A

PROJECT REPORT

On

SMART GLASSES FOR BLIND PEOPLE

SUBMITTED TO THE SAVITRIBAI PHULE PUNE UNIVERSITY, IN PARTIAL FULFILLMENT FOR THE AWARD OF THE DEGREE

OF

BACHELOR OF ENGINEERING
IN
ELECTRONICS AND TELECOMMUNICATION
BY

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Year: 2020-2021

CERTIFICATE

This is to certify that the project report entitled

"SMART GLASSES FOR BLIND PEOPLE"

Submitted by

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is a bonafide work carried out by them at D.Y. Patil School of Engineering, Lohegaon, under the supervision of **Dr. S. M. Koli** and it is approved for the partial fulfillment of the requirement of Savitribai Phule Pune University , for the award of the degree of Bachelor of Engineering (Electronics & Telecommunication Engineering). The work presented in project report has not been submitted to any other institute or University for the award of any degree or diploma.

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have satisfactorily completed and presented report on topic "**Smart Glasses For Blind People**" at D.Y. Patil School of Engineering, Lohegaon in partial fulfillment of requirement of Savitribai Phule Pune University for the student of T.E (Electronics and Telecommunication Engineering) in semester VI during academic year 2020-21

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Abstract:

These “Smart Glasses” are designed to help the blind people to read and translate the typed text which is written in the English language. These kinds of inventions consider a solution to motivate blind students to complete their education despite all their difficulties. Its main objective is to develop a new way of reading texts for blind people and facilitate their communication. The first task of the glasses is to scan any text image and convert it into audio text, so the person will listen to the audio through a headphone that’s connected to the glasses. The second task is to translate the whole text or some words of it by pressing a button that is connected to the glasses as well. The glasses used many technologies to perform its tasks which are OCR, (gTTS) and Google translation. Detecting the text in the image was done using the OpenCV and Optical Character Recognition technology (OCR) with Tesseract and Efficient and Accurate Scene Text Detector (EAST). In order to convert the text into speech, it used Text to Speech technology (gTTS). For translating the text, the glasses used Google translation API. The glasses are provided by Ultrasonic sensor which is used to measure the required distance between the user and the object that has an image to be able to take a clear picture. The picture will be taken when the user presses the button. Also the Ultrasonic sensor will have the feature of obstacle detection, which will warn user about the obstacle if present nearby. All the computing and processing operations were done using the Raspberry Pi 3 B+ and Raspberry pi 3 B. For the result, the combination of using OCR with EAST detector provide really high accuracy which showed the ability of the glasses to recognize almost 99% of the text. However, the glasses have some drawbacks such as: supporting only the English language and the maximum distance of capturing the images is between 40-150 cm. As a future plan, it is possible to support many languages and enhance the design to make it smaller and more

comfortable to wear.

1. **Introduction**:

In our lives, there are many people who are suffering from different diseases or handicap. These people need some help to make their life easier and better. The main goal of “Smart Glasses” is to help blind people and people who have vision difficulties by introducing a new technology that makes them able to read the typed text. These glasses are provided with technology to scan any written text and convert it into audio text. Also, it can translate words from English to Hindi using Google API. The goal of “Smart Glasses” is helping those people in different life aspects. For example, these glasses effectively helpful in the education field. Blind people and people with vision difficulties can be able to read, study and learn everything from any printed text images. “Smart Glasses” encourage blind people or people with vision difficulties to learn and succeed in many different fields.

1.1. **Project Background**:

There are special schools and universities for people with special needs. There are different levels of needs and not all levels require special places and special schools. For instance, people with vision difficulties can study with normal students if they have an appropriate chance. Most blind people and people with vision difficulties did not study and that is because special schools for people with special needs not everywhere and most of them are private and expensive or they study at home acquiring basic knowledge from their parents.
Most blind people are smart people and can study if they have the chance to be able to study in normal schools because they are government school everywhere. Most people thought blind people and people with vision difficulties cannot live alone and they need help all the times. In fact, they do not need help all the times, they can depend on them self in most of the times and they have the chance to live like a normal person in this life. The main reason for implement “Smart Glasses” for blind people was to prove for all people that blind people and people with vision difficulties have the chance to live a normal life with normal people and study in any school or university without the need for help all the times. By “Smart Glasses”, the percentage of educated people will increase.

1.2 **Literature Review**

Blind mobility is one of the major challenges encountered by visually impaired persons in their daily lives. Their life and activities are greatly restricted by loss of eyesight.

