PROJECT DEAF

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Research purpose

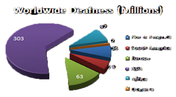
For a long period of time, the Egyptian health care problem have been an irritation reason for all its citizens. Such an unbearable health service has contributed to a various set of challenges that Egypt needs to solve, all of which acts as a huge obstacle in the way of Egypt's ambitious plans for development. The consequences vary dramatically in a variety of fields, From the rapid rising of the epidemics and chronic diseases in Egypt, To the huge social separation among the population layers of our society in basic every human need, to even the huge tax payers money spent on stabilizing minimum care requirement. The lack of supporting health care as seen is devesting for our country inhabitance. Diseases such as hepatitis and diabetes became a common sight now, but the one that stood out during our research was unsurprisingly the hear loss. For our scientific project to be considered a successful solution for the Egypt most wide spread health problem, it should be a cheap, simple yet practical and accurate device capable of aiding the suffered people in their everyday communication needs. That is just what our prototype is all about. A valid successful solution for such a problem is what the prototypes of our solution is hopping to figure out.

Abstract

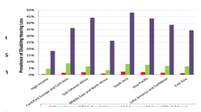
As seen before in our project purpose, A set of basic capabilities must be identified in order to build a successful solution. Such as, being able to construct our prototype using cheap and available electronic materials from the surroundings in addition to simple assembling technics that saves costs. By which, making it more accessible yet reliable for a huge portion of the consumers. The end result of these hypnotized criteria are two wearable gloves suitable for everyday use that embeds within it a voice to display conversion, sign language to speech translator and even an additional band that gives music and poetry a taste to live for. Through implementing our project, we give the deaf person a way of listening and response and feel the world connectivity -basic human interactions need. The real-life test results were very optimistic about its implementation in real world scenarios. Adding the ease of use and portability of our gloves system undoubtedly makes it an unmistakable chance of improving millions of lives. In the next sections, all of the above details will be more elaborated briefly.

Background Research

Our team researches have figured out that almost more than 10% of all Egyptians across a large portion of all ages are suffering from complete hearing loss in 2007 alone. All of this without even counting those having intermediate hearing difficulties. Such a scary figure superbases even the total diagnosed diabetes cases from 2005. But such a problem isn't only an abuse on Egypt, nearly 470 million human being is suffering right now from deafness, an astonishing 6% of all the world population (as shown in figures 1,2) .To makes the matter worse. The struggling of developing nations in providing minimum health care requirements and the population explosion phenomena than envelops the whole globe makes a progress un possible.



So, in theory the demand is immense for a solution. For this particular reason, A diverse amount medical solutions have been developed. One of the noticeable attempts was the cochlear implant operation, which involves planting an electronic sound magnifier that emphasize the cochlear nerves inside the ear canal that can help to hear sounds. But with the modern estimated prices ranging between 30,000 $ and 50,000 $ US dollars without at least insurance, for most of case its away from people hands.



But our 2 prototypes on the other hand are a completely different story. with the basic equipment cost ranging between 30$ and 50$ us dollars for both of them it's a guarantee that its more available for a larger portion of the consumers. Via the appliance of our prototypes in human life, the human essential needs of hearing can be provided with ease, resulting in 180-degree change of people's way of living. this is important since the suicidal rate in their lifetime can touch the 30% barrier due to the social, culture and communication problems. So, there a hope that it can really saves even others life's

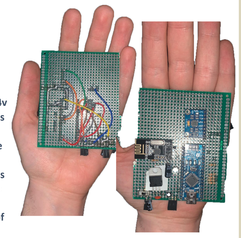
Hypothesis

In our 2 prototypes we hypnotized several important key factors that can aid in their success. In the band of vibration, it's the fact that losing one sense can help in aiding the other dramatically. This fact is already proven well in the scientific community and have a solid ground upon which we can built a reliable prototype.

Some researches theorize that after losing hearing abilities within 72 days later, nearly 84% of his auditory neurons have been completely responsible for somatosensory in his body alone, leading to an observable increase in the patient touch recognition skills (as shown in figure 3). This is exactly what the band prototype exploits, by using such a trick we can obtaining sound waves from the surrounding and process them by an algorithm that can help in identifying the average frequency per tone. With this analyzed frequency spectrum in hands, the prototype can divert it into vibrations via specialized motors. All of this lead by the help of deaf people high somatosensorial abilities, can be used in order to determine every sort of audible art a deaf person can wish to hear. On the other hand, in the second glove prototype, another approach is chosen. As by know almost 70 million humans worldwide communicate and learns sign language to get their hear-less everyday life needs, but only a staggering 10% of the deaf person relatives knows what does it mean. Depending on this, the second protype in its first stage uses a variety of movement and elevation sensors (as will be briefly explained later) Thus, making it capable of translating it via a pre written instruction into hearable audio, so they can express them self's and feel more connected to the world. Adding to this that most of his day-to-day life scenarios and interactions will be outside we embedded a screen to write the other talker words, by which making it easier to interact with any deaf person on the run.

