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Artificial Vision For The Blind Using I-Cane Electronic aid for blind people

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Abstract: *Technology should be implemented and delivered to those who need it the most. Our proposal, the* ***I-Cane****, is a novel, adjustable and a robust artificially intelligent assistive device which help the blind comprehend the environment like normal humans do. Built considering the country's infrastructure and user centric needs, the I-Cane provides greater confidence to the blind to explore the world. It has a processor connected with a camera for exactly identifying what obstacle is ahead and informing the same to the user by giving an audio output using text to speech conversion. In case of persons, the faces are detected to tell their number, indicating the traffic. Furthermore, ultrasonic sensors are located in the front and at the bottom of the stick to detect obstacles at a distance of 100 cms in front and pits, staircase with a gap of 10cms from the ground level. The temperature sensor is introduced for fire detection. The device is made more intelligent by connecting the processor to voice cloud storage.*

Keywords: *Raspberry pi, Arduino, Camera, Digital image processing, artificially intelligent****,*** *Ultrasonic sensor, Temperature sensor (TMP 36), Object Detection and Identification, Cloud Storage.*

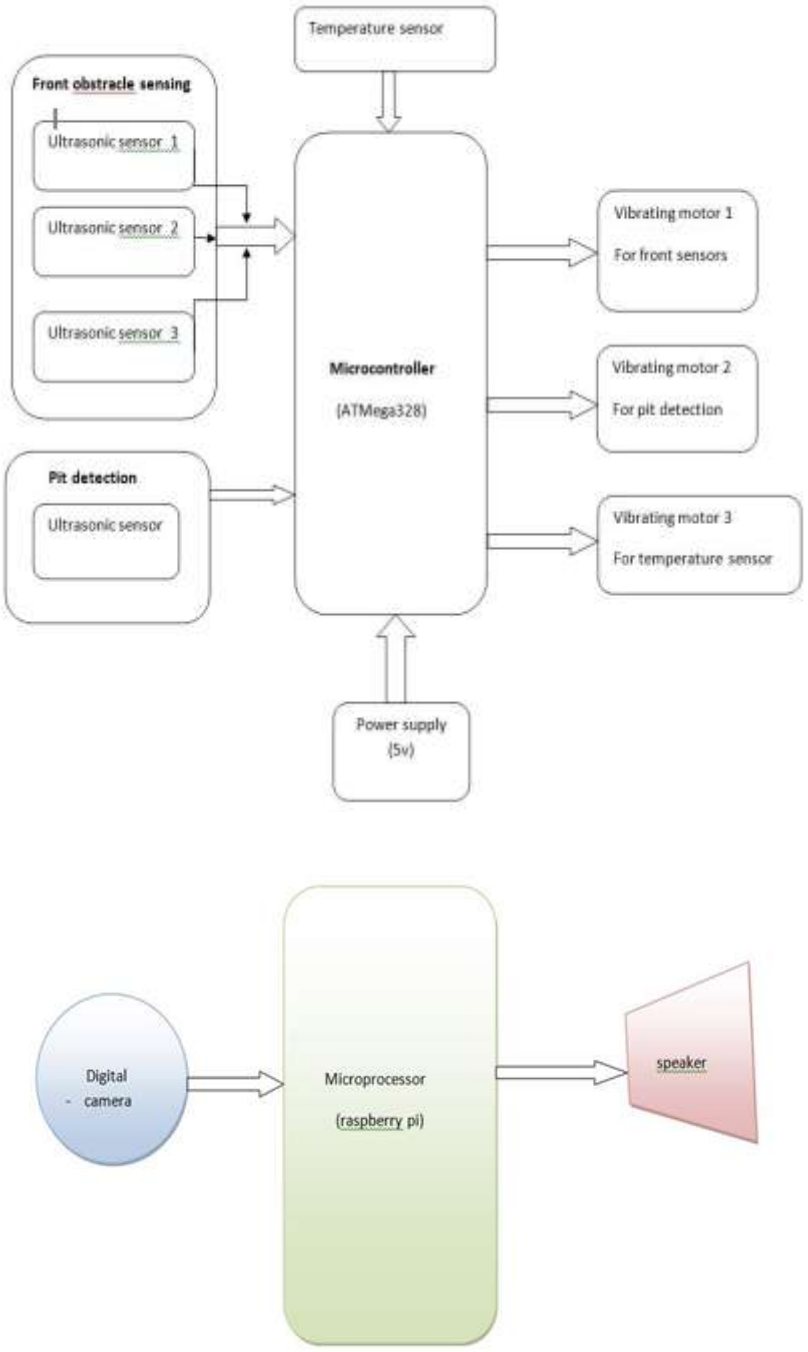
I. Introduction

Vision is an important aspect of life as 83% of the information about the environment human beings get is by sight. The blind, devoid of this aspect, face challenges everyday for safe and independent mobility. According to the statistics provided by the World Health Organization (WHO) in 2011, there are 285 billion people in world with visual impairment, 39 billion people are blind, 246 billion suffer with low vision and around 15 million people are blind in India [8]. Although many devices like the white cane, smart cane etc have been in use by the blind, they fail to provide complete information leading to accidents till date. The former neither detects hanging objects nor does it give any information about the movement of the obstacle [1]. The latter on the other hand, detects hanging objects but fails in recognizing it. Also, when the blind tends to touch the object in an attempt to know what it is, it might turn out to be dangerous. Our product, the I-Cane, includes all the advantages of the already existing assistive devices along with overcoming their disadvantages.

