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Smart Handy Devices for the Blind and the Dumb

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Abstract: ***In this paper, two smart handy devices for the blind and the dumb people has been designed using Lilypad and NodemCU. This project has been implemented in order to overcome the travelling difficulties for the visually impaired group, by giving these people guidance efficiently and safely. On the other hand, the Hand Talk that can be used by Individual with Hyper functional voice disorders, Individuals with Aphonia consequent to laryngectomy, for Treatment of apraxia and other neuro communication disorders allow an effective communication with the blind person.***

Keywords: Ultrasonic Sensor, Lilypad, NodemCU, Flex Sensor, IoT, ThingSpeak, NEO 6m GPS module.

I. INTRODUCTION

One of the most common buzzwords in technology circles right now is "*Internet of Things*" (*IoT*). New services, devices, apps and technologies of the Internet of Things (IoT) are being introduced at a feverish pace and the world is silently growing more hyper-connected with each passing day. Various technologies and research works have been done in order to improve life for partially sighted and blind people, and IOT is now digitally transforming their lives by connecting them smartly over the internet.

The main aim of this smart device is to overcome the travelling difficulty for the visually impaired group, by giving these people guidance efficiently and safely. [1] A novel sensor-based obstacle avoiding algorithm is proposed, which utilizes ultrasonic sensor to solve the problems of detecting small obstacles. As soon as the obstacle is detected by the sensor within the minimum distance, the buzzer beeps. On the other hand, wandering or disorientation is commonly experienced by people suffering from the visual impairment. If this happens, it is imperative that they are found right away to prevent harm from catching up on them. That's why their location is tracked immediately using NEO 6M GPS module interfaced in the spectacles, which updates the latitude and longitude points of the person's current location using IOT in the ThingSpeak IOT platform and then parses that value onto the Google Maps. [2] Using an Internet-connected smartphone or a system, their movements can be viewed in real time. Not only does it help to monitor their movements, it also helps their well-wishers locate them immediately in the event they get lost.

Meanwhile, there are certain medical conditions such as acute laryngitis, or Dysphonia where people have hoarse vocal cord or lose of voice. A range of issues can cause laryngitis, including long-term tobacco smoking, stomach acid reflux, overusing your voice, viral infections, such as cold and flu viruses. There are certain patients with Vocal cord paralysis and some other surgical operations include the removal of the thyroid gland and heart or lung surgery can damage the nerves to the larynx causing either temporary or permanent vocal cord paralysis (palsy). Patients with such condition are prone to psychological effects when they learn about them losing their larynx. For such patients, hand gloves provide them with an artificial standard voice module which automatically plays once the user interprets a symbol. [3] This is an alternative and augmentative communication (AAC) tool for predicting the that encompasses the communication methods used to supplement or replace speech or writing for those with impairments in the production or comprehension of spoken or written language. [4]Everyone uses multiple forms of communication, based upon the context and our communication partner. Effective communication occurs when the intent and meaning of one individual is understood by another person. The form is less important than the successful understanding of the message. So, it is necessary that those individuals with such vocal disorders need to communicate with those people who have visual impairment. Hence whenever the person shows a particular sign, the Lilypad interprets the values from the flex sensors based on the bending or variable resistance values and outputs the corresponding audio (.wav file format). [5]

II. EXISTING SYSTEM

The existing system for the visual impaired group of people only dealt with the detection of obstacles at the ground level. It does not detect obstacles above the ground level, until and unless it is integrated with a wearable device which tends to be another carry-item for the adults or the elderly. Moreover, the individual is forced to carry a tracking device with them to know about their where-about. The conventional tracking system requires two separate circuit networks both at the transmitting and receiving end which makes it complex. [6] On the other hand, the interpretation of sign language can be done in various methods such as using electromyogram (EMG) sensor which is highly expensive and involves a large amount of data computation; those systems which only convert the gestures in alphabetical output rather than the sign as a whole. [7]

III. PROPOSED SYSTEM

Because of certain drawbacks in the existing system, here smart handy devices are proposed which over the minute drawbacks faced by those devices by intellectually detecting the obstacles above the ground level, such as a pillar or wall, and at the same time tracking their location anytime and anywhere, by using ThingSpeak without using any transmitter and receiver circuits. Meanwhile, the gestures are interpreted, and the audio output is the complete sentence for the sign rather than an alphabet or a word.

