VIVEKANAND EDUCATION SOCIETY'S INSTITUTE OF TECHNOLOGY
Department of Computer Engineering

Project Report on

MACHINE LEARNING BASED OBJECT POSITIONING FOR VISUALLY IMPAIRED

In partial fulfillment of the Fourth Year, Bachelor of Engineering (B.E.) Degree in Computer Engineering at the University of Mumbai Academic Year 2017-2018

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Project Mentor
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(2017-18)

VIVEKANAND EDUCATION SOCIETY'S INSTITUTE OF TECHNOLOGY

Department of Computer Engineering

Certificate

This is to certify that ***Sejal Gianani, Abhishek Mehta, Twinkle Motwani, Rohan Shende*** of Fourth Year Computer Engineering studying under the University of Mumbai have satisfactorily completed the project on "***MACHINE LEARNING BASED OBJECT POSITIONING FOR VISUALLY IMPAIRED***" as a part of their coursework of PROJECT-II for Semester-VIII under the guidance of their mentor ***Prof. Sharmila Sengupta*** in the year 2017-2018.

This thesis/dissertation/project report entitled ***Machine Learning Based Object Positioning For Visually Impaired*** by ***Sejal Gianani, Abhishek Mehta, Twinkle Motwani, Rohan Shende*** is approved for the degree of ***BE(Computer Engineering)***.

Programme Outcomes	Grade
PO1,PO2,PO3,PO4,PO5,PO6,PO7, PO8, PO9, PO10, PO11, PO12 PSO1, PSO2	

Date:

Project Guide: Mrs. Sharmila Sengupta

Project Report Approval
For
B. E (Computer Engineering)

This thesis/dissertation/project report entitled ***Machine Learning Based Object Positioning For Visually Impaired*** by ***Sejal Gianani, Abhishek Mehta, Twinkle Motwani, Rohan Shende*** is approved for the degree of ***BE(Computer Engineering)***.

Internal Examiner

External Examiner

Head of the Department

Principal

Date:
Place:

Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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(Sejal Gianani, 19)	(Abhishek Mehta, 33)
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Date:

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We express our hearty thanks to them for their assistance without which it would have been difficult in finishing this project synopsis and project review successfully.

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We wish to express our profound thanks to all those who helped us in gathering information about the project. Our families too have provided moral support and encouragement at several times.

Computer Engineering Department
COURSE OUTCOMES FOR B.E PROJECT

Learners will be to,

Course Outcome	Description of the Course Outcome
CO 1	Able to apply the relevant engineering concepts, knowledge and skills towards the project.
CO2	Able to identify, formulate and interpret the various relevant research papers and to determine the problem.
CO 3	Able to apply the engineering concepts towards designing solution for the problem.
CO 4	Able to interpret the data and datasets to be utilized.
CO 5	Able to create, select and apply appropriate technologies, techniques, resources and tools for the project.
CO 6	Able to apply ethical, professional policies and principles towards societal, environmental, safety and cultural benefit.
CO 7	Able to function effectively as an individual, and as a member of a team, allocating roles with clear lines of responsibility and accountability.
CO 8	Able to write effective reports, design documents and make effective presentations.
CO 9	Able to apply engineering and management principles to the project as a team member.
CO 10	Able to apply the project domain knowledge to sharpen one’s competency.
CO 11	Able to develop professional, presentational, balanced and structured approach towards project development.
CO 12	Able to adopt skills, languages, environment and platforms for creating innovative solutions for the project.

Abstract

Visual impairment is the functional loss of the eye or eyes in which a person's eyesight cannot be corrected up to a normal level. Visually impaired people face many problems in their day to day life and the most common inconvenience is to find their personal items which are misplaced in their indoor space. With advancement in technology, normal conduction of tasks can be made possible for such cases. This report describes a system which is a user friendly human computer interface enhanced with computer vision technology which will be able to support the visually impaired to localize and pick up objects used in their daily life. Several efforts have been taken in the past few years to improve the quality of life of such people. The aim of our blind assistive technology system is to bridge the gap between what the disabled people wants to do and what the existing social infrastructure allows them to do.

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Chapter 1:
INTRODUCTION

1. Introduction

1.1 Introduction to the Project

Computer vision tasks include methods for acquiring, processing, analyzing and understanding digital images, and extraction of high-dimensional data from the real world in order to produce numerical or symbolic information, in the forms of decisions. Sub-domains of computer vision include scene reconstruction, event detection, video tracking, object recognition, 3D pose estimation, learning, indexing, motion estimation, and image restoration. Computer vision holds great promise for helping persons with blindness or visual impairments to interpret and explore the visual world. To this end, it is worthwhile to assess the situation critically by understanding the actual needs of the visually impaired population and which of these needs might be addressed by computer vision.

1.2 Motivation for the Project

Lots of computer vision related researches had been done for the visually impaired to solve their sight related problem. The motivation of this project is to develop an object finder for the visually impaired since they are having difficulties locating and finding an object without sight. There is a need and responsibility for the society and community to explore technologies to help the visually impaired.

According to WHO, an estimated 253 million people live with vision impairment and the population of visually impaired is growing at an alarming rate. These, coupled with the availability of inexpensive digital cameras and computers have motivated the author into developing our product to assist visually impaired to locate for items.

1.3 Problem Definition

Visual impairment is a disability that causes problems for object detection and not fixable by usual means. Visually impaired people face much inconvenience when interacting with their surrounding environments and the most common challenge is to find dropped or misplaced personal items. With advancement in the technology, memory and processing power the growth of computer vision technology is gradually accelerating and is quite economical. People suffering from visual impairment need better perception and control of their personal objects, so a solution is proposed to help them manage their daily necessities. The software will be able to support them to localize and to pick up objects within their vicinity. In addition, the system also increases the confidence level and comfort level of the visually impaired in the way that they become more independent. All people suffering from visual impairment in different working environments like home, office, educational institutions can use this system. Training institutes, any non-profit organization will be benefited from this.

1.4 Relevance of the Project

1.4.1 Visually impaired

As of 2015 there were 940 million people with some degree of vision loss. 246 million had low vision and 39 million were blind (according to Wikipedia). The majority of people with poor vision is in the developing world and is over the age of 50 years. This system can be used for helping such group of people.

1.4.2 Training Institutes

The term "vision rehabilitation" includes a wide range of professional services that can restore functioning after vision loss, just as physical therapy restores function after a stroke or other injury. Vision rehabilitation services allow people who have recently lost vision, are blind, or have low vision to continue to live independently and maintain their accustomed quality of life.

Training institutes provide Vision rehabilitation services for adults who have recently lost vision, are blind, or have low vision are provided by a team of specially trained professionals, which may include low vision therapists, vision rehabilitation therapists, and orientation and mobility specialists. Thus the system can be used in such institutes by trainers and the visually impaired population for training and learning.

1.4.3 Non-profit organizations

Adapting to life with little or no vision can be a daunting challenge. Fear and uncertainty can be overwhelming. Even a lifelong home can suddenly become a foreign and perilous. In blindness or visual impairment, much of what a sighted person takes for granted needs to be relearned in a completely new way. Non-profit organizations provide help in counseling, education and employment for visually impaired. Such organizations can use our system to make the blind more independent.

1.5 Methodology Employed for development

The model that has been used for the development of the system is Iterative model. An iterative model does not start with full requirements specification and implementation; it starts by specifying and implementing a part of the system. Then the system is reviewed again and again iteratively producing new versions of the system in every iteration. Further requirements are gathered in each step and the system is implemented iteratively. Fig 1.5 shows the various steps that were repeated iteratively for the development of the system. Each of the following versions went through all the steps shown in Figure 1.5.

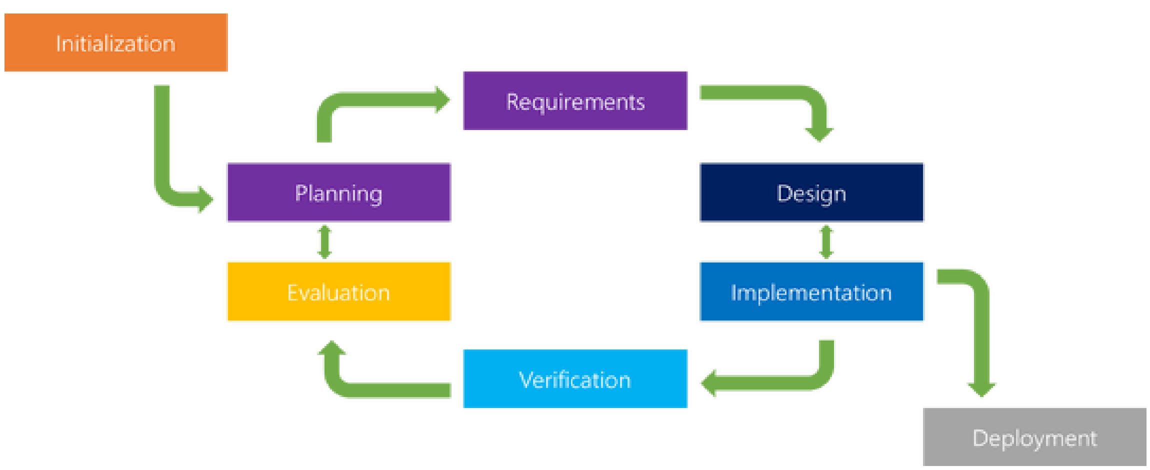

Fig 1.5.1 - Iterative model

The different versions of our system were developed as follows -

1. In the initial version, the system was designed for detection of objects using the dataset provided by caffe model. It had various objects like bottle, TV, sofa, person, chair, airplane, potted plants etc.
2. The system was developed with the addition of object mapping module. Only the required object was mapped to the real time input. Also text was converted to speech and vice versa thereby allowing user to communicate via voice commands.
3. Requirements for object positioning were gathered. For determining the position of the object from user's hand, there was a need that we compute the approximate centroid of user's hand. For this a unique identity was given to the user by providing him with a unique colour band. Band detection was implemented using image processing techniques. The positioning module was added which determined the position of the object in terms of angle computations and distance calculations.
4. The system was to be designed for visually impaired users for positioning objects that they come across in their daily life. The initial model did not entirely satisfy this requirement. Hence there was a need to include objects that the user would come across in his daily life. Hence the object detection module was reviewed and redesigned using COCO dataset and Tensorflow which included useful set of objects like bottle, book, mobile, remote, cup etc.
5. After complete design of software, the system was transferred into the hardware and a wearable prototype was designed for the visually impaired user.

CHAPTER 2:

LITERATURE SURVEY

2. Literature Survey

2.1 Research Papers

2.1.1 Study on Object Detection using OpenCV – Python

Link: https://pdfs.semanticscholar.org/30b8/bf71cc49d6651fb5c361dcea7f0363e790a6.pdf

2.1.1.a Abstract of the research paper

Object detection is a well-known computer technology connected with computer vision and image processing that focuses on detecting objects or its instances of a certain class (such as humans, flowers, animals) in digital images and videos. There are various applications of object detection that have been well researched including face detection, character recognition, and vehicle calculator. Object detection can be used for various purposes including retrieval and surveillance. In this study, various basic concepts used in object detection while making use of OpenCV library of python 2.7, improving the efficiency and accuracy of object detection are presented.

2.1.1.b Inference drawn from the paper

The possibilities of using computer vision to solve real world problems are immense. The basics of object detection along with various ways of achieving it and its scope have been discussed. Python has been preferred over MATLAB for integrating with OpenCV because when a Matlab program is run on a computer, it gets busy trying to interpret all that Matlab code as Matlab code is built on Java. OpenCV is basically a library of functions written in C\C++. Additionally, OpenCV is easier to use for someone with little programming background. So, it is better to start researching on any concept of object detection using OpenCV-Python. Feature understanding and matching are the major steps in object detection and should be performed well and with high accuracy. Deep Face is the most effective face detection method that is preferred over Haar-Cascade by most of the social applications like Facebook, snapchat, Instagram etc. In the coming days, OpenCV will be immensely popular among the coders and will also be the prime requirement of IT companies. To improve the performance of object detection IOU measures are used.