On an approximation 285 million people are visually impaired across the globe, among which 39 million are blind and 246 have low vision according to WHO statistics of 2011 [1]. About 90% of the world's visually impaired live in low-income settings whereas 82% of people living with blindness are aged 50 and above. India is now home to the world's largest number of 102blinds. Out of the 37 million blind people worldwide, over 15 million are from India. The worst thing is that 75% of these are cases of avoidable blindness. India has an acute shortage of optometrists and donated eyes for the treatment of corneal blindness. While India needs 40,000 optometrists, it has only 8,000. Blind people are usually dependent on assistance from others. The assistance can be from human beings, dogs or some special electronic devices. There are already many existing devices which help a blind person in walking. The most common is the simple walking stick or cane. The blind man uses it to detect the obstacles by sweeping the cane back and forth but unfortunately sometimes the blind man gets aware about the obstacle too late. With the recent advances in technology normal walking cane has been modified to a blind stick with an ultrasonic sensor attached to it. It has several limitations. Therefore, the solution that has been protrayed in this paper is cost effective, reliable, robust and portable device which would help a blind person to walk on the streets almost like any other pedestrian.

2.0 **Previous Works**:

[1] NuEyes Pro from NuEyes-

NuEyes bill their smart glasses as an electronic visual prosthesis for people with low or no vision. The lightweight glasses run on Android and include features like up to 12x magnification, the ability to change the colours and contrast of what you are looking at, bar/QR code scanning and OCR (optical character recognition) to recognise and speak out print documents. They can either be operated with a wireless controller or using simple voice commands.

The NuEyes Pro smart glasses are very powerful but also very pricey. Coming in at $5995 they're really meant to be provided under health insurance or, possibly one day, on the NHS.

[2] AIRA-
AIRA are smart glasses that also use a camera and connectivity to bring assistance to people with a visual impairment. In this case, however, what you're connected to is a trained assistant who provides spoken feedback about what you are looking at. Useful for help with identifying objects, reading documents, menus or medication. These offer a pair of eyes to guide you through unfamiliar routes or indoor surroundings or perhaps to provide some crucial fashion advice! Currently only available in the US, the AIRA service is being trailled in other countries including the UK.
Monthly price plans in the US start at $89 for 100 minutes of assistance. This includes the smart glasses, insurance and training on how to use them.

[3] QD Laser-
With QD Laser we're now getting really futuristic. Not yet available for consumers, this product does away with mini computer-screens mounted in front of your eyes and instead projects images directly on to your retina using lazers. Providing similar capabilities to the NuEyes technology above but with less bulk and weight, this technology is still at least a year away - although functioning prototypes were available on show at the QD Laser booth. They are estimated to cost a similar amount as the NuEyes product above – coming in at around $5000.
So those are the three smart specs that were making a splash at CSUN this year. For an audio tour of each product and interviews with each manufacturer, check out the Blind Bargains podcast.

[4] IrisVision-

IrisVision electronic glasses for the blind and visually impaired are a highly innovative assistive technology solution, which is registered with the FDA as a Class-1 medical device and is redefining the concept of wehindile low vision aids.
A combination of a Samsung's VR headset and a smartphone, IrisVision gives birth to an innovative solution aimed at helping people with eye problems like macular degeneration, cataracts, glaucoma, diabetic retinopathy (DR), retinitis pigmentosa (RP) and so forth.Price: $2,950/-

[5] Acesight-
Acesight is also one of the latest wehindile low vision aids produced by Zoomax, designed to help people with low vision conditions. Based on 'Augmented Reality' technology, it offers an HD display floating right before your eyes, thanks to a pair of head-mounted goggles, which are connected to a controller through a wire. Provides up to 15X magnification, while the wired controller allows you to customize the colors and contrast. This electronic eyewear is designed to cater to the needs of people with visual acuity ranging from 20/100 to 20/800, as affected by a host of eye diseases like macular degeneration, glaucoma and diabetic retinopathy.

Price: $4,995/-

[6] NuEyes Pro
NuEyes Pro is a head-worn lightweight and wireless pair of smart glasses, which can be controlled either through a wireless handheld controller or a set of voice commands. It is designed to help visually impaired and legally blind see better. Glaucoma, macular degeneration, and diabetic retinopathy are some of the visual conditions NuEyes Pro can help you with. A camera on the front of the glasses captures the image and displays it magnified inside of the lenses. You can get up to 12X magnified images. There are various other features, which make these e-glasses more than just a pair of electronic reading glasses.

Price: $5,995/-

[7] MyEye2-
These are low vision electronic glasses designed to make reading, writing, recognizing faces and various other daily activities easier for visually impaired people. A light attachable camera distinguishes it from an ordinary pair of glasses, which is mounted on the frame of the glasses by the side.