The microcontroller is connected to the ultrasonic and the temperature sensor. The ultrasonic sensors are always preferred because they are small enough, cheap and immune to the environment noise. They give the essential pre-warning and allow path finding. Fire accidents can be prevented by the temperature sensor attached at the bottom of the stick. The camera connected to the microprocessor identifies the obstacle using image processing and gives the audio output of the same by text to speech conversion. The processor is also connected to the voice cloud service, that is, the amazon alexa voice services, which is an open source. With internet connectivity, it gets the information from the cloud storage.

II. System Design

The system can be broadly classified into the input unit, the control unit and the output unit. These units are aligned on the blind stick for the perfect object and edge detection. The temperature sensor alignment is done for the hot object detection. The blind stick can be adjusted to any size according to the height of the person using the stick. The whole system is powered by rechargeable LiPo battery for long lasting performance. It is placed near the handle and is light in weight. The camera identifies the faces, traffic, pits and steps etc. The ultrasonic sensors are connected at the bottom and middle of the I-cane which help in sensing the obstacles and differentiating between them. The I-Cane can be also be programmed to identify the known faces such as the user's family and friends. It is made artificially intelligent by connecting it to the voice cloud which replies back to any query asked by the user provided there is good internet connectivity.



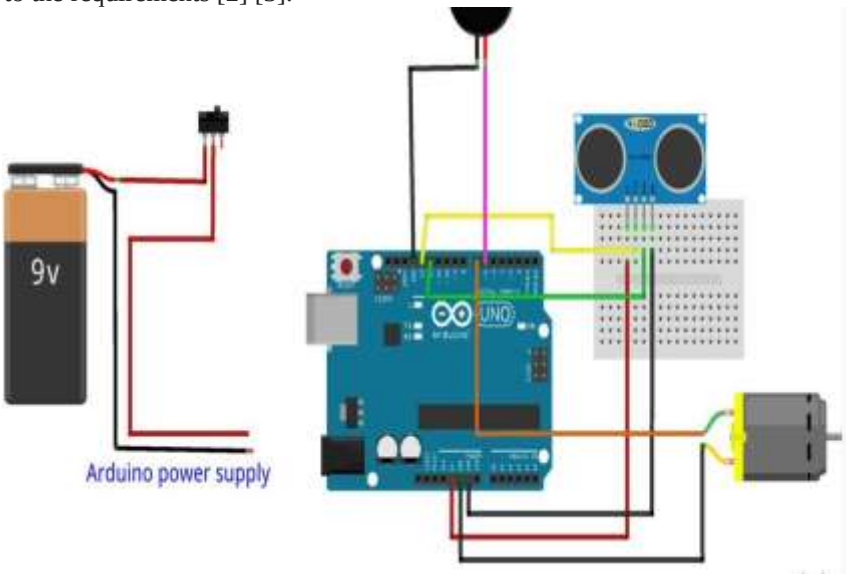
A. *Camera*

The camera is attached in the middle part of the stick and is connected to the microprocessor. It captures the images at regular time intervals and converts the rgb (red, green, blue) frame into a gray scale frame. The inputs are compared to the images stored in the database in order to identify them. The microprocessor is coded in python to get the number of faces recognized by the camera in the text format [5]. The output is given after converting the text (code) to audio. It also recognizes crowd by returning the number of faces in the input image. The camera can detect steps by sequential algorithm.

B. UltraSonic Sensors

The ultrasonic sensors judge the distance of the obstacle by the time taken by the ultrasonic signal to strike the obstacle and return. We employ two ultrasonic sensors in the I-Cane. The one in the front signals the vibrating circuit if an obstacle is at a distance less than 100 centimetres from the obstacle. The sensor at the bottom is used for pit detection which notifies if the distance (size of the pit) exceeds 10 centimeters. The

ultrasonic sensor is connected with arduino. The output of this sensor is connected by a buzzer. Arduino can be coded according to the requirements [2] [3].