2.1.2 Object classification Techniques using Machine Learning Model

Link: http://www.ijcttjournal.org/Volume18/number-4/IJCTT-V18P140.pdf

2.1.2.a Abstract of the research paper

Detecting people in images is key for several important application domains in computer vision. This paper presents an in-depth experimental study on pedestrian classification; multiple feature-classifier combinations are examined with respect to their performance and efficiency. In investigate global versus local, as exemplified by PCA coefficients. In terms of classifiers, consider the popular Support Vector Machines (SVMs), Adaptive boost with SVM. Experiments are performed on a large dataset consisting of 4,000 pedestrian and more than statistically meaningful results are obtained by analysing performance variances caused by varying training and test sets. Furthermore, to investigate how classification performance and training sample size are correlated. Our experiments show that the novel combination of SVMs with Adaptive Boost.

2.1.2.b Inference drawn from the paper

This paper presented an in-depth experimental study on pedestrian and vehicle image classification. Multiple feature-classifier combinations were examined with respect to their performance and efficiency on a large data set with ground truth. Global features, here represented by PCA coefficients, were found to be inferior to local features. SVMs out-reformed the other classifiers tested, except for the Adaboost cascade approach, which achieved comparable performance at much lower computational costs. The greatest performance gain was, however, achieved by increasing the training sample size. Here, the automatic generation of non-pedestrian examples resulted in a performance gain that, after few iterations ran into saturation. In future, to enhance the work in following areas: 1) Features Selection: In this work used only geometrical feature but it's not represent context information of image because context information might be helpful in proper classification of image. 2) Classifier: In this work used support vector machine but it not represent relation between features. In future, to use graphical models like Hidden markov model, CRF etc.

2.1.3 Object Finder for the Visually Impaired

Link: http://eprints.utar.edu.my/936/1/IA-2013-1003862.pdf

2.1.3.a Abstract of the research paper

In this paper, the author proposes an application to assist the visually impaired to find an object by exploring the computer vision technique. In order to achieve the goal of the application, context based template matching technique will be investigated and implemented to detect, track and guide a user's finger. Furthermore, due to the limited time frame on this project the targeted object is assumed to have a fixed colour tone to simplify the problem. As the first step, the system will require user to manually crop one of his/her fingers from an image. Then the system will extract a contextual template from the finger image. After that, the system will track the user's finger by matching the template to the input image.

Finally, the system gives instruction to guide the finger to the targeted object in the form of voice commands. The final deliverable will enable a machine and its operator (in this case the visually impaired) to successfully guide and assist user's finger to reach targeted object by simple voice instructions.

2.1.3.b Inference drawn from the paper

This paper has given an account of and reasons on the importance of delivering object finder software for the visually impaired using computer vision technique. The project was undertaken to design a user friendly object finder for the visually impaired to assist them in locating specific items employing voice commands. In order to achieve the ultimate goals, different computer vision techniques – feature detection (SURF – Speed Up Robust Feature, SIFT – Scale Invariant Feature Transform) and template matching were evaluated. Among all the technique, the most efficient and effective one – context based template matching technique is chosen as the implementation method to perform corresponding tasks.

The final deliverable of this project will benefits visually impaired in terms of bringing them happiness and confidence in personal and in the same time helps the visually impaired society and families to further reduce costs.

2.1.4 A Selective Attention Neural Network for Object Recognition

Link: http://ieeexplore.ieee.org/document/5726767/?reload=true

2.1.4.a Abstract of the research paper

The proposed system is a selective attention neural network for recognizing multiple objects in any position or orientation. Selective attention controls where the neural network focuses in the scene and at what times. By using selective attention, we trade neurons for speed. Since the network does not process all the inputs in parallel, we can build neural networks that can handle multiple objects and high resolution scene images using current simulators.

2.1.4.b Inference drawn from the paper

They have developed an object recognition module and implemented it using a recurrent neural network. The object recognition module takes the output of the selective attention module, builds up an internal representation of the object and makes a decision on the object's identity using the internal representation. Preliminary results have shown that the object recognition network decides on the object's identity before processing the entire object. Here, the network needs to process only part of the object before making its decision. This allows a neural network to recognize partially occluded objects, a difficult problem using classical techniques.

2.2 Study of Patent

2.2.1 Methods and systems for object recognition

Link: https://patents.google.com/patent/US9489401

2.2.1.a Title of the patent and year of the patent

Methods and systems for object recognition: US 9489401 B1

Filing date: Jun 16, 2015

Publication date: Nov 8, 2016

2.2.1.b Summary of patent

An object identification system comprises at least one database of reference images. Each reference image comprises an identifiable reference object and is associated in the database with a corresponding text description of the reference object. The system also comprises image query resolution data structures, each containing a collection of records having an image descriptor of one of the reference images, and searchable using a corresponding search algorithm. Upon receiving a query comprising an input image including a query object, the system generates a query image descriptor of the input image corresponding with one or more search algorithms, and searches the corresponding image query resolution data structure to identify a closest match record. A best available match record is identified from the closest match records identified in the image query resolution data structures, and a text description of the query object is retrieved corresponding with the associated reference image.

2.2.2 Determining scene distance in digital camera images

Link: https://patents.google.com/patent/US8073318

2.2.2.a Title of the patent and year of the patent

Determining scene distance in digital camera images: US 8073318 B2

Filing date: 21 Apr 2008

Publication date: 6 Dec 2011

2.2.2.b Summary of patent

A method for producing a distance map of scene distance values for a digital image captured by a digital camera includes capturing a first digital image of a scene under a first illumination condition, wherein the first digital image includes a plurality of pixels and the scene includes a plurality of scene objects located at different distances from the digital camera, capturing a second digital image of the scene under a second illumination condition that is different from the first illumination condition, and using the first and second digital images to produce a distance map having a plurality of scene distance values, wherein each scene distance value relates to the distance between the digital camera and the corresponding scene object.

2.2.3 Object detection using deep neural networks

Link: https://patents.google.com/patent/US20150170002A1/en

2.2.3.a Title and year of the paper

Object detection using deep neural networks: US 20150170002 A1

Filing date: May 27, 2014

Publication date: Jun 18, 2015

2.2.3.b Summary of patent

Methods, systems, and apparatus, including computer programs encoded on computer storage media, for detecting objects in images. One of the methods includes receiving an input image. A full object mask is generated by providing the input image to a first deep neural network object detector that produces a full object mask for an object of a particular object type depicted in the input image. A partial object mask is generated by providing the input image to a second deep neural network object detector that produces a partial object mask for a portion of the object of the particular object type depicted in the input image. A bounding box is determined for the object in the image using the full object mask and the partial object mask.

2.2.4 Training a neural network to detect objects in images

Link: https://patents.google.com/patent/US9514389B1/en

2.2.4.a Title of the patent and year of the patent

Training a neural network to detect objects in images: US 9373057 B1

Filing date: Oct 30, 2014

Publication date: Jun 21, 2016

2.2.4.b Summary of patent

A method for training a neural network that receives an input image and outputs a predetermined number of candidate bounding boxes that each cover a respective portion of the input image at a respective position in the input image and a respective confidence score for each candidate bounding box that represents a likelihood that the candidate bounding box contains an image of an object, the method comprising, receiving a training image and object location data for the training image, wherein the object location data identifies one or more object locations in the training image; providing the training image to the neural network and obtaining bounding box data for the training image from the neural network, wherein the bounding box data comprises data defining a plurality of candidate bounding boxes in the training image and a respective confidence score for each candidate bounding box in the training image; determining an optimal set of assignments using the object location data for the training image and the bounding box data for the training image, wherein the optimal set of assignments assigns a respective candidate bounding box to each of the object locations; and training the neural network on the training image using the optimal set of assignments.

2.2.5 Digital object recognition audio-assistant for the visually impaired

Link: https://patents.google.com/patent/US20050208457A1/en

2.2.5.a Title of the patent and year of the patent

Digital object recognition audio-assistant for the visually impaired: US 20050208457 A1

Filing date: Jan 5, 2005

Publication date: Sep 22, 2005

2.2.5.b Summary of patent

A camera-based object detection system for a severely visually impaired or blind person consisting a digital camera mounted on the person's eyeglass or head that takes images on demand. Near-real time image processing algorithms decipher certain attributes of the captured image by processing it for edge pattern detection within a central region of the image. The results are classified by artificial neural networks trained on a list of known objects, in a lookup table, or by a threshold. Once the pattern is classified a descriptive sentence is constructed of the object and its certain attributes and a computer-based voice synthesizer is used to verbally announce the descriptive sentence. The invention is used to determine the size of an object, or its distance from another object, and can be used in conjunction with an IR-sensitive camera to provide - sight in poor visibility conditions, or at night.

CHAPTER 3:

REQUIREMENT GATHERING

3. Requirement Gathering

3.1 Functional Requirements

- The product will be able to recognize basic objects that we come across in our daily life.
- Object recognition is a process for identifying a specific object in a digital image or video. Object recognition algorithms rely on matching, learning, or pattern recognition algorithms using appearance-based or feature-based techniques.
- User will be able to provide the input regarding which object he/she wants to reach.
- The system will be able to process the speech input provided by the user.
- System will then perform scaling of that particular object that the user has stated or the object that the user wants.
- System will be able to determine the position of the object with respect to the user.
- It will determine whether object is within an arm's distance from the user and if it is reachable or not.
- The product will direct the user to reach or grab the object through voice commands.

3.2 Non - functional Requirements

- Performance: The response time of the system should be less than one second.
- Efficiency: The system should be able to detect objects correctly.
- Reliability: The system should never crash.
- Accuracy: There should be negligible difference between the output distance provided by the system and the real distance.

3.3 Constraints

- The dataset is limited to a few objects. It is designed for objects in an indoor environment. The dataset includes those objects which are required in day to day life.
- Lighting condition and contrast background may affect the detection of the object. Proper lighting and contrast background is required to achieve efficiency and accuracy.
- Restricted for objects within an arm's distance. The system is not designed for navigation purposes.

- Processor constraint: Minimum processor requirement is - CPU: 1.2 GHz quad-core
- GPU: Broadcom VideoCore IV @ 250 MHz. This requirement should be met to avoid time lag and to provide fast and precise communication with the user with minimal instructions and delay.

3.4 Hardware and Software Requirements

3.4.1 Hardware

This project uses Raspberry PI as the base hardware unit to make the system portable, lightweight, and of small size. Other Hardware unit includes -

- Raspberry PI camera module: for feeding real time input to the system.
- Microphone: for user to provide input to the system through speech recognition.
- Speaker/microphone: The system will provide processed output to the user through voice commands.

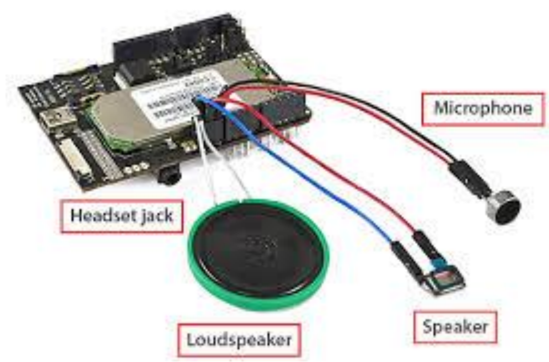

Fig. 3.4.1 – Raspberry PI connected with mic, speaker, and headset

3.4.1. a Raspberry PI

The Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote the teaching of basic computer science in schools and in developing countries. The original model became far more popular than anticipated, selling outside of its target market for uses such as robotics. Peripherals (including keyboards, mice and cases) are not included with the Raspberry Pi. Some accessories however have been included in several official and unofficial bundles.