Price: $3,500/-

[8] eSight-
These electronic glasses for low vision are designed to assist people suffering from different types of low vision issues to see better. eSight is a specially designed head-mounted unit, which is connected to a battery through a wire. This can affect your mobility to a certain degree and you also need to be aware of the charging level of the device's battery.

Price: $5,950/-

[9] OrCam-
The device uses the power of Artificial Vision to assist people who are living with vision loss. It is a tool for blind people to become more aware of their surroundings. By audio description provided by the device, users can become more independent in their day to day life.The OrCam device has two parts. There is the lightweight camera that clips onto the wearer's glasses. The device is a tiny, portable, and wehindile. It uses audio feedback to relay visual

information (through speech) to the user. It can read texts, recognize faces, identify products, barcodes, and colors. recently, a whole new world of opportunities has opened up for OrCam users with the new interactive reading feature.

[10] Project Prakash-

"Project Prakash", an empathetic attempt towards the blind children to help them gain knowledge of a set of obstacles around them by using their brains.

[11] Smart glasses for blind-

Sheth et al worked on how a blind people can be able to detect any type of pits, potholes and several ups and downs by using a smart white cane where they have used ultrasonic sensors. In this device a multilingual system for audio feedback cannot be used because it can record only for 680 seconds.

[12] H.A.L.O or Haptic Assisted Location of Obstacles-

It consists of rangefinders that would take input from the ultrasonic sensors and output feedback to pulse vibration motors which are placed on the blind man's head. When the person gets closer to the object, the intensity and frequency of the vibration are increased. The main limitation is the use of vibration motor. The vibrations as an output feedback are far way irritating for any blind person.

[13] Oton Glass -

Created by Japanese company (Keisuke Shimakage). These smart glasses are designed to help dyslexic to read. The camera will capture pictures of words that the user wants to read and reads the words for the user via the earpiece. The glasses currently feature a conversion of English and Japanese text into voice audio and translate multilingual text into Japanese and English voice audio

[14] Eyesynth-Smart glasses for the Blind-
Created by Eyesynth (Spanish company), Marcelo Alegre (Designer). Eyesynth is consist of special glasses with 3D cameras. These glasses make a 3D volumetric analysis of the scene and process the information, turning it into abstract sound, which provides nuances of position, size, and shape.This audio signal is non-verbal, so it is a universal product in terms of language, so it can be used in any country.
The method that is used to transmit the sound is through cochlear headphones which improve the safety of the user.

[15] Smart Glasses-
Created by Shoaa, Hawra, Lina and Aqeela (CE students).Help people who have vision difficulties especially blind people. It Contains a sensor to warn the users if there is something in front of them or behind them. Increase the education level for blind people. Help to search for more information about any word in the image that the camera scans it. Drawback is it supports only english language.

[16] Google glasses-
Google Glasses show information without using hands • Users can communicate with the Internet via normal language voice commands.

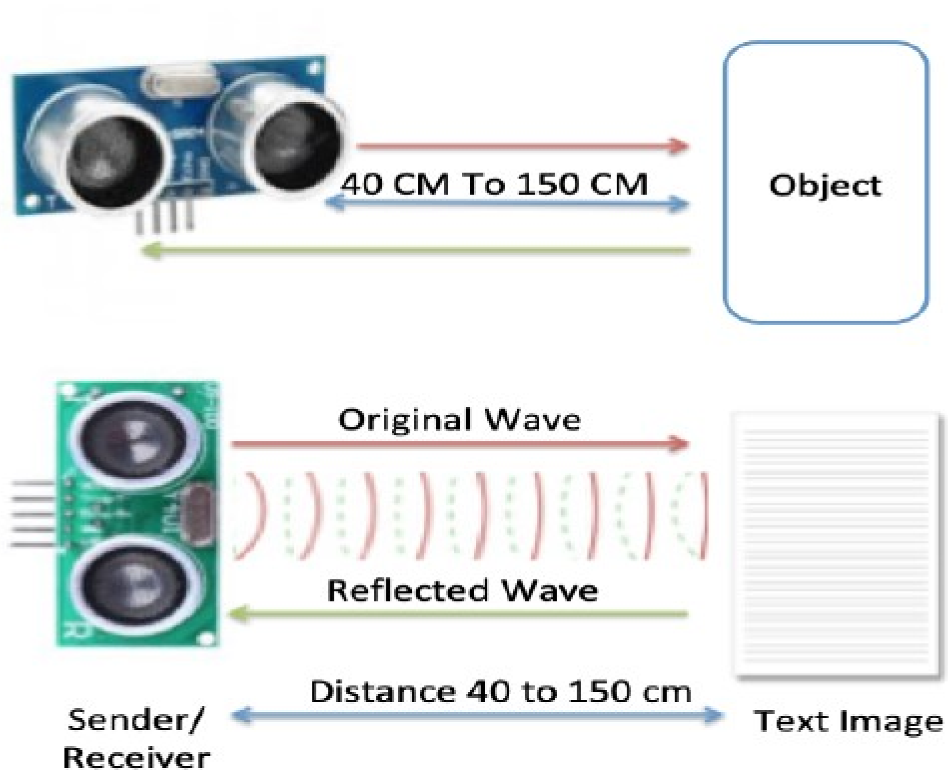
Benefits- 1. Take a picture 2. Record a video 3. Get directions 4. Send messages 5. Phone calls 6. Google 7. Real-time Translation using word lens app
Drawback is it is expensive.Price -(1,349.99$).