IV. METHODOLOGY

Visual impairment is the source of numerous serious medical, psychological, social, and economic problems. According to the World Health Organization (WHO), the number of visually impaired people worldwide, in 2010, was estimated at 285 million, of whom 39 million were blind. Because more than 90% of visually impaired people reside in developing countries, WHO approved an action for "Vision 2020" over the next decade. On a survey among them, shows that almost 70% of the people face many hindrances in their day to day basis without any assistive technology.

This leads to the development of this low budget assistive handy device which is developed based on the IOT technology. Initially an ultrasonic sensor is integrated on the front side of the spectacles so that any obstacle above their forehead can be detected, which avoids the hitting of the person inadvertently. And also, by the use a GPS module, the current location of the person can be tracked in real time form anywhere around the world.

For the Hand Talk gloves, various repeatability analog values are taken from the most occurring range of values are chosen based on which the algorithm is written. On showing a particular gesture, the corresponding analog audio is outputted.

V. SYSTEM ARCHITECTURE

The system as a whole consists of two handy devices, one being the Smart Spectacles which detects the above-the-ground obstacles and keeps a track of the location of the individual; and another one being the hand talk gloves which helps the group of people who suffer from neuro communication disorders with communication.

A. Smart Spectacles for the Blind

The Smart Spectacles for the Blind or the visually impaired group allow the detection of obstacles above the ground level such as trees, pillars, or walls using an ultrasonic sensor and Lilypad Microcontroller. Meanwhile, many people tend to get lost in their locality and thus creating chaos among their relatives. Hence the GPS module sends the data to ThingSpeak.com (an open IOT platform with MATLAB analysis).

The GPS data from ThingSpeak is read and shown in the Google map using ESP12e NodemCU and GPS Neo 6M Module. The data id uploaded on ThingSpeak server using ESP12e NodemCU module. The data is continuously taken from GPS Neo 6m Module which is connected to our ESP12e NodemCU module. Finally, a web page is created where this data is parsed in Google maps using a google map API key. [8] The block diagram of the architecture of the smart spectacles is as given below:

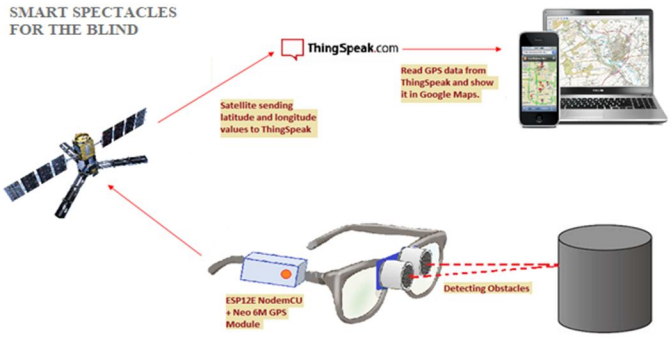

Fig 1 Block Diagram for Smart Spectacles

B. Hand Talk Gloves For Gesture Interpretation

Rather than interpreting the gesture as an alphabet or a word, this Hand talk glove outputs an entire sentence for a particular gesture. In this paper, two audio output files for two respective gestures are included. Any number of audio files can be included, but each gesture can output only one audio file. All the audio files in the .wav format are stored in a SD card and using a SD card reader module and Lilypad the audio file is read when a particular gesture is made. The block diagram is as given below:

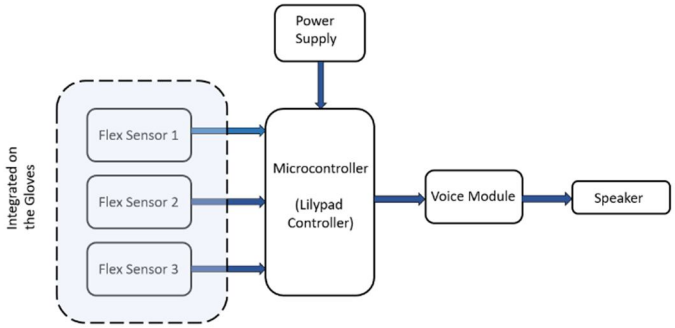

Fig 2 Block Diagram for Hand Talk Gloves

The hand talk glove uses flex sensors which acts as a variable resistor and based on the amount of bending of each finger, the analog value of each flex sensor is varied. Thus, based on these repeatability values, each gesture is assigned a particular audio file. Every time a particular gesture is made by an individual, the analog values change accordingly and based on the algorithm used, the audio file (in the .wav format) is played from the SD card. A SD card reader module is used which is connected to the micro controller (Lilypad) which reads the audio file stored in the SD card and plays the respective audio file.

VI. ALGORTHMS AND SOFTWARE DESIGN

The Arduino IDE is used for programming micro controllers used. Two different algorithms are used for the two handy devices, which is as explained below:

A. Smart Spectacles for the Blind

The ultrasonic sensor uses the regular design to determine the distance between the sensor and the obstacles. The distance between the obstacle and the sensor is calculated based on the time duration between the emission and the reception of the ultrasonic waves from the trigger and echo pin respectively. The distance is calculated using the formula:distance = (duration/2) / 29.1

In the above formula, 29.1 is the pace of the sound (i.e. reciprocal of the speed of sound in ss/cm). But the algorithm for the spectacles is written such that the if the distance between the obstacle and the glasses (meaning the ultrasonic sensor) is greater than or equal to the 50 cm (the distance range of the ultrasonic sensor being from 2 cm to 400 cm). [9]

Fig 3 Ultrasonic sensor hardware

On detecting an obstacle within this range, the buzzer is enabled HIGH. Lilypad Arduino is the most happening toolkit which empowers novices to design and engineer by its highly portable and small size structure.

B. Hand Talk Gloves For Gesture Interpretation

Lilypad Arduino is an Arduino programmed microcontroller which is explicitly designed for easy integration and development of e-textile and wearable projects. [9] Hence the use of this Arduino along with an FTDI (Future Technology Device International, a Serial Bus technology used along with Lilypad) in the development of the Hand talk glove has been an asset.

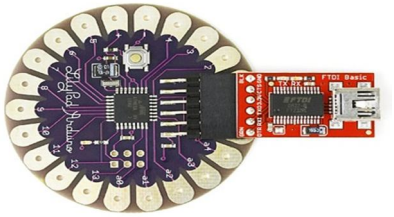

Fig 4 Lilypad with FTDI board

Initially the audio file (in mp3 format) to be played a particular gesture need to be converted into the .wav format, since the system uses a SD card along with an Arduino. The Lilypad Arduino can play the audio files only in the .wav format. Hence the .mp3 format is converted into the .wav format with the following specifications:

Bit Resolution	8 Bit
Sampling Rate	16000Hz
Audio Channel	Mono
PCM format	PCM unsigned 8-Bit

Table (1) Specifications for conversion of mp3 to wav format.

On conversion of the audio file, the SD card reader module reads the respective audio file whenever it is enabled. Now the condition for when the audio file must be enabled is to be determined.
In this device, three flex sensors are used and their analog values a standard two gestures is determined. The assumed two gestures and their respective output is as given:

Fig 5 Gestures used for this device.