According to the Raspberry Pi Foundation, over 5 million Raspberry PIs have been sold before February 2015, making it the best-selling British computer. By November 2016 they had sold 11 million units in March 2017 12.5m making it the third best-selling "general purpose computer" ever. They are made in a Sony factory in Pencoed, Wales.

Fig. 3.4.2 – Raspberry PI 3 model B

3.4.1.b Raspberry PI camera module

The Raspberry Pi camera module can be used to take high-definition video, as well as stills photographs. It’s easy to use for beginners, but has plenty to offer advanced users if you’re looking to expand your knowledge. There are lots of examples online of people using it for time-lapse, slow-motion and other video cleverness. We can also use the libraries we bundle with the camera to create effects.

If you’re interested in the nitty-gritty, you’ll want to know that the module has a five megapixel fixed-focus camera that supports 1080p30, 720p60 and VGA90 video modes, as well as stills capture. It attaches via a 15 cm ribbon cable to the CSI port on the Raspberry Pi. It can be accessed through the MMAL and V4L APIs, and there are numerous third-party libraries built for it, including the Picamera Python library.

The camera module is very popular in home security applications, and in wildlife camera traps. It can also be used to take snapshots.

The camera consists of a small (25mm by 20mm by 9mm) circuit board, which connects to the Raspberry Pi's Camera Serial Interface (CSI) bus connector via a flexible ribbon cable. The camera module is shown below:

Fig. 3.4.3 – Raspberry PI connected with camera module

3.4.2 Software

The softwares used in this system are Python, OpenCV and tensorflow. It specifically requires python 3.5 above versions as tensorflow is not compatible with the previous versions of python –

3.4.2.a Python 3.5.x

Python is a widely used high-level programming language for general-purpose programming created by Guido van Rossum and first released in 1991. An interpreted language, Python has a design philosophy that emphasizes code readability (notably using whitespace indentation to delimit code blocks rather than curly brackets or keywords), and a syntax that allows programmers to express concepts in fewer lines of code than might be used in languages such as C++ or Java. The language provides constructs intended to enable writing clear programs on both a small and large scale.

Python interpreters are available for many operating systems, allowing Python code to run on a wide variety of systems. CPython, the reference implementation of Python, is open source software and has a community-based development model, as do nearly all of its variant implementations. CPython is managed by the non-profit Python Software Foundation.

3.4.2.b OpenCV 3.3.0

OpenCV (Open Source Computer Vision) is a library of programming functions mainly aimed at real-time computer vision. Originally developed by Intel, it was later supported by Willow Garage and is now maintained by Itseez. The library is cross-platform and free for use under the open-source BSD license. OpenCV supports the Deep Learning frameworks TensorFlow, Torch/PyTorch and Caffe.

3.4.2.c Tensorflow 1.6

TensorFlow is an open-source software library for machine learning across a range of tasks. It is a symbolic math library, and also used as a system for building and training neural networks to detect and decipher patterns and correlations, analogous to human learning and reasoning TensorFlow was developed by the Google Brain team for internal Google use. It was released under the Apache 2.0 open source license on 9 November 2015.

CHAPTER 4:

PROPOSED DESIGN

4. Proposed Design

4.1 Block Diagram of the System

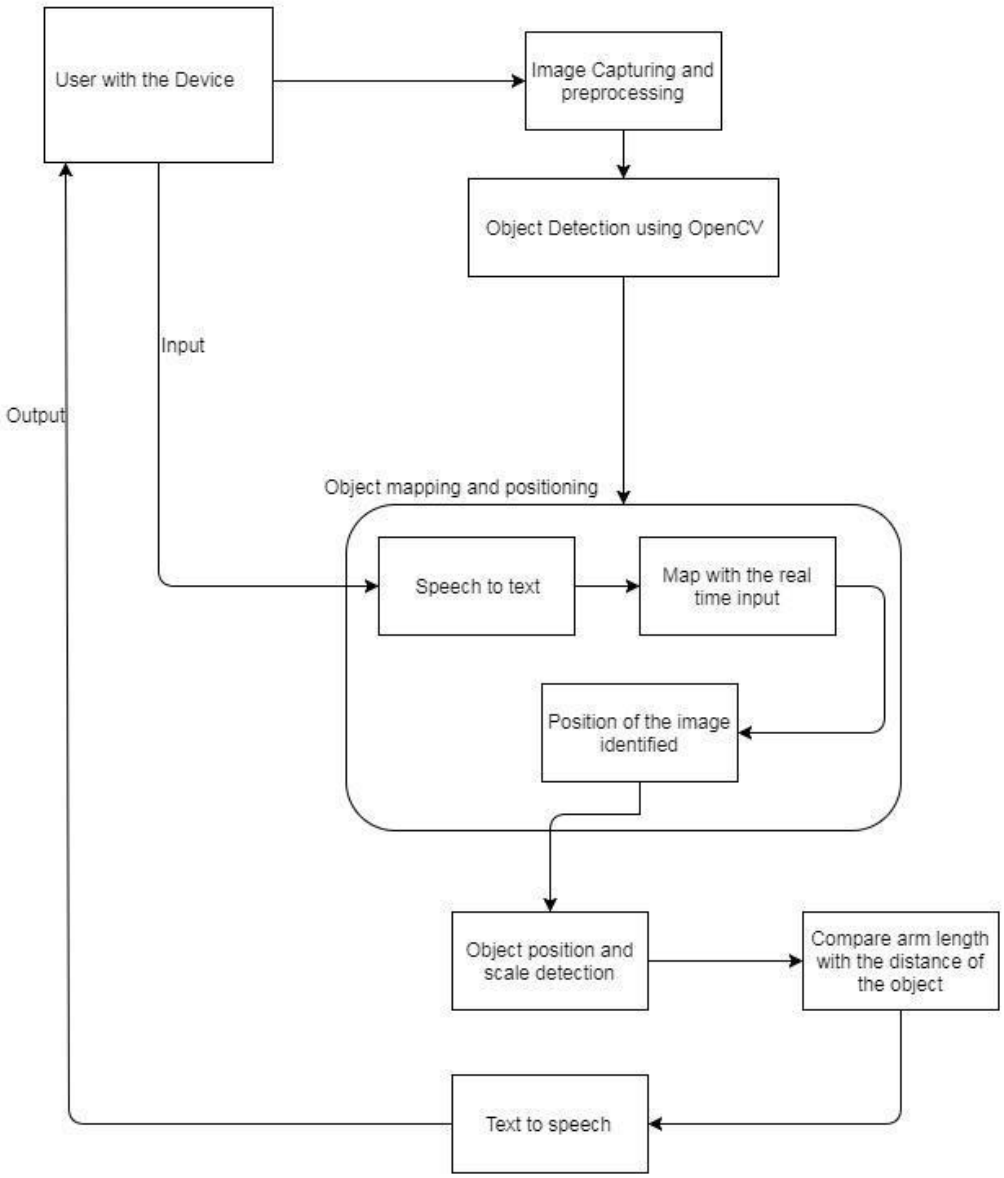

Fig. 4.1.1 – Block Diagram

In the above designed block diagram it first starts with the object detection part which is real time object detection with the camera after capturing the image and pre-processing it and detecting the objects then the input is taken from the user regarding which object the user wants to grab. After the input is received from the user, scaling factor is calculated for that particular object and the directions of the position of the object is then converted into speech and given as the output to the user. So that they can grab the object that he/she wants to.

4.2 Modular Design of the System

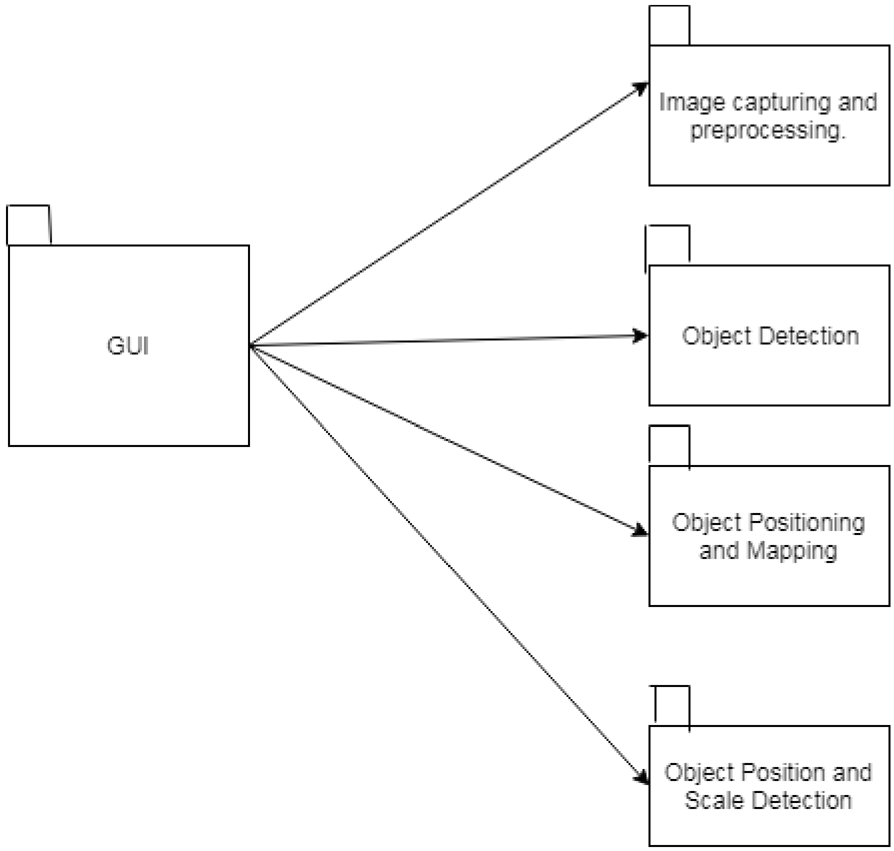

Fig. 4.2.1 – Modular diagram

The modules are as follows:

- Image Capturing and pre-processing
- Object Detection
- Object Positioning and Mapping.
- Scaling

4.3 Data Flow Diagram (level 0, 1)

- Level 0 (context level)