3. Product Architecture and Components:
The idea of the project is to make glasses for blind people that help them in education life at university. So, based on the goal of the project and after making some searches team members decided to work with the following components:

3.1. Sensor:
3.1.1. Ultrasonic Sensors:

Ultrasonic Sensor

Description:
The purpose of ultrasonic sensors is to measure the distance using ultrasonic waves. Ultrasonic sensors emit the ultrasonic waves and receive back the reflected. So, by this time the ultrasonic sensor will measure the distance to the object. It can sense from 2-400 cm.
Function:
In “Smart Glasses”, the Ultrasonic sensor is used to measure the distance between the camera and an object to detect the text from the text image. The distance should be from 40 cm to 150 cm and that is because this is the required range to capture a clear image. Also this sensor will warn the User if an obstacle is too closer to avoid collision.



3.2. Communication:

3.2.1. Webcam:

Webcam

Description:

The webcam has a view angle of 60° with a fixed focus. It can capture images with maximum resolutions of 1289 x 720 pixels. It is compatible with most operating systems platforms such as Linux, Windows, and MacOS. It has a USB port and a built-in mono mic.

Function:

In the project, the Webcam will be used the eyes of the person who wears the
“Smart Glasses.” The camera is going to capture a picture when the button is pressed, in order to detect and recognize the text from the image.

3.2.2. Headphones:

Headphones

Description:

Wired headphone will be used in the project since Raspberry Pi 3 Model B & B+ come with Audio jack, it is better to take advantage of this feature rather than occupying one of the four USB ports that can be useful for other

peripherals in the project.
Function:
The headphones will be used to help the user listen to the text that is been converted to audio after it is been captured by the camera or to listen to the translation of the text. The headphones are going to be small, light and connected to the glasses, so the user will not worry about losing the headphones or bothered by wearing them.

3.3. Controller:

3.3.1. Raspberry Pi Model B+ and B:

. Raspberry Pi Model B+ and B

Raspberry Pi 3 Model B

Description:

Raspberry Pi is a credit card-sized computer. It needs to be connected with a keyboard, mouse, display, power supply, SD card and installed operating system. Raspberry Pi is a low-cost embedded system that can do a lot of significant tasks. It can be run as no-frills PC, a pocketable coding computer, a hub for homemade hardware and more. It includes GPOI (general purpose input/output) pins to control electronics components. It is also a great machine to attract children to learn more about how computers work and motivate them to improve their programming skills which help to create the next generation of developers

Function:

Raspberry Pi 3 used for many purposes such as education, coding, and building hardware projects. It is the main component of the project. It used as a low-cost embedded system to control and connect all of the components together. It uses the Raspbian or NOOBs as the operating system which can accomplish many important tasks However, for the project the team decided to work on Raspbian as the operating system.

3.4. Battery:

5V 2.5A Powerbank

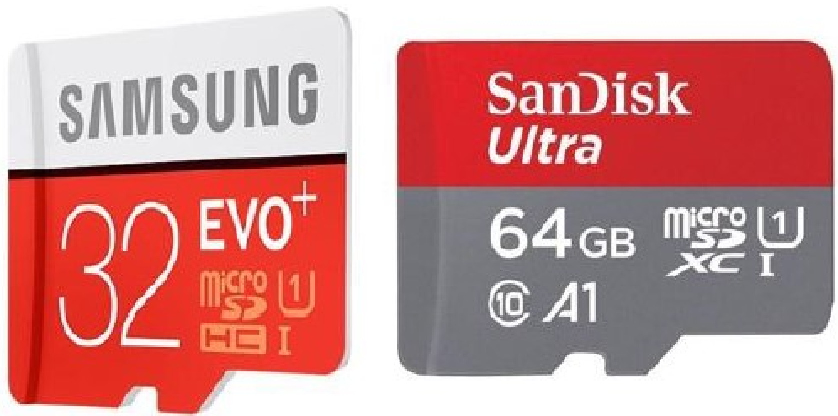
In the beginning, “Smart Glasses” used Normal battery that provided with the
raspberry pi 3 which is 5V and 2. A. Then the team thought that the blind students will use “Smart Glasses” all the

time during university time and the way for the battery provided with raspberry not helpful because the student needs to move from one class to another. With the updated “Smart Glasses”, it uses Power Bank 5V and 2.5 A, and the student able to use the power everywhere in the university or school.