C. Temperature Sensor

LM 35 informs about any hot object or fire in front so that the blind doesn't get hurt in an attempt to touch it. The initial calibration is done for normal room temperature. If the temperature detected is more than the range, the output is given to the buzzer [6].

III. Control unit

Raspberry Pi

Raspberry pi is a system on chip with Broadcom BCM2836 – 900 MHz quad core microprocessor and 512 MB of RAM, on chip GPU, SD cards, USB slots, HDMI, Ethernet port and a 3.5 mm phone jack for audio. It is connected to the camera and has the voice cloud service installed. After text to audio conversion, the output is given to the speakers. To make the stick more artificially intelligent, raspberry pi is connected to the voice cloud storage. It is connected with a switch between the 3rd pin (ground) and 12th pin which is pressed to ask any question and get instant reply provided the processor is connected to the internet. [4][7]

Arduino

Arduino is a microcontroller board based on the ATmega328P which has 14 digital input/output pins, 6 analog inputs, 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. The ultrasonic sensors and temperature sensor are connected to the microcontroller where the output is given either to the buzzer or a vibratory circuit.

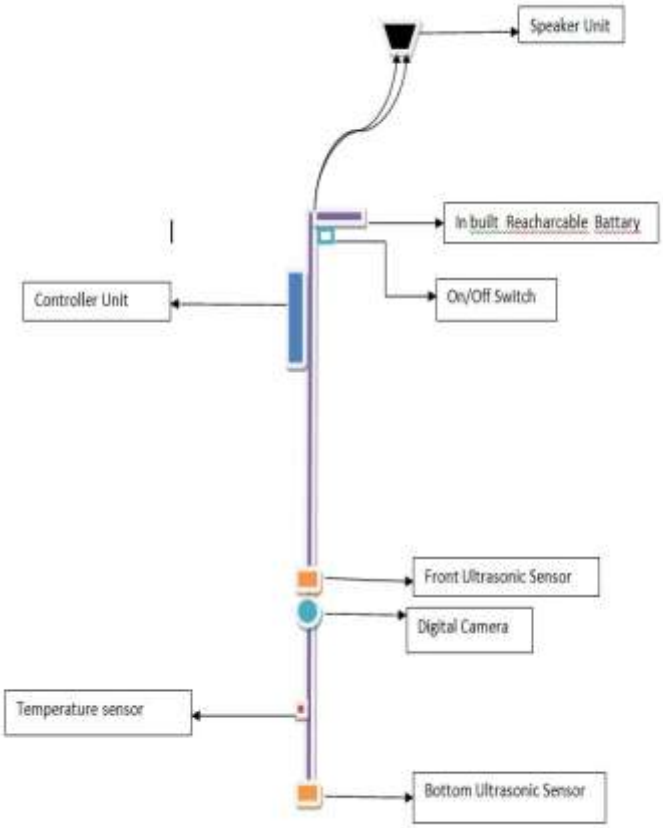
IV. Output unit

The output from the microcontroller and microprocessor are given either to the speakers or the vibratory circuit. The vibratory circuit, trigger, is situated at the handle of the I-Cane. The output sourcing for audio out should be in the form of speaker but not in the form of earphones to the blind so that we do not restrict the blind from hearing the environment noises.

V. Python Logic

```
import numpy as np
import cv2

face_cascade = cv2.CascadeClassifier('frontalface.xml')
eye_cascade = cv2.CascadeClassifier('eye.xml')
cap = cv2.VideoCapture(0)

while(True):

ret, img = cap.read()

#img = cv2.imread('H://f2.jpg')
gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)

faces = face_cascade.detectMultiScale(gray, 1.3, 5)
for (x,y,w,h) in faces:
cv2.rectangle(img,(x,y),(x+w,y+h),(255,255,0),2)
roi_gray = gray[y:y+h, x:x+w]
roi_color = img[y:y+h, x:x+w]
eyes = eye_cascade.detectMultiScale(roi_gray)
for (ex,ey,ew,eh) in eyes:
cv2.rectangle(roi_color,(ex,ey),(ex+ew,ey+eh),(0,255,255),2)
cv2.imshow('frame',img)
if cv2.waitKey(1) & 0xFF == ord('q'):
break

#cv2.imshow('img',img)
#cv2.waitKey(0)
#cv2.destroyAllWindows()
cap.release()
cv2.destroyAllWindows()
```