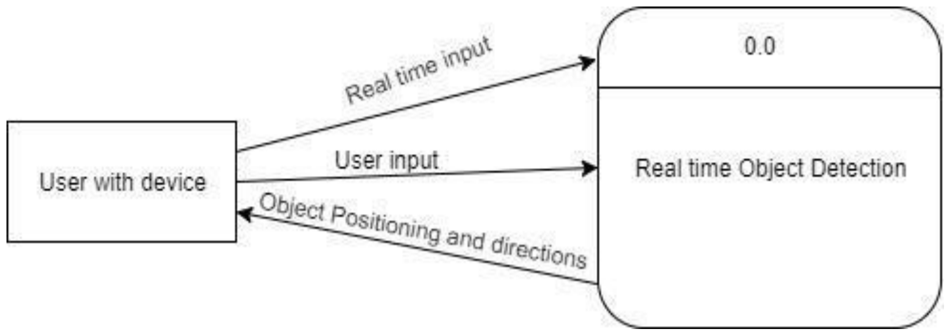

Fig. 4.3.1 – DFD level 0

- Level 1

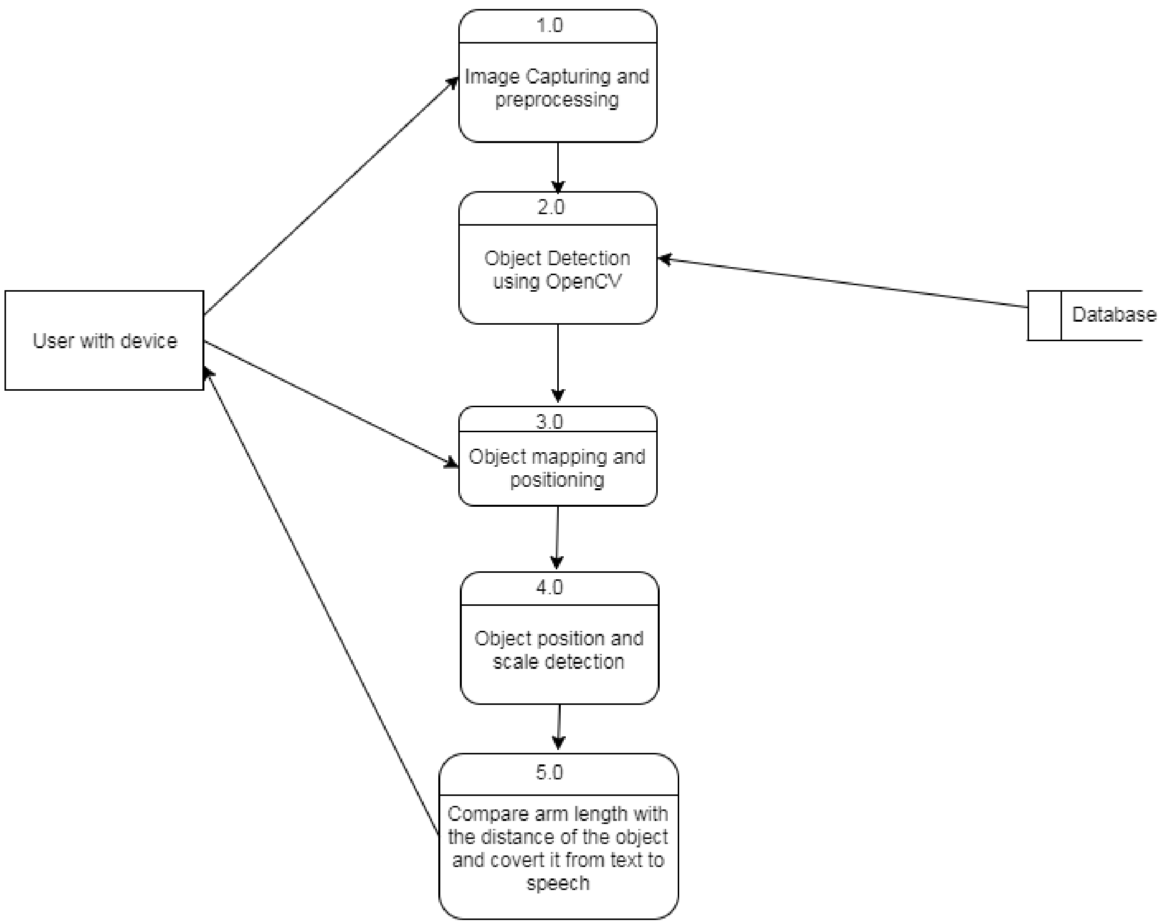

Fig. 4.3.2 – DFD level

4.4 Project Scheduling & Tracking using Timeline/Gnatt Chart

At Risk	Task Name	Start Date	End Date	Assigned To	Durat...	% Complete	Prede...
	Real Time Video Input	**08/10/17**	**09/12/17**		**23.5d**	**45%**	
	Preprocessing	08/10/17	08/21/17		8d	50%	
	Switching on camera module	08/22/17	09/07/17		13d	50%	4
	Capturing Image Frames	09/08/17	09/12/17		2.5d	0%	5
	Object Detection	**09/22/17**	**10/24/17**		**23d**		
	Input Frame	09/22/17	10/03/17		8d		
	Feature Extraction of Objects in Vision	10/04/17	10/18/17		11d		8
	Object Recognition	10/19/17	10/24/17		4d		9, 6
	Milestone 1	10/24/17	10/24/17		0		10
	Position of the object identified	**10/25/17**	**04/02/18**		**114d**		
	Object position	10/25/17	11/15/17		16d		11
	Scale detection	11/16/17	12/29/17		32d		13
	Compare arm length with the distance of objects	01/01/18	Thursday, November 16, 2017		66d		
	Text to speech	01/01/18	04/02/18		66d		14
	Voice instructions to User	04/02/18	04/02/18		0		16

Fig. 4.4.1 - Project scheduling tasks

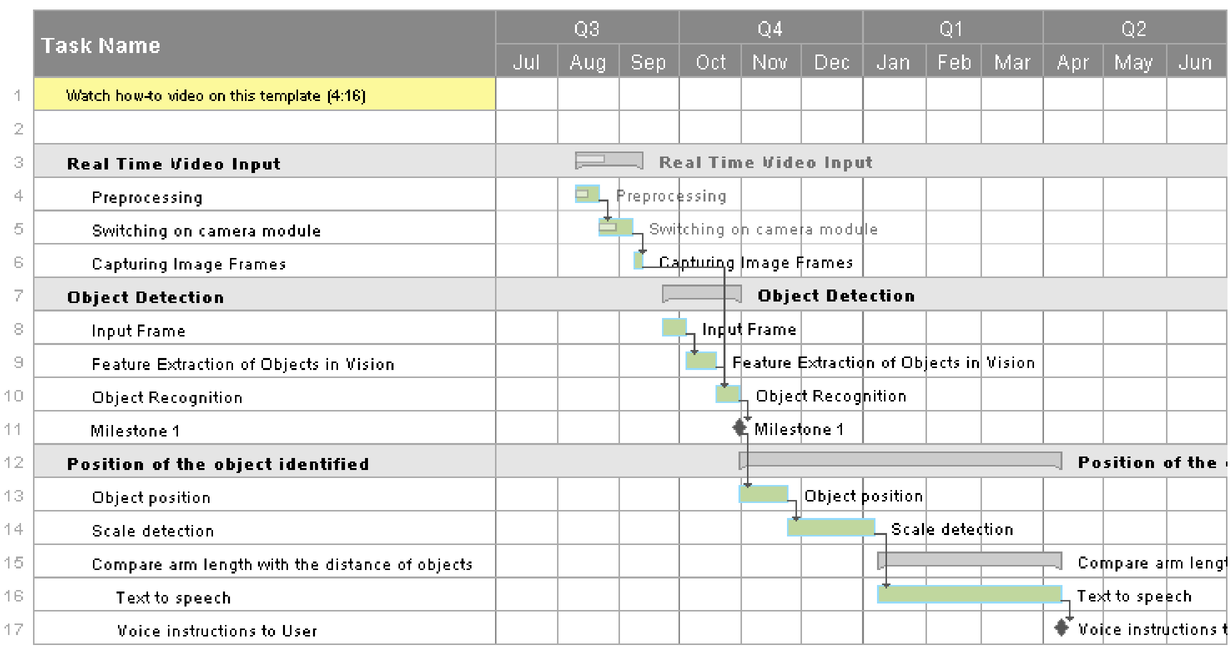

Fig. 4.4.2 - Project scheduling timeline

CHAPTER 5:

IMPLEMENTATION DETAILS

5. Implementation Details

5.1. Algorithms for the respective modules developed

5.1.1 Object Detection

There are many different ways to do object detection or image recognition. When it comes to deep learning-based object detection there are three primary object detection methods that you'll likely encounter:

- Faster R-CNNs
- You Only Look Once (YOLO)
- Single Shot Detectors (SSDs)

MobileNets - When building object detection networks, we normally use existing network architecture, such as VGG or ResNet, and then use it inside the object detection pipeline. The problem is that these network architectures can be very large in the order of 200-500MB.Network architectures such as these are unsuitable for resource constrained devices due to their sheer size and resulting number of computations. Instead, we can use MobileNets. If we combine both the MobileNet architecture and the Single Shot Detector (SSD) framework, we arrive at a fast, efficient deep learning-based method to object detection. MobileNet SSD and deep neural network (dnn) module in OpenCV was used to build our object detector.

TensorFlow Object Detection API - Google recently released a new TensorFlow Object Detection API to give computer vision everywhere a boost.

The API has been trained on the COCO dataset (Common Objects in Context). This is a dataset of 300k images of 90 most commonly found objects.

5.1.2 Object Positioning

After detection of the object and the band (worn by user on his wrist), we have to position the object with respect to users hand. The position of the object is instructed to the user by telling him whether the object is to his right, left or center, at what angle and distance is the object from user's hand.

The output (detected objects) is fed to a function called detections. Number of objects and the centroid coordinates of each object are calculated. A line is drawn connecting the centroids and the Euclidean distance is computed. The result is obtained in pixel which is converted into centimeters and then multiplied by a scaling factor to get the ***real life distance.*** The scaling factor is computed by conducting an experiment through which scaling factor for x and y axis is calculated. Using these values and trigonometry scaling factor at any other angle was found out. ***Angle*** was found out using trigonometry and centroid coordinates.

Scaling factor results

Table 1 shows the results of an experiment performed. An experiment to find out the scaling factor between the image of an object on the paper and the object as it appears in real life was performed.

Centre to right	1 cm in image = 4.59 cm in real
Centre to left	1 cm in image = 4.5 cm in real
Centre to forward	1 cm in image = 18.89 cm in real
Centre to backward	1 cm in image = 12.5 cm in real

Table. 5.1.1 - Experimental Results

Scaling factor for x axis: 4.5 cm

Scaling factor for y axis: 15 cm

Finding the Angle

Let (ax, ay) and (bx, by) be the centroid coordinates of the object and the band. The following conditions were tested:

1. (bx-ax) not equal to zero: If the object lies on any other line other than vertical line then its slope is calculated using two-point form. This gives the angle with respect to horizontal axis. Then we find the angle with respect to vertical axis by subtracting it from ninety degrees.
2. (by-ay) equal to zero: If the object lies on horizontal axis, then it simply returns angle as 90 degrees.

3. (bx-ax) equal to zero: If the object lies on vertical axis, then it simply returns angle as zero degrees.

Finding the Distance

Euclidean distance between two points a and b is the length of the line segment joining them. If **a** = (ax, ay) and **b** = (bx, by) then the distance is given by-

d(a, b) = $\sqrt{(ax - bx)2 + (ay - by)2}$

The conditions mentioned above for angle computations are again tested for distance and the distance is multiplied by appropriate scaling factors to get the actual distance.

Actual distance = Euclidean distance*scaling factor*0.0265 (for pixel to centimeters)

5.2. Comparative Analysis with the existing algorithms

5.2.1 A Selective Attention Neural Network for Object Recognition

An object recognition module was developed and implemented it using a recurrent neural network. The object recognition module takes the output of the selective attention module, builds up an internal representation of the object and makes a decision on the object's identity using the internal representation. Preliminary results have shown that the object recognition network decides on the object's identity before processing the entire object. Here, the network needs to process only part of the object before making its decision. This allows a neural network to recognize partially occluded objects, a difficult problem using classical techniques.

5.2.2 Object Finder for the Visually Impaired

The project was undertaken to design a user friendly object finder for the visually impaired to assist them in locating specific items employing voice commands. In order to achieve the ultimate goals, different computer vision techniques – feature detection (SURF – Speed Up Robust Feature, SIFT – Scale Invariant Feature Transform) and template matching were evaluated. Among all the technique, the most efficient and effective one – context based template matching technique is chosen as the implementation method to perform corresponding tasks.

The final deliverable of this project will benefits visually impaired in terms of bringing them happiness and confidence in personal and in the same time helps the visually impaired society and families to further reduce costs.