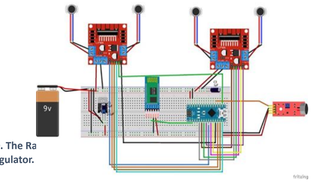
Methods

Gloves connections:



We have used Arduino nano to make our gloves it is small and powerful microcontroller each glove contains one Arduino. First each glove is supplied with 7.4v batteries that is connected to Arduino and 5v output voltage regulator. Each glove has Led that is connected to Arduino and a 1Kohm resistor to the GND. Each finger has a Velostat flex sensor. This sensor is cheaper than other flex sensors and have the same accuracy. It has two pins ending one of them is connected to 5v supply and other is connected to an analog pin of Arduino which is connected to 10 K Ohm resistor that is connected to the GND. We have connected gyro and acceleration sensor mpu6050 to 5v and GND. Then it is connected to I2C pins of Arduino and pin 2 for interruptions. Also, there is 2.4GHz Transceiver module this module is connected through SPI pins of Arduino and two of the digital pins.

The left glove has two additional components. First it has mp3 module that have an SD card containing audio files of words. The TX pin of module is connected to an Arduino digital pin. The RX pin is connected to 1KOhm resistor then to digital pin. The other component is a 0.5W speaker that is connected to mp3 module.

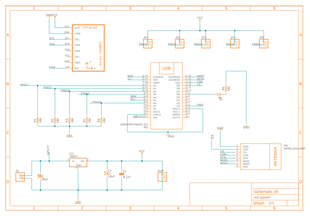


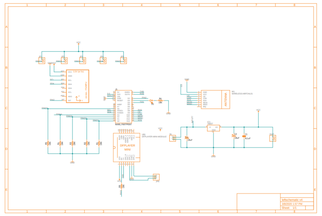
For speech recognition device:

In this prototype, We have used Raspberry pi zero which is connected to USB microphone through a USB port. The OLED display is connected to Raspberry pi through I2C pins, 5V and GND. The Ra is supplied by 5v and connected to GND from right hand voltage regulator.

For first part of our prototype:

We have used Arduino pro mini which is smaller than Arduino nano. This part is supplied by 7.4v batteries which is connected to Arduino and to 5v output voltage regulator. The two motor drivers and sound sensors are connected to 5V. All parts are connected to a common ground. The Four vibrating motors are used. Each two are connected to motor driver. We connected the PWM pins of Arduino to 4 EN pins of the two-motor driver to control the intensity of motors. Then we have connected 8 IN pins of motor drivers to digital pins of Arduino to turn on and off the motor. The analog pin of sound sensor is connected to an analog pin of Arduino.





Analysis

Many people don't know sign language. Both the deaf and other normal people struggle to communicate to each other. So We invented a portable gloves That translate the sign language to Word through a Speaker implemented in It. This gloves have also a display that change the speech to text in both Arabic and English.

For the gloves:

First the Arduino collects data from the bend sensor which is made from velostat that is cheap material and perform as variable resistor and from its characteristics is when more pressure is applied on it the lower resistance to electricity . The rubber band on its end increase the flexibility so when you bend a finger the resistance decrease and analog data increase. Then Arduino communicate with the mpu6050 through I2C .we set the sensitivity to maximum and set the offsets of the sensor that gives more accurate raw data of gyro and acceleration in x, y and z-axis. Then Arduino prepare the data collection. First, it puts the data into variables to do mathematical calculations using quaternion and force of gravity to get Euler angle of yaw, pitch and roll in degrees form. This operation happens in the two hand simultaneously, then the right glove send its readings to the left that contains a speaker by nrf24L01 module. The left hand receives the data and check it continuously. A group of hand signs is added to code of the left glove arduino. The Arduino checks continuously the value of yaw , pitch ,raw and the analog data of 5 bend sensors in each hand. When you make a sign the Arduino make sure the value is correct 20 times before it makes the decision and avoid fast decision. If it is correct the Arduino communicate directly to mp3 module which have an SD card that contains audio files of some words. After that the sound is played.

For the speech recognition device:

We made small device consists of raspberry pi , microphone and small OLED display. when he want to know what person in front of him says, he press a button and start to record what a person says this speech is changed into text in two ways if the speaker speaks English the speech will be converted offline using sphinx database . If the speaker is Arabic the speech will be converted using google Arabic database this database needs an internet connection . After the speech converted into words, It displayed on the display.

