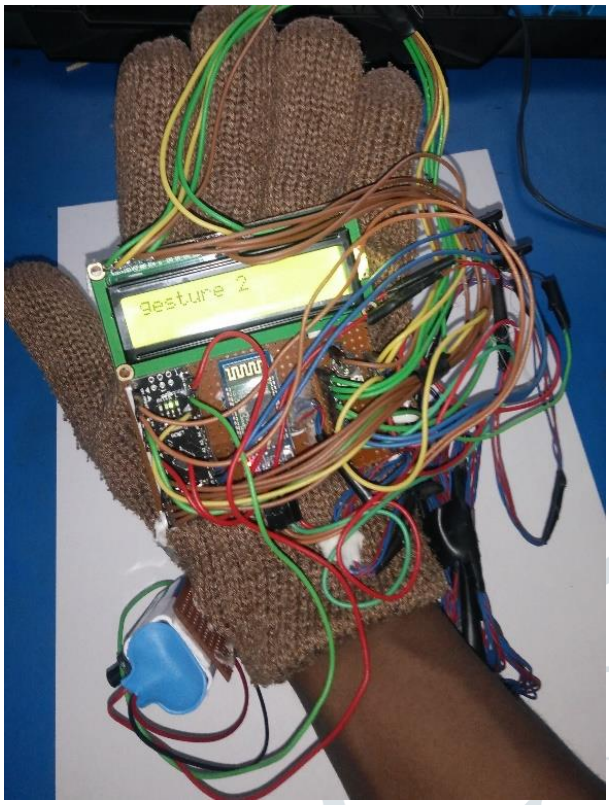

Fig. 4

VII. COMPARATIVE STUDY

The comparisons between Infinity glove with the already existing wired gloves based on IoT, i.e. **"*Infinity glove Vs. Existing wired gloves*"**

1. **Accelerometer v/s Flex Sensors-**
   The accelerometer sensor is faster when compared to flex sensors because the change in the 3 coordinates (x, y and z-axis) can be easily recognized when compared to recognition of the change in voltage in flex sensors.

2. **Portability v/s Stationary-**
   The design is portable because of adopting a wireless approach.

3. **Sensors v/s Image Processing-**
   Data can be easily processed in accelerometers whereas if flex sensors are used for analysing data, image processing will be used which makes the performance slower.

4. **Compact v/s Bigger-**
   As GY-61 3-axis accelerometer sensors are used which is more compact than flex sensors, design is more compact. Flex sensors were used in existing gloves which were bulky. Handling is easy when GY-61 is used in Infinity glove.

We can convert some gestures into words unlike only other projects which convert only alphabets. A programmable mode can be employed to enable the user to register own gestures for ease of communication.

VIII. CONCLUSION

This paper has introduced an IoT based smart glove named Infinity Glove for differently abled people. This glove is not only helping deaf and dumb people to communicate on equal basis but will help normal people to understand them a bit more clearly. Infinity Glove is convenient than other gloves due to its wireless approach i.e. Bluetooth and less bulkiness due to use of less number of sensors as compared to other gloves which uses quite a no. of flex Sensors. The Infinity Glove is faster and precise because we are using 2-axes of the accelerometer placed on the glove. Gestures are plotted on a 3-axis graph rather than using image processing which makes the processing even slower and overall glove costly. Infinity Glove is also capable of handling automations around oneself which is also helping normal people to ease their life a bit let alone differently abled. Hence, we can conclude that it is a better approach in comparison to most of the already existing IoT smart gloves out there.

IX. FUTURE SCOPE

The Infinity glove can have various useful applications like:-

1) In defence sector and war equipment system, where solider need not put their life in danger and can control the artillery or explosive without coming in direct contact of it from a safe distant zone.
2) This smart glove can be used in robots for rescue operations.
3) Successive Gesture Typing with minimum of 3 trigger switch.
4) A gesture controlled communication aid for elderly and disabled people

Hence, the smart wearable glove can solve many issues and also fulfill the requirements of different fields like in healthcare, military & defence sector, automation and public safety.

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