5.3. Evaluation of the developed system

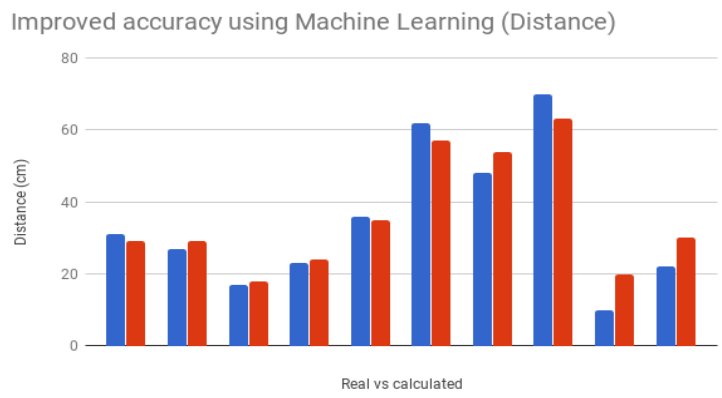

Fig. 5.3.1 - Real vs. calculated distance

The bar graph in the Fig. 5.3.1 depicts the difference in real distance (between the hand of the user and the object) and the distance calculated by our system.

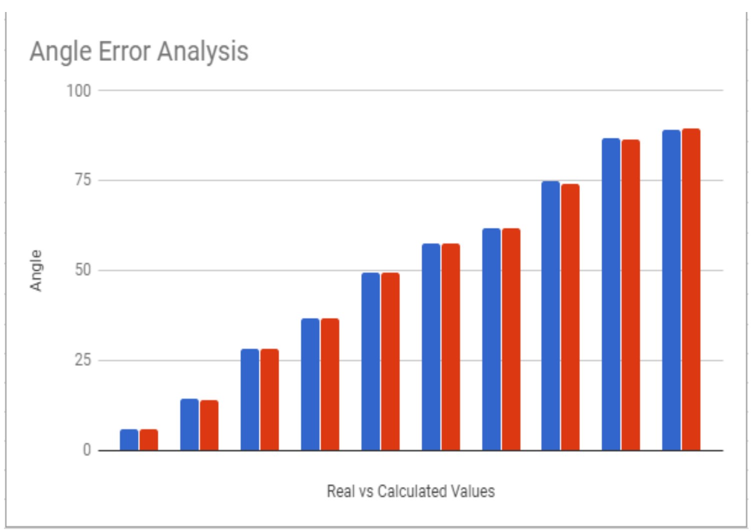

Fig. 5.3.2 - Real vs. calculated angle

Fig. 5.3.2 denotes the difference between the actual angle value and the angle value calculated by our system. We can see that the calculated values are as accurate as the real values.

CHAPTER 6:

TESTING

6. Testing

Case 1: Pass

The book kept on the table was correctly detected and positioned by the system.

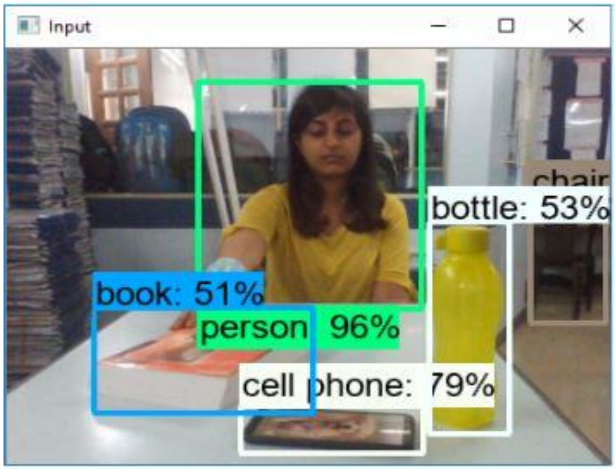

Fig. 6.1 - Book positioned

Case 2: Pass

The bottle kept on the table was correctly detected and positioned by the system.

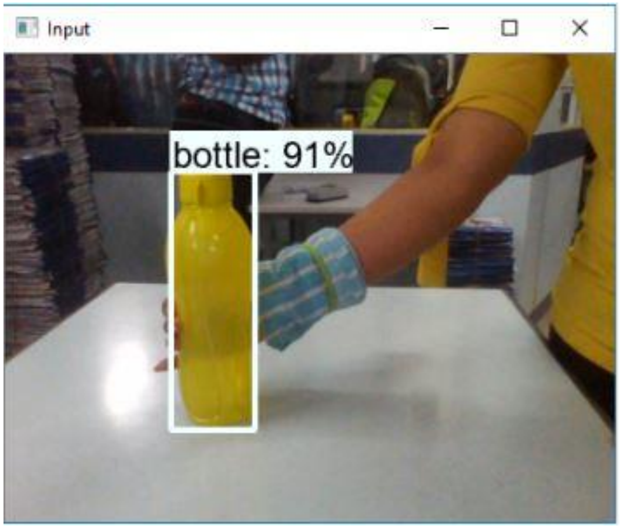

Fig. 6.2 - Bottle positioned

Case 3: Pass

The cellphone kept on the table was correctly detected and positioned by the system.

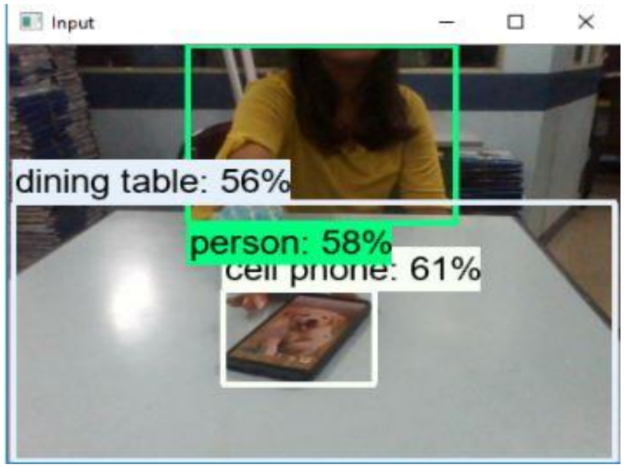

Fig. 6.3 - Phone positioned

Case 4: Fail

The system considered a perfume bottle as a regular bottle because of its similar shape and hence the user grabbed the wrong object.

Fig. 6.4 - Wrong object positioned

Case 5: Fail

The bottle was not detected because it lies at a distance out of the range for which the system works.

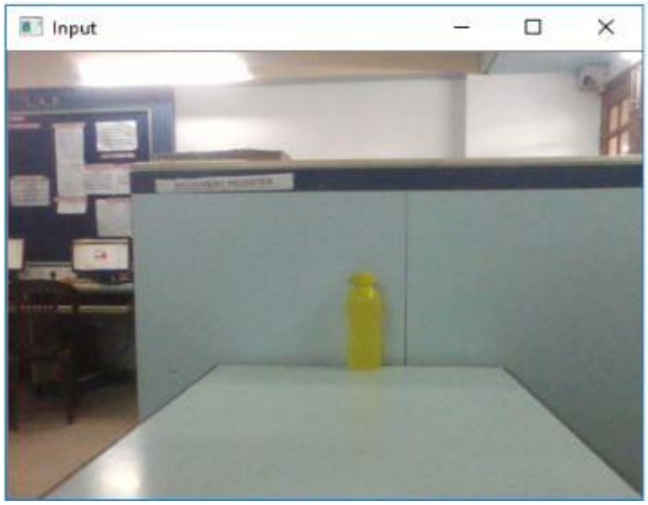

Fig. 6.5 - Object not detected

Case 6: Fail

The user could not grab the bottle because his hand was at at greater height than that of the bottle.

Fig 6.6 - Failure in grabbing the object

CHAPTER 7:
RESULT ANALYSIS

7. Result Analysis

7.1 Simulation Model

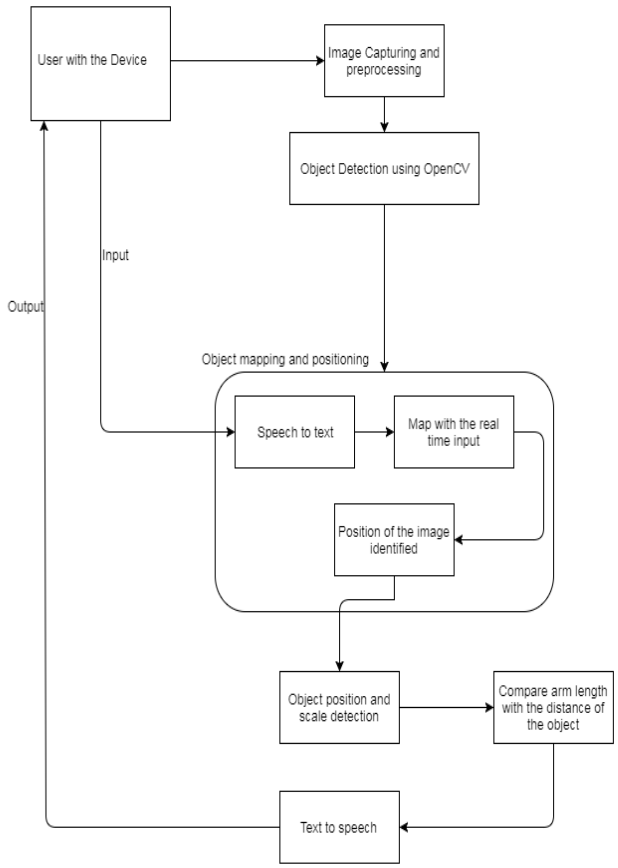

Fig 7.1.1 block diagram

Fig 7.1.2 – prototype of the system

7.2 Parameters considered

The dataset is limited to a few objects. It is mainly used for objects in an indoor space. The dataset includes those objects which are required in daily life. Lighting condition and contrast background may cause an issue for the detection of the object. Proper lighting and contrast background is required. This system only deals within an arm's distance. The system is not designed for navigation purposes. Processor constraint: Minimum processor requirement is - CPU: 1.2 GHz quad-core. GPU: Broadcom VideoCore IV @ 250 MHz. This requirement should be met to avoid time lag and to provide fast and precise communication with the user with minimal instructions and delay. The height of the object is not taken into consideration. The colour of the band should not match with the colour of any other object in the background.

7.3 Graphical outputs

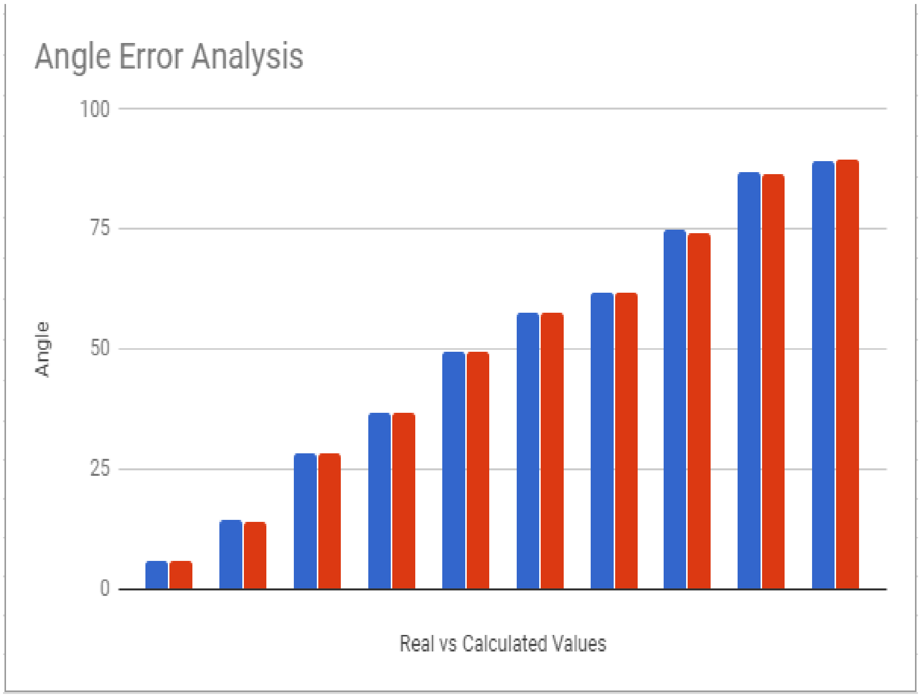

Fig 7.3.1 Angle Error Analysis

Fig 7.3.1 shows the difference in angles computed for different cases in real life and by the system.