For Sound vibrations device:

Deaf people See us when we speak but they couldn't feel the sound and they can't recognize the different sound frequencies like our ear, add to this also their inability to feel the music they read it only as a Poem or like a paragraph. So our Project is about to make the deaf person feels the volume and different frequencies. First, the microphone receives the Sound surrounding him (about 3 meters around him) of each user.

Materials

Two gloves

Item name	Quantity	Price (L.E)	Shape
Arduino nano	2	170	
Gloves	2	50	
MPU650	2	160	
NRF 24|01	2	60	
LED	2	5	
0.5W SPEAKER	1	20	
MP3 MODULE	1	100	

Speech recognition

Raspberry pie zero	1	500	
O-LED display	1	70	
USB microphone	1	50	

Vibrator device

Item name	Quantity	Price (L.E)	Shape
Arduino pro mini	1	70	
Motor driver TB6612FNG	2	180	
Sound sensor	1	100	

Basic compounds to be used

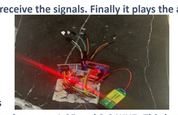
Jumper wires	-	30	
Pref board	3	20	
Female pin headers	-	2	
Voltage regulator	3	5	
10 K OHM resistors	10	3	

Basic compounds to be used

Item name	Quantity	Price (L.E)	Shape
1 K OHM resistors	-	1	
Ceramic capacitors	-	1	
Electrolytic capacitors	-	2	
Velostat sheet	-	100	
Conductive threads	-	15	
Leather	-	10	
Fabric	-	10	

Final products

then transfer this to it up to 200 times. The speaker connected to it to receive the signals. Finally it plays the audio fileanalog data. Arduino microcontroller receives this data then changes it using a complicated FFT(fast Fourier transform) algorithm. this algorithm changes analog data of sound sensor to points in terms of frequency and time values to determines the frequencies and their amplitude(volume). After that Arduino takes these points and aggregates it to 4 groups of frequencies between 0 to 4.5 kHz. First group between 0 and 1.05 kHz. Second group between 1.05 and 2.04KHZ. Third group between 2.04 kHz and 3.02KHZ. The fourth group is between 3.02 and 4.5KHZ. The frequency of the human voice overall ranges between 80HZ to 260 HZ. Any sound above 4.5 kHz will not be good to hear it. The four groups of frequencies are assigned to 4 vibrating disc motor. The intensity of motor depends on the amplitude of the sound in group frequency which each motor is assigned to. for example, if someone is talking to you, the room is quiet, and you are using the device.The motor which is assigned to a frequency less than or equal 1KHZ will vibrate and its intensity will change according to the amplitude of this person's voice. You can recognize the words after using the device for some time. This device connects even to a mobile app that has simply basic functions. The first one is as follows If the surrounding sound amplitude is high. You decrease the intensity of the motor to not be affected by this noise. Also, if the place is to quite you can amplify the intensity of the motor and feel the sound in front of you. The app sends a value o to decrease the analog Write value that controls the intensity of motor and get higher amplitudes inside the Arduino then increase the intensity of motor to get Lower amplitude. all of these allow for more personalized user experience according to the exact need



Test plan

After constructing our prototypes, a series of tests were conducted to test their ability to be used in real-world scenarios. we need a sample of 3 people with hearing problems and exposed them to our prototypes. Firstly: For the first prototype using special common words in Arabic like greetings and requests , the hard hearing people will be exposed to it 4 times each ,then measure how many words they will be able to identify from 10 words

Secondly: a different type of test was conducted to test google text-to-speech recognition skills in native Arabic using the raspberry pi device. 2 different people with varied accent will say a series of 20 sentence, and the number of the correct sentence identified from 20 will be counted. Finally: a series of tests was conducted to test The gloves prototype ability to identify motion to sounds using special pre-programmed commands Into the code itself.

Results

After a handful of experiments have been conducted the following results have been concluded

Vibrations prototype	Near deaf people	Normal people
2 vibration samples trail 1	5 sentence	2 sentence
vibration samples 2 trail 2	4 sentence	3 sentence
vibration samples 4 trail 1	7 sentence	5 sentence
4 vibration samples trail 2	8 sentence	4 sentence
6 vibration samples trail 1	10 sentence	6 sentence
6 vibration samples trail 2	8 sentence	4 sentence

Mobile app	1st person	2nd person
Trail 1	23 words	21 words
Trail 2	24 words	20 words

Glove trails	1st person	2nd person
Trail 1	8 words out of 9	7 words out of 9
Trail 2	9 words out of 9	8 words out of 8

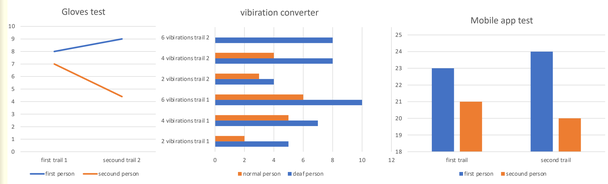
Positive results:

As seen above in the charts and tables, a real-world appliance of our project can show to be an exceptionally profitable for future customers.