1) Gesture (1) – Standard or Rest Position
2) Gesture (2) – Introduction of an Individual
3) Gesture (3) - Regards conveyed to the other person

In order to determine the range of analog values, a survey of various analog values for each finger is determined, and based on the repeatability od these values, the range is determined.
Hence the analog value of each flex sensor is determined and is compared with the predefined values. Now based on these conditions, the respective file is outputted. The analysis of the repeatability of the analog values is as given below:

Rest Position			Introduction Gesture			Regards Gesture		
FF	MF	RF	FF	MF	RF	FF	MF	RF
563	510	549	563	510	569	562	530	566
562	514	553	563	514	568	563	527	565
562	514	554	563	513	566	563	527	566
562	514	553	561	513	566	562	527	565

Table 2 Analysis of Repeatability

Now based on these values the algorithm for playing the respective audio file is written. A sample of the algorithm used in the device is as given below:

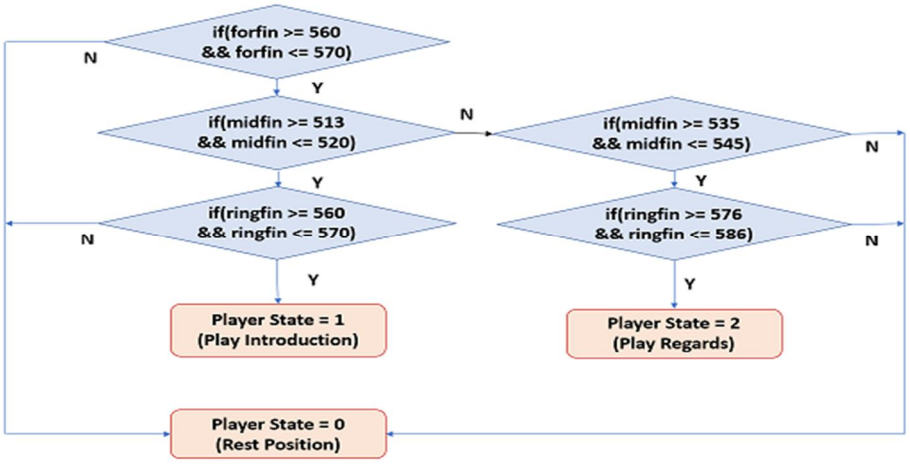

Fig 6 Algorithm for Playing audio

VII. RESULTS

Due to the use of IOT and ThingSpeak IOT platform, the MATLAB plot for the latitude and longitude value of the device at various time durations can be viewed as follows:

Fig 7 Latitude and Longitude plot on ThingSpeak

When these latitude and longitude values are parsed onto the google maps page, the respective real time location of the individual can be viewed and accessed at anytime and anywhere. A sample output is as given below:

Fig 8 Parsing values in Google Maps

On the other hand, the hand talk outputs the respective audio file when the appropriate gesture is made. It is highly portable due the use Lilypad microcontroller which is stitched on the glove using the conducting wire, thus making it more user-friendly.

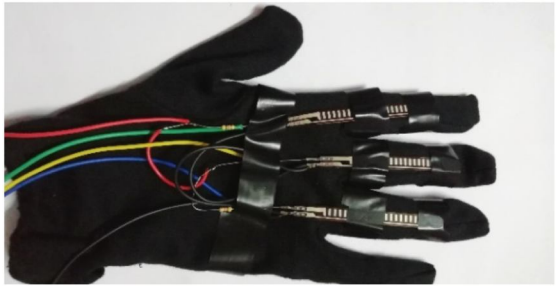

Fig 9 Prototype of the Hand Talk Gloves

VIII. CONCLUSION

In this work the design two handy devices are shown, one being the Smart Spectacles for the visually impaired group, and the other device for individuals with certain medical conditions such as acute laryngitis, or Dysphonia where people have hoarse vocal cord or lose of voice or in other words bring dumb. These devices are made portable and compact by using microcontrollers such as Lilypad and NodemCU. NodemCU has an inbuilt Wi-Fi module which makes it usable for IoT based dynamic functions. It integrates various functionalities into a single block of components, unlike carrying various devices for each functionality. The major limitation in this design is that the individual who is wearing the spectacles should be in the range of Internet connectivity for his movement to be tracked.