7.4 Tables obtained

Moved from	In Real (cm)	In Image (cm)
Center to left	16.2	3.6
Center to right	17.9	3.9
Center to front	15	1.2
Center to back	17	0.9

Table 7.4.1 - Distance Calculations

Centre to right	1 cm in image = 4.59 cm in real
Centre to left	1 cm in image = 4.5 cm in real
Centre to forward	1 cm in image = 18.89 cm in real
Centre to backward	1 cm in image = 12.5 cm in real

Table 7.1.2 - Results obtained after scaling

Table 7.1.1 and 7.1.2 shows the results obtained after scaling experiment was conducted.

CHAPTER 8:

CONCLUSION

8. Conclusion

8.1 Limitations

- The dataset is limited to a few objects. It is designed for objects in an indoor environment. The dataset includes those objects which are required in day to day life.
- Lighting condition and contrast background may affect the detection of the object. Proper lighting and contrast background is required to achieve efficiency and accuracy.
- Restricted for objects within an arm's distance. The system is not designed for navigation purposes.
- Processor constraint: Minimum processor requirement is - CPU: 1.2 GHz quad-core
- GPU: Broadcom VideoCore IV @ 250 MHz. This requirement should be met to avoid time lag and to provide fast and precise communication with the user with minimal instructions and delay.

8.2 Conclusion

This report has given an account of and reasons on the importance of delivering object finder software for the visually impaired using computer vision technique. The project was undertaken to design a user friendly object finder for the visually impaired to assist them in locating specific items employing voice commands.

This system helps this group of people to become more independent. They can locate object that they want rather than depending on other people to help them. This might indirectly help the family and the society to have cost saving spent on visually impaired.

In addition, the system also increases the confidence level and the happiness level of the visually impaired in the way that they became more independent.

8.3 Future Scope

- Sensors could be integrated with the system to detect whether an object is too hot or cold so as to prevent any discomfort or harm to the user.
- It could be extended for the outdoor environments; GPS could be integrated with the system to use the product for navigation purpose as well. If the system is made adaptable, it could be used in a new environment.

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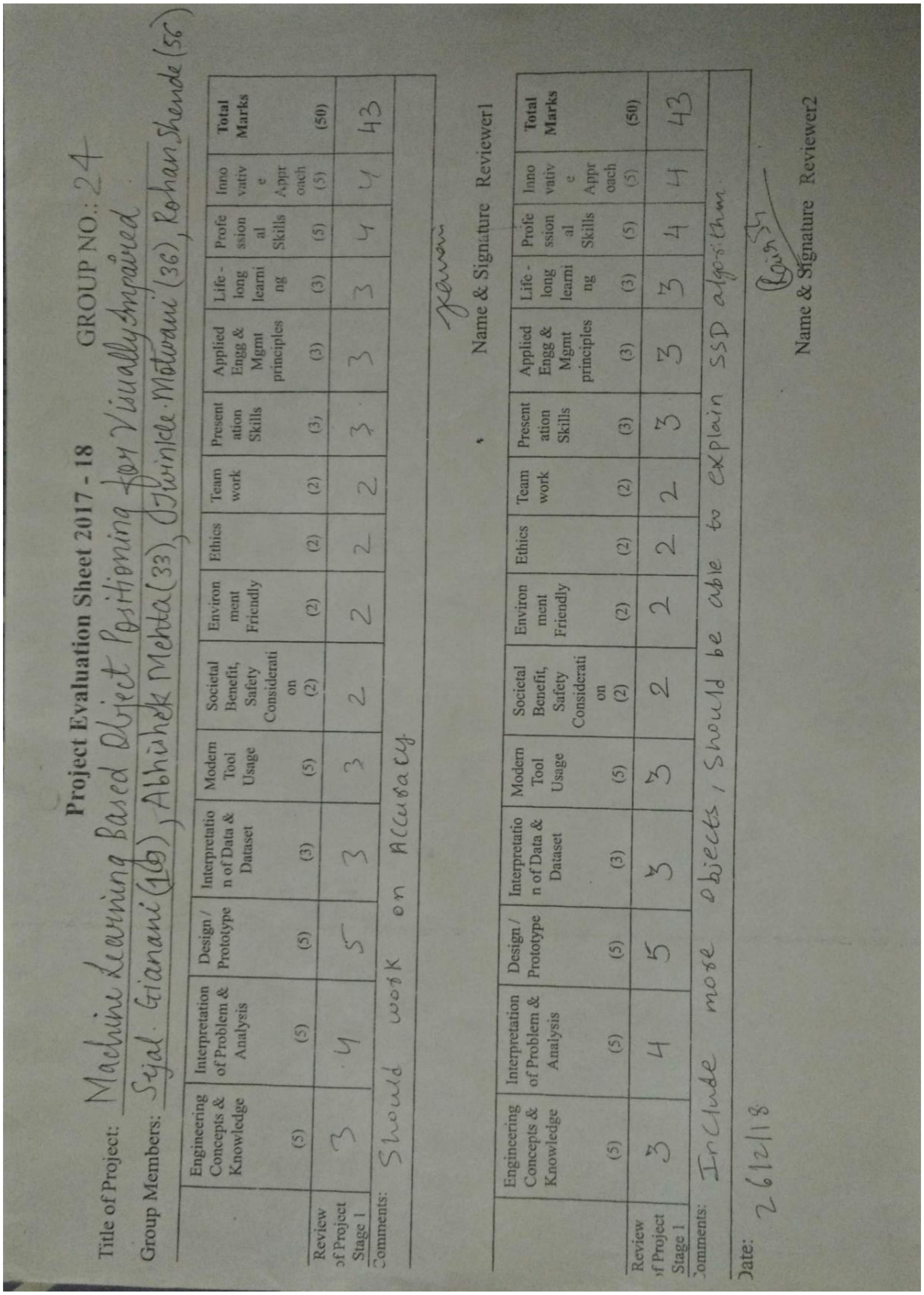
PROJECT PROGRESS REVIEW SHEETS

- Review sheet 1



Project Evaluation Sheet 2017 - 18

Title of Project: Machine Learning Based Object Positioning for Visually Impaired GROUP NO.: 24

Group Members: Sejal Gianani (16), Abhishek Mehta (33), Twinkle Motwani (36), Rohan Shende (56)

	Engineering Concepts & Knowledge (5)	Interpretation of Problem & Analysis (5)	Design / Prototype (5)	Interpretation of Data & Dataset (3)	Modern Tool Usage (5)	Societal Benefit, Safety Consideration (2)	Environment Friendly (2)	Ethics (2)	Team work (2)	Presentation Skills (3)	Applied Engg & Mgmt principles (3)	Life-long learning (3)	Professional Skills (5)	Innovative Approach (5)	Total Marks (50)
Review of Project Stage 1	3	4	5	3	3	2	2	2	2	3	3	3	4	4	43

Comments: Should work on Accuracy

Name & Signature Reviewer1

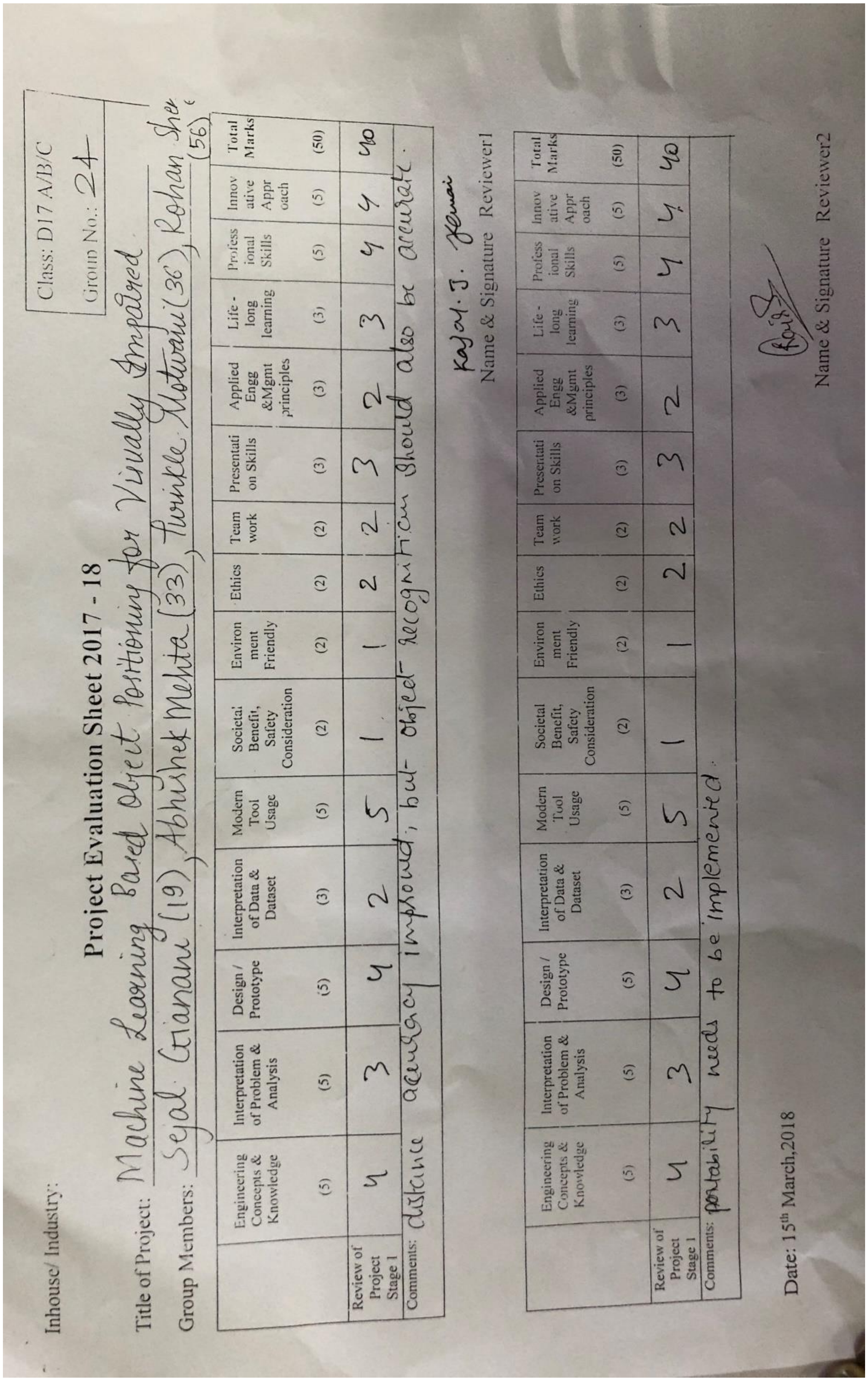
	Engineering Concepts & Knowledge (5)	Interpretation of Problem & Analysis (5)	Design / Prototype (5)	Interpretation of Data & Dataset (3)	Modern Tool Usage (5)	Societal Benefit, Safety Consideration (2)	Environment Friendly (2)	Ethics (2)	Team work (2)	Presentation Skills (3)	Applied Engg & Mgmt principles (3)	Life-long learning (3)	Professional Skills (5)	Innovative Approach (5)	Total Marks (50)
Review of Project Stage 1	3	4	5	3	3	2	2	2	2	3	3	3	4	4	43

Comments: Include more objects, Should be able to explain SSD algorithm.