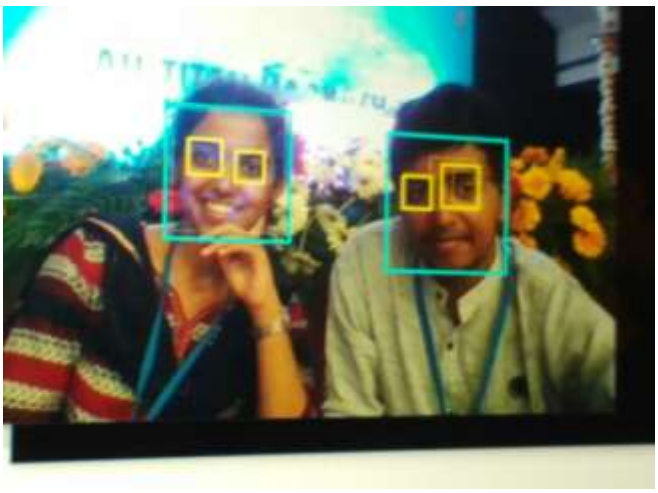
VI. Hardware Prototype



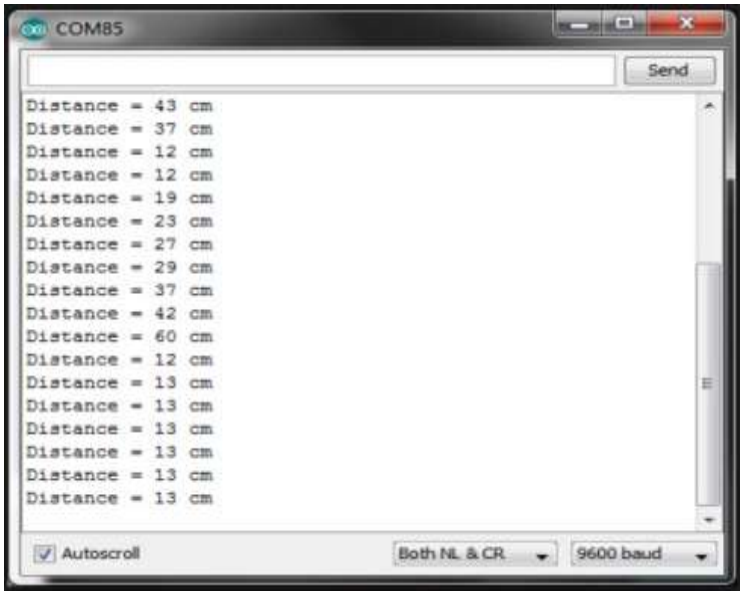
Fabrication

VII. TEST CASES

A. Image processing



B. ***UltraSonic Sensor***



C. Temperature Sensor

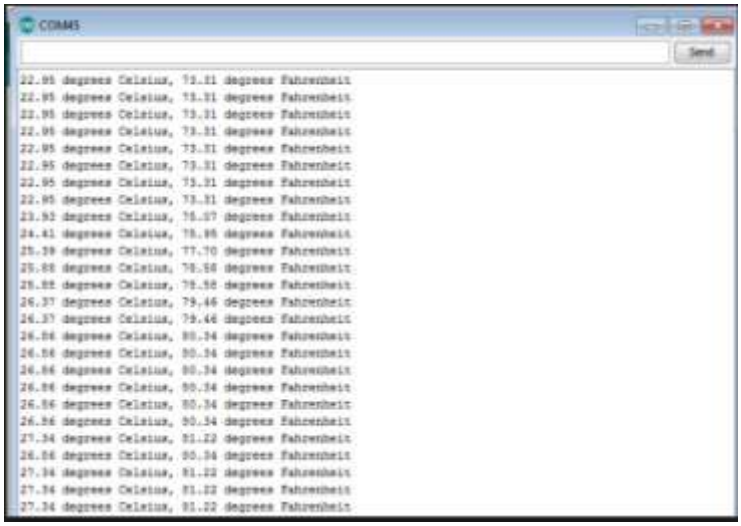


Table 1

Serial Number	Parameters	Description
1	Size	Adjustable
2	Weight	Less than 900 grams
3	Battery	Lithium polymer battery
4	Camera	13 mega pixel
5	Ultrasonic Sensor	Front ultrasonic sensor Detects obstacles within the range of 100 cms Down ultrasonic sensor Detects pits and steps when the distance is more than 20 cms.
6	Temperature Sensor	TMP36, it does not requires external calibration, output is linearly proportional to Celsius Temperature.
7	Processor	Raspberry Pi
8	Micro Controller	Arduino Uno
9	Vibrator	DC motor is placed near the handle to get vibrating sense
10	Power supply	5 volts
11	Total cost	<5000

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