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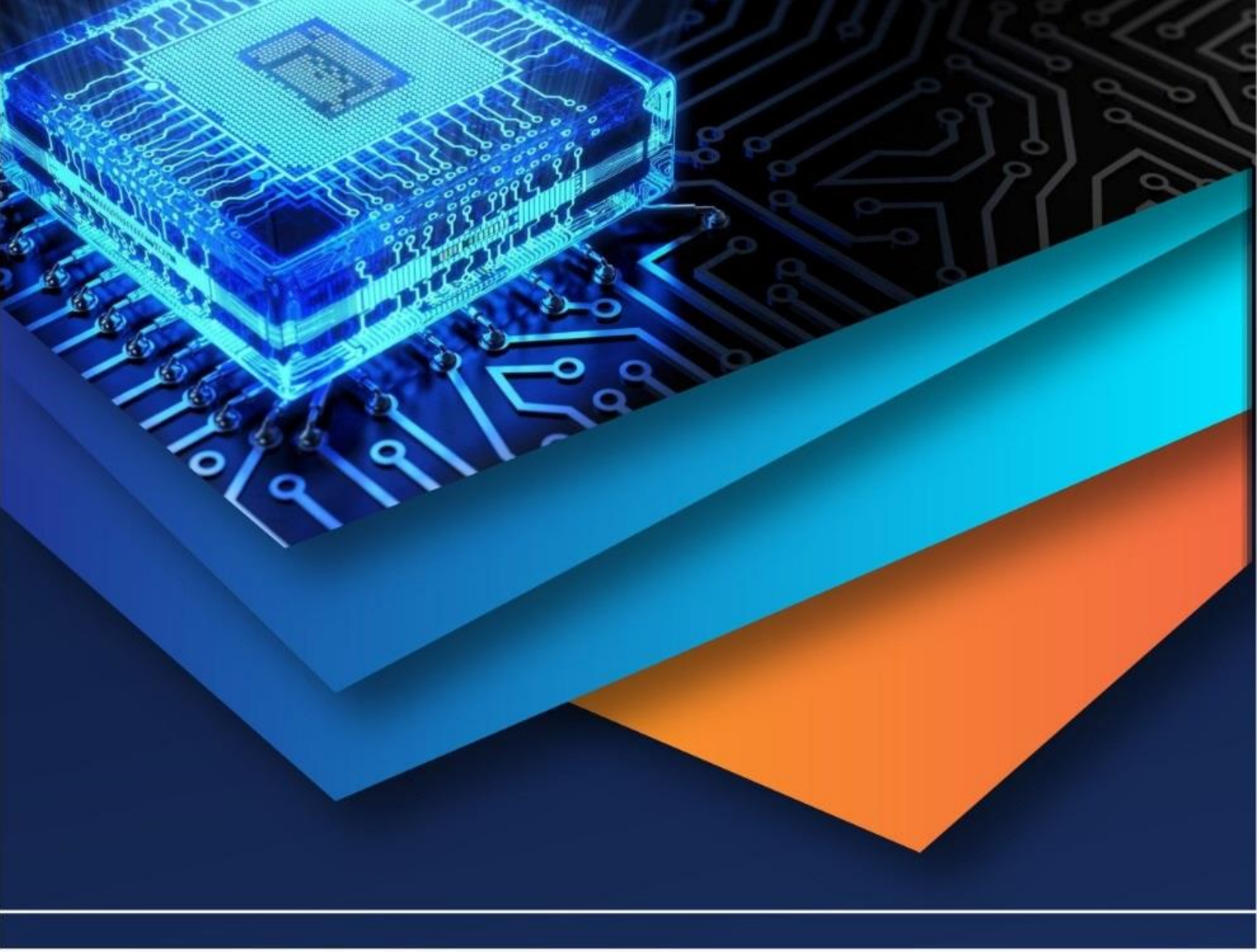

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