Date: 26/12/18

Name & Signature Reviewer2

- Review sheet 2



Inhouse/ Industry:

Class: D17 A/B/C

Group No.: 24

Project Evaluation Sheet 2017 - 18

Title of Project: Machine Learning Based Object Positioning for Visually Impaired

Group Members: Sejal Gianani (19), Abhishek Mehta (33), Twinkle Motwani (36), Rohan Sher (56)

	Engineering Concepts & Knowledge	Interpretation of Problem & Analysis	Design / Prototype	Interpretation of Data & Dataset	Modern Tool Usage	Societal Benefit, Safety Consideration	Environment Friendly	Ethics	Team work	Presentation Skills	Applied Engg &Mgmt principles	Life-long learning	Professional Skills	Innovative Approach	Total Marks
	(5)	(5)	(5)	(3)	(5)	(2)	(2)	(2)	(2)	(3)	(3)	(3)	(5)	(5)	(50)
Review of Project Stage I	4	3	4	2	5	1	1	2	2	3	2	3	4	4	40

Comments: distance accuracy improved, but object recognition should also be accurate.

Kajal J.

Name & Signature Reviewer1

	Engineering Concepts & Knowledge	Interpretation of Problem & Analysis	Design / Prototype	Interpretation of Data & Dataset	Modern Tool Usage	Societal Benefit, Safety Consideration	Environment Friendly	Ethics	Team work	Presentation Skills	Applied Engg &Mgmt principles	Life-long learning	Professional Skills	Innovative Approach	Total Marks
	(5)	(5)	(5)	(3)	(5)	(2)	(2)	(2)	(2)	(3)	(3)	(3)	(5)	(5)	(50)
Review of Project Stage I	4	3	4	2	5	1	1	2	2	3	2	3	4	4	40

Comments: portability needs to be implemented.

Name & Signature Reviewer2

Date: 15th March,2018

APPENDIX

Technical Papers

• Paper 1

Paper title: Juvo – An Aid for the Visually Impaired

Paper details: Presented in IEEE organized International Conference on Smart City and Emerging Technologies (ICSCET 2018), on 5th Jan 2018 to be published in IEEE EXPLORE.

JUVO - An Aid for the Visually Impaired

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***Abstract* - Visual impairment is a disability that causes problems for detection and recognition of objects not fixable by usual means. Visually impaired people face many challenges while operating with their surrounding environments and the most common inconvenience is to locate personal items which are either misplaced or dropped. With advancement in the technology, memory and processing power the growth of computer vision technology is gradually accelerating and is quite economical. People with partial or complete vision loss need better positioning and control of their personal objects, so a solution is proposed to help them handle objects used daily. The software will be helping them to localize and to pick up objects within their vicinity. In addition, the system also increases the confidence level and comfort level of the visually impaired in the way that they become more independent. All people suffering from visual impairment in different working environments like home, office, educational institutions can use this system. Training institutes, any non-profit organization will be benefited from this.**

Keywords - Object detection; OpenCV; Deep learning; MobileNets; Single shot detectors; visually impaired

I. INTRODUCTION

In the past few years, there have been many developments in the field of assistive devices for the visually impaired group of people to improve their quality of life [1] [2]. However, hardly any solutions have been developed to help them in identifying common objects in indoor environments. Since computer vision based solutions are easily affordable and accessible, they are emerging now as one of the most promising options. Computer vision can be defined as the field of science and artificial intelligence for building artificial systems that obtain knowledge from images or multi-dimensional data and give computers a visual understanding of the world. Understanding the actual needs of the visually impaired population and which of these needs might be addressed by computer vision is important.

This paper describes how real time object detection is performed using OpenCV, positioning the detected object using scaling method and distance calculations and directing the visually impaired user to grab it via voice instructions. An integrated hardware unit consisting of Raspberry Pi, a camera module, along with a microphone and headphones or a speaker to send and receive voice instructions for directing the user is being developed.

II. METHODOLOGY

A. Overview

This paper describes the work in two parts viz. object detection and object positioning. Object detection is the method of recognizing the object that makes use of computer vision technology and image processing techniques. Object positioning is determining the position of the object with respect to user's hand.

Fig. 1 depicts the flow of the system and the different modules it is associated with. When the system is switched on, it will be continuously taking real time input from the camera and detecting the objects in its vision; and the user will be able to provide the input of the object he/she wants to reach. The system will then process the voice input provided by the user and map that object in the image. It will perform scaling and will determine whether that object is within an arm's distance i.e. if it is reachable or not. If the object is reachable, the system will provide further voice instructions to the user in a loop till he/she reaches that particular object. All the communication between user and the system will be done through voice commands.

B. Object Detection

There are many different techniques to perform object detection which includes traditional methods like template matching, feature extraction algorithms (SIFT, HOG, SURF etc.). The problem with these algorithms is that they involve using a block-wise orientation histogram feature and does not achieve high accuracy results [3]. Since, there are different labels it is difficult to differentiate among them as these methods encode very low level characteristics of the objects. We have implemented object detection (a.k.a. image classification) using OpenCV (Open source Computer Vision) which is an open source library for programming functions in python developed by Intel for a range of tasks in real time computer vision. OpenCV also supports deep learning frameworks.

When it comes to deep learning based object detection, there are primarily three object detection methods viz. Faster R-CNN's, YOLO (You Only Look Once), SSD (Single Shot Detectors) [4]. MobileNets [5] - Existing network architecture, like VGG or ResNet are normally used when building an object detection network, and then we use it inside the object detection pipeline. The problem with these network architectures is that they can be very large (up to 500MB). These types of network architectures are thus very unsuitable for resource constrained devices such as Raspberry PI due to their heavy size and also they require a large number of computations. Hence, we have combined both the Single Shot Detector (SSD) framework and the MobileNet architecture to arrive at a fast and efficient deep learning based method for object detection. This network architecture is then trained to detect common objects such as bottles, chairs, person etc. [6]. Fig. 2 shows an output in which we can see that a bottle is detected with an impressive 99.61% confidence.

C. Object Positioning

To find the distance of the object from the camera (or user) in real life, we have found out the scaling factor through an experimental setup which is shown in *section III.* After obtaining the scaling factor, by calculating the distance between objects in images [7], we can easily find out the physical distance between objects. Computing distance between objects in an image is similar to computing size of objects in an image and for that we need a reference object, then we find centroid-to-centroid Euclidean distance in image and lastly scale it to find the physical distance.

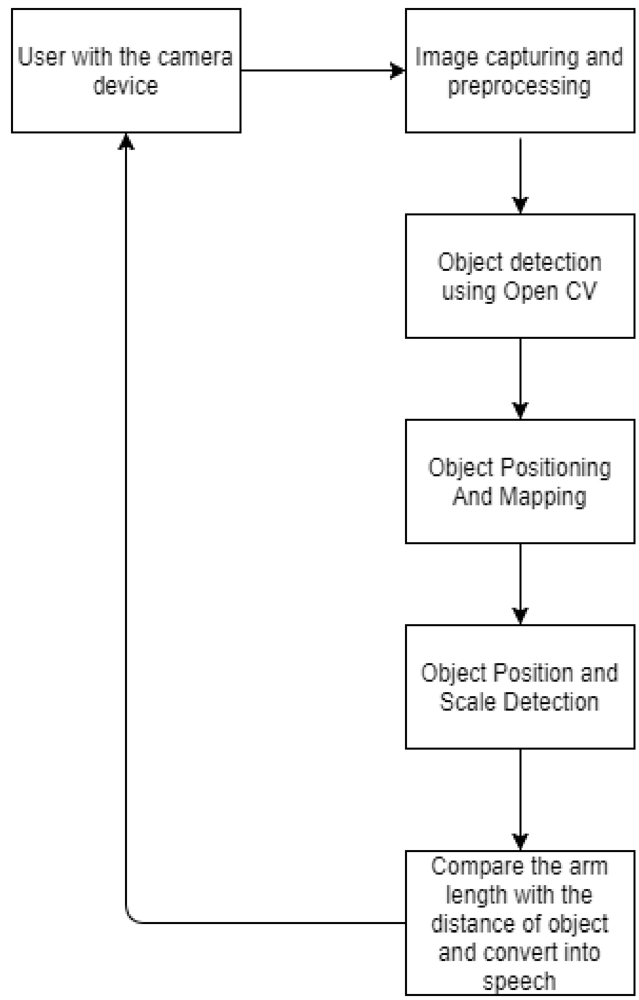

Fig. 1. System Design

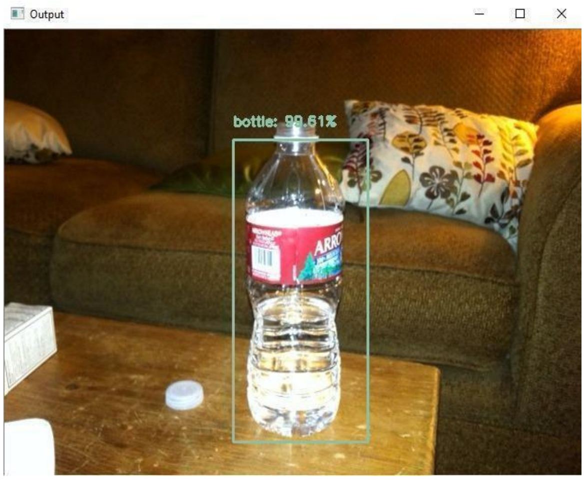

Fig. 2. Object Detection

III. EXPERIMENTAL ANALYSIS

A scale factor is defined as the number which multiplies some quantity, or scales it. The ratio of any two corresponding lengths in two similar geometric figures is also called a scale factor. An experiment to find out the scaling factor between the image of an object on the paper and the object as it appears in real life was performed. The intersecting lines in Fig. 3 and Fig. 4 is said to be the "center" of the image. These figures depict that the object is displaced from center to left and right respectively. Further all the calculations are carried out with respect to the center of the image. TABLE I shows the distances measured in real and image and TABLE II gives the relation between them. The following results were obtained.

Distances measured with respect to viewer/camera:

TABLE I. DISTANCE CALCULATIONS

Moved from	**In Real (cm)**	**In Image (cm)**
Center to left	16.2	3.6
Center to right	17.9	3.9
Center to front	15	1.2
Center to back	17	0.9

Center to camera (vertical) = 22.75 cm
Center to camera (horizontal) = 71 cm

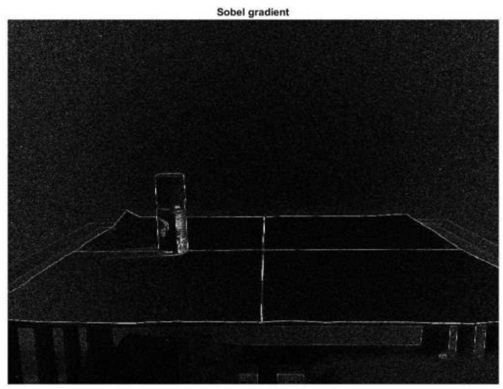

Fig. 3. Object is moved from center to left

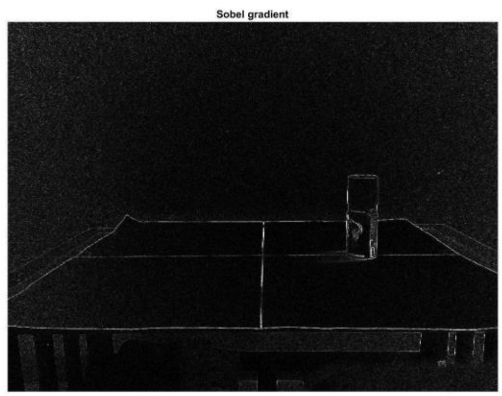

Fig. 4. Object is moved from center to right

Scaling Factor:

TABLE II. RESULTS OBTAINED AFTER SCALING

Centre to right	1 cm in image = 4.59 cm in real
Centre to left	1 cm in image = 4.5 cm in real
Centre to forward	1 cm in image = 18.89 cm in real
Centre to backward	1 cm in image = 12.5 cm in real

Fig. 5. Prototype of the system

Fig. 5 gives us an idea about how the final deliverable consisting of Raspberry PI along with headset is going to look like.