This is in addition to the outstanding work of text-to-speech recognition display. And its satisfying ability to differentiate between a Varity accents and high accuracy, and the adaptive motion recognition system relatively accurate estimations

Negative results:

A method was thought to implement the second prototype of sound sensation into the glove itself, making it more of a complete package rather than an accessory. But the real-world testing showed that it has irritated the test subjects making unpleasant movement at the hand. Even if we had the capabilities to construct it within the small glove area. It's not favorable for the sake of consumer comfort.



Future Plans

After our projects prototypes have proven them self on the real world with concrete like results, a variety of plans have been considered benefit the humanity from our inventions, saving it in the process from an unpleasant world spreading phenomena.

If there is enough motivation and demand on our prototypes, it might be able to enter the production lines and be mass produced for the willing customers. Taking I mind its accuracy, usability and practicality proven it may not be a concern to fail. The results speaks about itself, with relatively accurate identification ability of the surrounding sounds and great communication ability and interactions between it and the gloves both of the prototypes might be a hit in the markets. Its highly encouraged that maybe the Egyptian governments can aid in supporting its manufacturing cost, making it more available to the masses. In this case of mass production and high demand a better improvement for the prototype processing power maybe favorable with also higher resolution easier to read and more durable screen. Another area of improvement may also be in the voice recognition algorithm, accurate recognition of the frequency resulting in a more nature identification process with easier learning process. Aided by a better directions and elevation sensors with the voice algorithm and the prototype can almost reach the state of perfection. Other plans also include making the glove in a smaller easier to carry package without any exposed parts. With all of these plans scattered around our minds being applied correctly, our prototype can provide a point of change and impact to the whole deafness community.

Recommendations

Making it more portable and practical to carry around

In order to reach the goal of making a more practical device for the consumer use, it have been evaluated that reducing its size to a tiny amount and hide out most of exposed parts in an elegant packaging that appear to various people will make it much more easier to carry around and use it in everyday life in an easy yet simple way. To archive this, a custom module with less space and only essential processor compounds without useless power adjustors and pins is required. Implementing also a custom-made PCB board may lead to a large amount of space being available by eliminating the usage of long non-necessary wires and make an easier way of connection. For the last, adding a smaller yet more modern generation of Bluetooth module like 5.1 can lead to overall more reducing to more spaces in the project with addition of easier and faster data communication setup to be exploited.

Using a higher performance microcontroller

The identification of sound from the surrounding to frequencies via an advanced FFT algorithm and coordinates change regulation and identification with a huge data dictionary on movements in sign language is too memory intensive for a small process to sustain. A CPU with a high clocking speeds and more cores to distribute the tasks with modern hyperthreading regulator is a must at our project algorithms scale. In order to make the max out of data usability in the databases and even archive Realtime voice recognition a custom CPU will just make it possible. Benefiting from even such a power how knows what else can be done?

Using machine learning sound detection system and movement identification

The usage of modern state of the art machine learning technology and artificial intelligence. Such an application via a trial and error learning of the movement nature and the voice identification can lead to a rich and more reliable database of sound frequencies and movement coordinates overall. The boundaries to such a process are unlimited in our project at least. A high accuracy for the prototype both movement of hands and sound identification are a grantee at this level. Such and advancement can lead to higher customer satisfaction with the prototype and overall better usability in every day real life scenarios.

Conclusion

Saving the best for the last, our prototypes after lots of evaluation and ground testing have proven out that its capable of delivering most of its expectations as much as it could on the best possible way when compared to the available solution. Our project excels in terms of cost effectiveness and practicality with a huge margin between it and its nearest possible contenders. Taking all of this into the consideration, it easily can satisfy most of the deafness and hard-hearing problems not only Egypt suffers from but the whole world, with destroying communication and social barriers in various countries. Such a breakthrough with modern available technology can even lead to a dramatic increase in the workforce numbers and the overall population participation in building the community, killing the unemployment of millions of people on its way. Taking this into consideration can help in flourishing our country economic state and a decrease in its payments in pensions and health care services as a total. By wall of which being a step in the right direction for the whole humanity.

Citations

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