3.5. Other Components:

These are other component used to complete the project

• SD Cards 32GB and 64GB



- Push Button

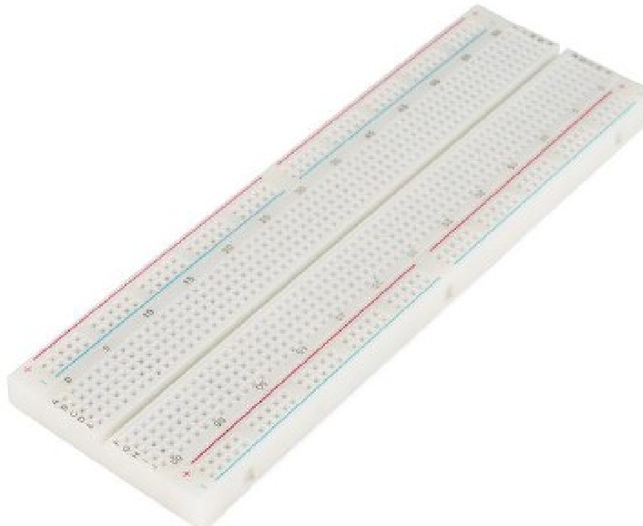
• Jumpers Wires

• Resistors

Resistors 1kΩ

Resistors 2kΩ

• Breadboard

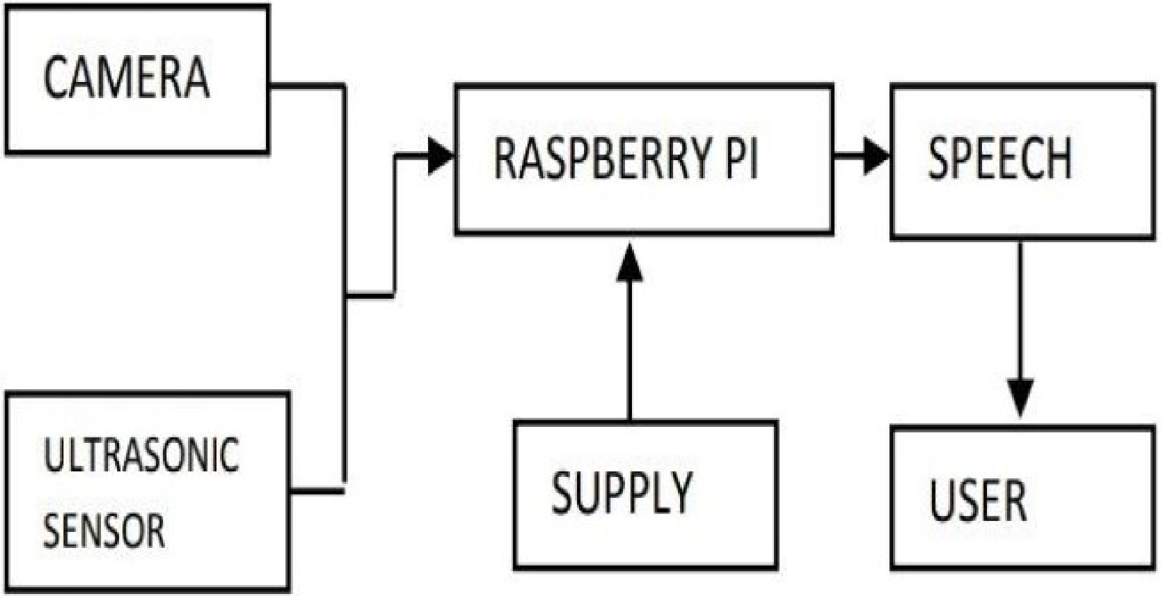


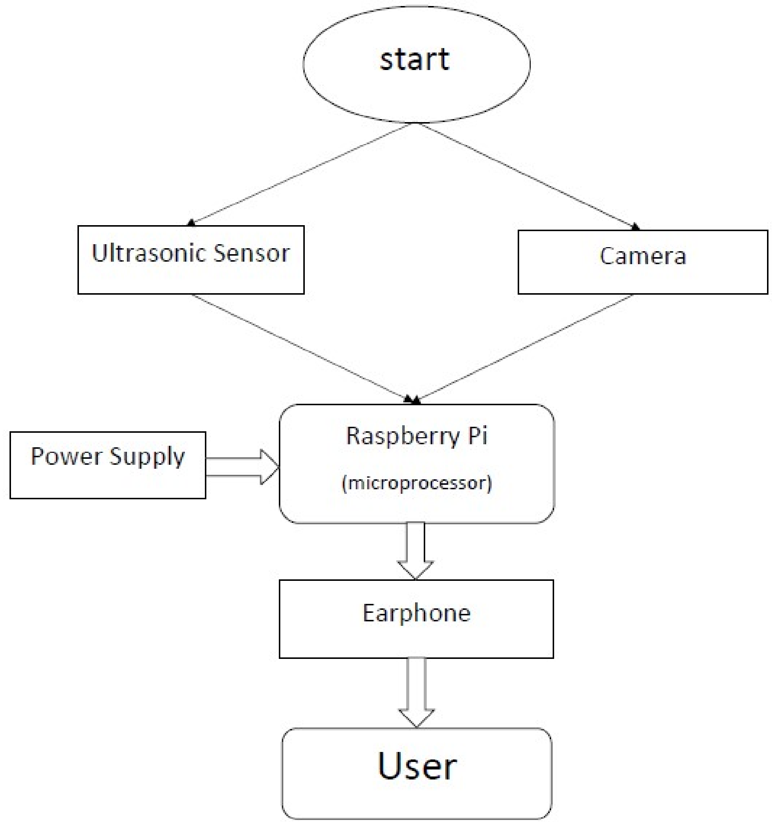
• Glasses

4. Valuation:

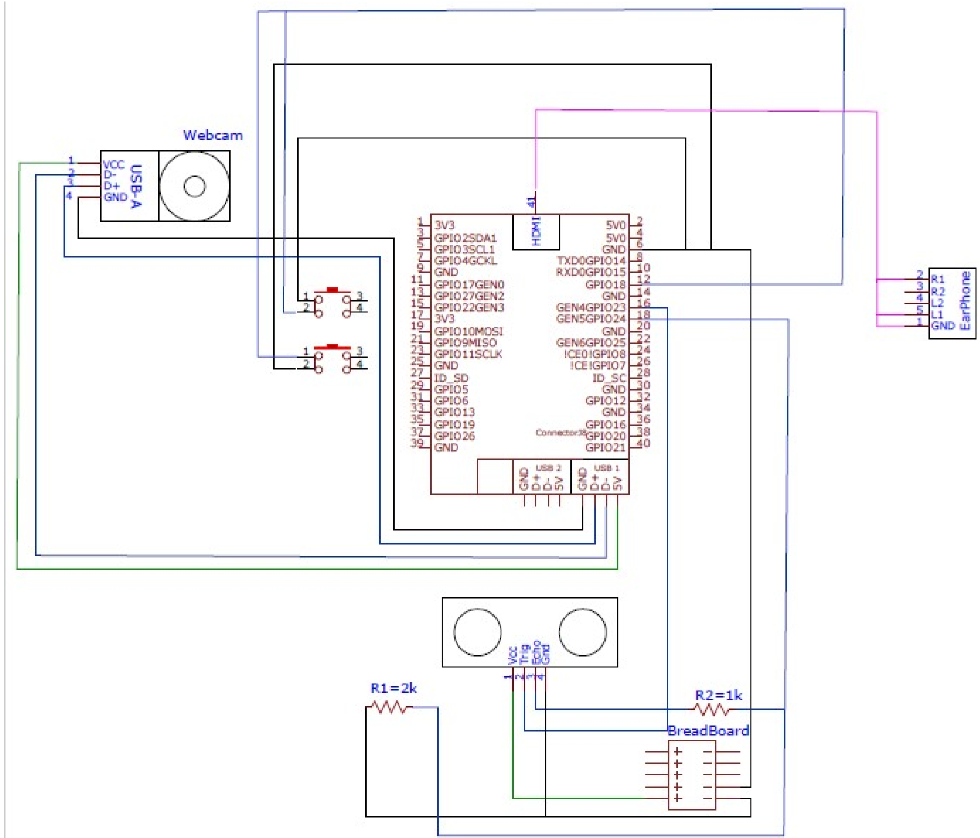
Components	**Cost in ₹**
Raspberry Pi 3	2500
Glasses	100
Camera Module	400
Ultrasonic Sensor	150
Earphones	200
Battery 5V	300
Wires	20
Click Button Switch	15
Memory Card	100
Breadboard	250
Total	**4035**

5. Block Diagram:




start
Ultrasonic Sensor
Camera
Power Supply
Raspberry Pi
(microprocessor)
Earphone
User

6. Circuit Diagram



7. Programming Data:

The programming language that is going to be used is Python. Multiple libraries will be used for ultrasonic sensor interfacing and Image Processing for Camera. The first task of the glasses is to scan any text image and convert it into audio text, so the person will listen to the audio through a headphone that's connected to the glasses. We use multiple libraries for this, for detecting the text in the image was done using the OpenCV and Optical Character Recognition technology (OCR) with Tesseract and Efficient and Accurate Scene Text Detector (EAST).

8. Implementation:

8.1. Installing Raspbian Stretch Operating System:

Before downloading the operating system on the SD card, the SD card should be formatted, it was used SD Card Formatter for this purpose, Figure 1.9. Then the Raspbian stretch files were moved to the SD card. After that, the SD card was inserted into the Raspberry Pi. Finally, the keyboard, the mouse, HDMI cable and lastly the power were inserted into the correct raspberry ports.

8.2. Installing OpenCV 4 Libraries:

OpenCV is a library of programming functions for real-time computer vision, the library is cross-platform and free for use under the open-source BSD license, Figure 1.10. For the installation of the OpenCV 4 libraries, the recommended operating system for the raspberry pi B+ which is Raspbian Stretch was installed. Win32 Disk Imager was used to flash the SD card.

Here are the installation steps for OpenCV 4:

Step (1): installing the OpenCV 4 dependencies:

Update the system:

- $ sudo apt-get update && sudo apt-get upgrade

Install CMake:

- $ sudo apt-get install build-essential cmake unzip pkg-config

Install image and video libraries:

- $ sudo apt-get install libjpeg-dev libpng-dev libtiff-dev

- $ sudo apt-get install libavcodec-dev libavformat-dev libswscale-dev libv4l-dev
- $ sudo apt-get install libxvidcore-dev libx264-dev

Install GTK, our GUI backend:
- $ sudo apt-get install libgtk-3-dev

Install a package to reduce GTK warnings:
- $ sudo apt-get install libcanberra-gtk*

Install numerical optimizations packages:
- $ sudo apt-get install libatlas-base-dev gfortran

Install the Python 3 development headers:
- $ sudo apt-get install python3-dev

Step (2): Download OpenCV 4 for Raspberry Pi:

Download Opencv & Opencv_contrib:
- $ cd ~
- $ wget -O opencv.zip https://github.com/opencv/opencv/archive/4.0.0.zip
- $ wget -O opencv_contrib.zip
https://github.com/opencv/opencv_contrib/archive/4.0.0.zip

Unzip the archives:
- $ unzip opencv.zip
- $ unzip opencv_contrib.zip

Rename the directories:
- $ mv opencv-4.0.0 opencv
- $ mv opencv_contrib-4.0.0 opencv_contrib

Step (3): Configure your Python 3 virtual environment for OpenCV 4:

Install pip, a Python Package Manager:
- $ wget https://bootstrap.pypa.io/get-pip.py

- $ sudo python3 get-pip.py

Install Virtualenv & Virtualenvwrapper:

- $ sudo pip install virtualenv virtualenvwrapper
- $ sudo rm -rf ~/get-pip.py ~/.cache/pip

Update ~/.profile:

- $ echo -e "\n# virtualenv and virtualenvwrapper" >> ~/.profile
- $ echo "export WORKON_HOME=$HOME/.virtualenvs" >> ~/.profile
- $ echo "export VIRTUALENVWRAPPER_PYTHON=/usr/bin/python3" >> ~/.profile
- $ echo "source /usr/local/bin/virtualenvwrapper.sh" >> ~/.profile
- $ source ~/.profile

Create OpenCV 4 Python 3 virtual environment:

- $ mkvirtualenv cv -p python3

Verify the cv environment:

- $ work on cv

Installing NumPy:

- $ pip install numpy

Step (4): CMake and compile OpenCV4:

- $ cd ~/opencv
- $ mkdir build
- $ cd build

Compile OpenCV 4:

- $ make

Install OpenCV 4 with two additional commands:

- $ sudo make install

- $ sudo ldconfig

Step (6): Link OpenCV 4 into your Python 3 virtual environment:

- $ cd ~/.virtualenvs/cv/lib/python3.5/site-packages/
- $ ln -s /usr/local/python/cv2/python-3.5/cv2.cpython-35m-arm-linuxgnueabihf.so cv2.so
- $ cd ~

8.3. How to set Wi-Fi on Raspberry Pi Model B+:

We can configure WIFI from the command line

1. Log in to the Pi.
2. If you do not know the password can write on command to generate a list of wireless networks available in your area.
3. Add WIFI name and password.
4. Enter code
5. Press CTRL-X, then Y to save and exit.
6. If not work restarts the Pi.
7. If you have monitor and keyboard you can access the WIFI from the desktop.

8.4. GPIO (General Purpose Input/Output):

Write on command window:

sudo pip install pySerial
sudo pip install nose
sudo pip install cmd2
then we import the GPIO:

8.5. Importing Ultrasonic Sensor:

“Smart Glasses” used the Ultrasonic Sensor to detect the text image. To connect the sensor the team used 1k Ω Resistor, 2k Ω Resistor, and Jumper Wires to connect Vcc, TRIG, ECHO, and GND. The team used python code to control the Ultrasonic Sensor detection then be able to measure the destination

8.6. Setting Up the Button:

“Smart Glasses” used two buttons one for capture the image and other for translating from English to Hindi using Google API. In order to, set the button the team runs small python code to connect the button. To check the button the team, add condition statement to print “Button Pressed” when the button was pressed. The connection was easy just two wires one for the ground and the other one connects the pin.

8.7. Taking Picture Setting Up:

Install the fswebcam package:

sudo apt-get install fswebcam

Add user to video group:

sudo usermod -a -G video <username>

Taking picture with no banner:

fswebcam -r 1280x720 --no-banner image3.jpg

fswebcam -r --no-banner image2.jpg

8.8. Convert text to voice:

One of the most important functions of the “Smart Glasses” is text to voice conversion. In order to implement this task, team installs gTTS which is abbreviations of Google Text-to-Speech. It is a python library that interfaced with Google Translate API. gTTS has many features such as convert ultimate length of text to voice, provide error pronunciation using customizable text pre-processors and support many languages and retrieve them when needed. Using python code, team members implemented the text to voice conversion task. The gTTS was installed using the following command:

$ pip install gTTS

9. System Testing and Analysis:

9.1. Test Ultrasonic Sensor:

Before using the Ultrasonic sensor on "Smart Glasses", the team tested the sensor if it was able to sense and detect the object from 2 cm to 400 cm or not. The team run a small python code and connected the sensor to test it. It was easy to connect the sensor using breadboard, wires, and resistors. The team set up time in the code to measure the distance. First, the team tested the sensor by placing the ultrasonic sensor in front of the table and it was sense and wrote the distance on the output. The team repeats the testing at a different distance. The problem was that the "Smart Glasses" used the ultrasonic sensor to control the distance between 40 to 150 cm to capture the image using the Webcam. So, the team was trying to set a condition to control the ultrasonic sensor to sense just between 40-150 cm. The team used If condition to sense when the object in front 40 cm to 150 cm so the webcam can capture the image.

9.2. System Testing:

The "Smart Glasses" has been tested with all components to make sure that everything is working. The team has done multiple tests for each part before putting them together. The first test was to make sure that the camera is taking a picture after pressing the button and checking the distance if it is in the required range. The second test was to see if the text in the picture has been detected and recognized or not. The third text was to make sure that the detected test has been converted into audio text. The fourth test was to see if the button pressed the detected text has been translated or not.

Test 1: Taking picture:

This test aimed to examine taking picture process which starts from pressing the button then checking the range between the camera and the picture using the Ultrasonic sensor. If the picture placed in the required range the picture will be taken. The camera was able to take a clear picture when the button is pressed and if the person is standing stable, but when the person moves after she/he presses the button the picture will be blurred or not clear.

Test 2: Text detection and Recognition:

In this test, the main goal was to check if the text detector that was used in this project which is EAST pre-trained text detector and the text recognizer which is OCR using Tesseract is working well. The test showed some good results on big clear texts and some bad ones on small texts. The team found out that this depends on the clarity of the text in the picture, it also depends on the font theme, size, and spaces between the words.

Test 3: Text to Voice:

The test here was to check if the detected text is converted to audio text. The team used gTTS (Google Text To Speech) libraries after they found that the voice is better and clearer than the other TTS libraries such as Festival TTS, Espeak TTS, and Pico TTS. The voice was clear for the right detected words.

Test 4: Text Translation:

In this test when the person presses the button, the detected text should be translated into Hindi and should be heard clearly. The right detected text was translated well using Google translate and gTTS libraries.

References;

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