IV. CHALLENGES

This paper designs a user-friendly system for positioning of the objects for the visually impaired to assist them in locating specific items employing voice commands.

The performance and accuracy of the proposed model depends on the correct capture of the object and quality of the camera i.e. it's lighting, resolution and focal length. Sensitivity of the camera should be maintained with respect to the dark and light areas, otherwise the object detection using image processing may not be accurate.

The co-ordination between the positions instructed by the system to the user and the way of approaching towards the object should be in synchronization with the instructions. The user will get the directions from the system via headphones using voice commands. The commands should be kept minimum and accurate which are easily understood by a user.

The dataset is limited to a few objects. It is designed for objects in an indoor environment. The dataset includes those objects which are required in day to day life as lighting condition and contrast background may affect the detection of the objects. The system is restricted for objects within an arm's distance. The system is not designed for navigation purposes.

V. FUTURE SCOPE AND CONCLUSION

Sensors could be integrated with the system to detect whether an object is too hot or cold so as to prevent any discomfort or harm to the user. It could be extended for the outdoor environments; GPS could be integrated with the system to use the product for navigation purpose as well [8]. If the system is made adaptable, it could be used in a new environment.

This system helps visually challenged people to become more independent. This might indirectly help the family and the society to accommodate them in their environment. Besides this, the system can also be used in robotics which can act and behave the same like humans [9].

ACKNOWLEDGEMENTS

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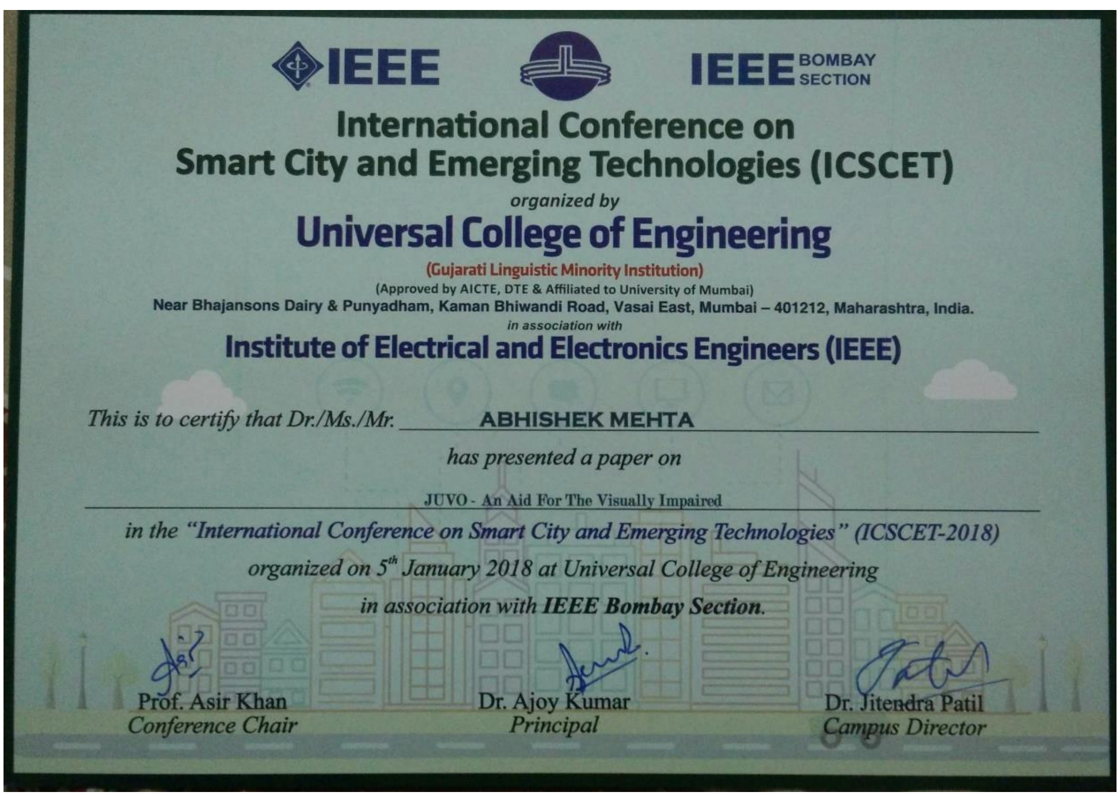

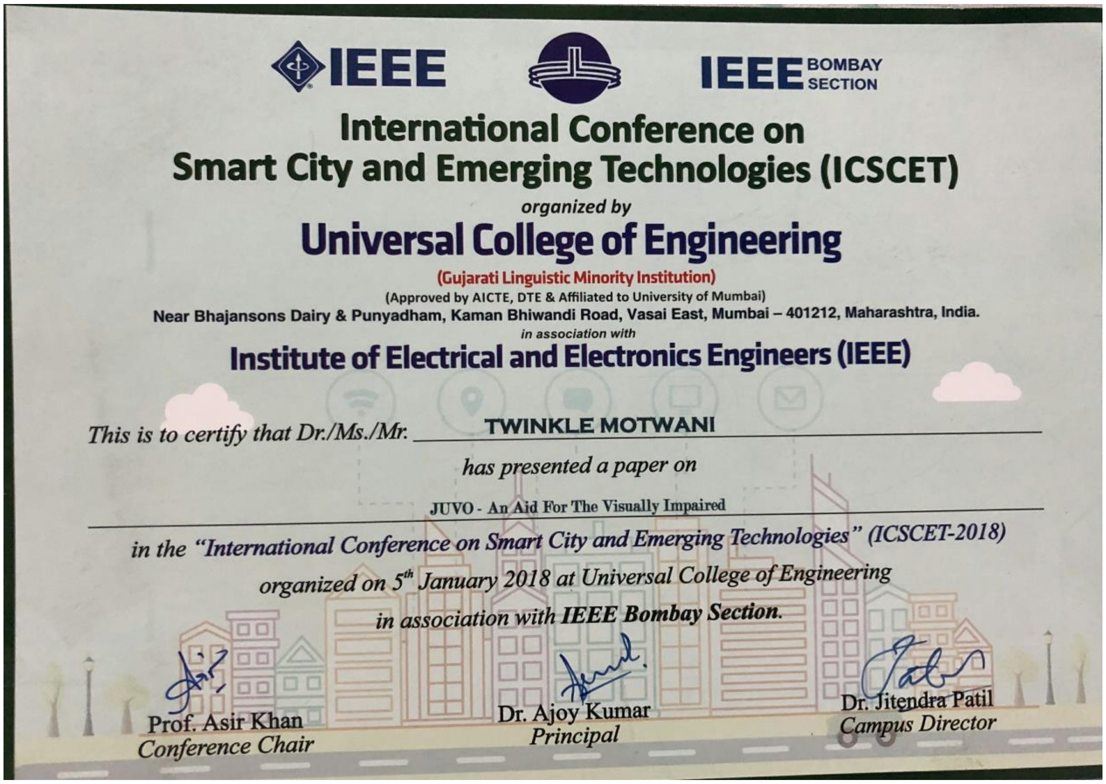

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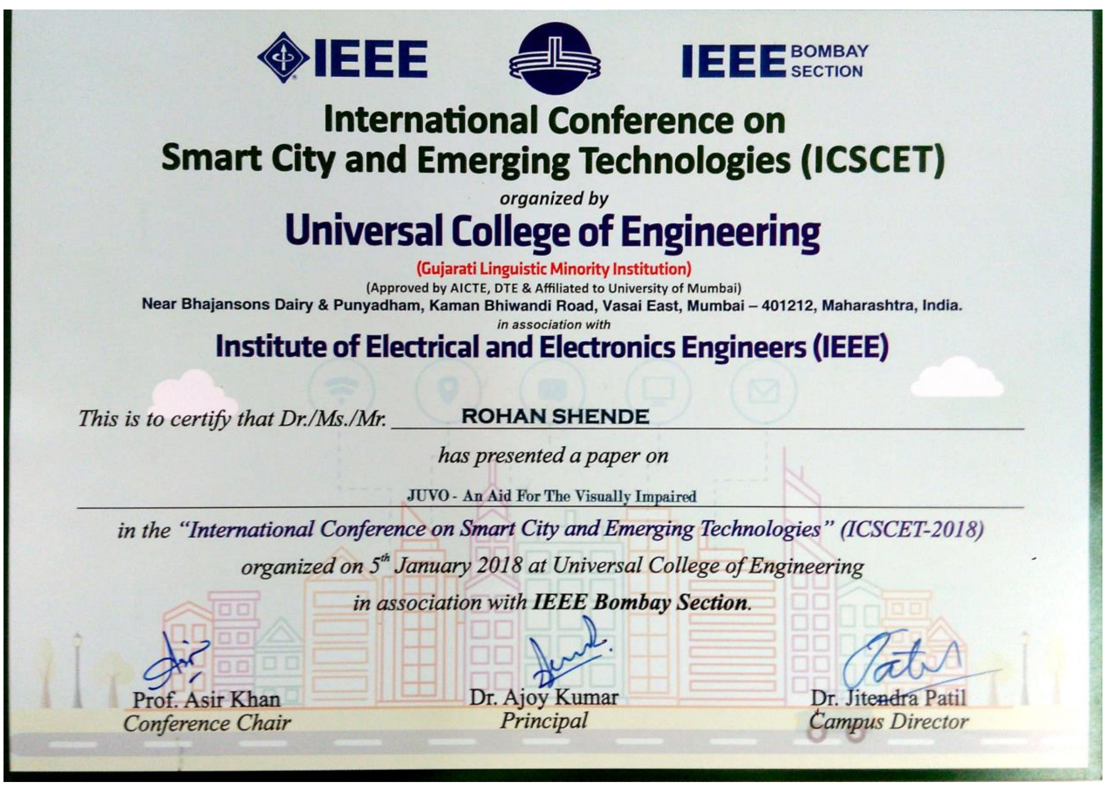

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- ## Paper 2

Paper title: Object Detection and their Localization for Visually Impaired Users

Paper details: Published on 18th April in International Journal of Computer Applications (IJCA), Volume - 179, Number - 35. ISBN: 973-93-80898-46-2

Object Detection and their Localization for Visually Impaired Users

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ABSTRACT

Visual impairment is the functional loss of the eye or eyes in which a person's eyesight cannot be corrected up to a normal level. Visually impaired people face many problems in their day to day life and the most common inconvenience is to find their personal items which are misplaced in their indoor space. With advancement in technology, normal conduction of tasks can be made possible for such cases. This paper describes a system which is a user friendly human computer interface enhanced with computer vision technology which will be able to support the visually impaired to localize and pick up objects used in their daily life. Several efforts have been taken in the past few years to improve the quality of life of such people. The aim of our system is to bridge the gap between what the disabled person wants to do and what the existing social infrastructure allows them to do.

Keywords

Visually impaired; Object detection; Object positioning; Deep Learning.

1. INTRODUCTION

According to the World Health Organization, 253 million people live with visual impairment, 36 million people are blind, 217 people have moderate to severe vision impairment. Computer vision can be delineated as the field of science and artificial intelligence for building artificial systems that obtain knowledge from images or multi-dimensional data and give computers a visual understanding of the world. Some of the latest technologies developed for the blind include - smart glasses [1] that can read and recognize faces, Finger reader, Blind reader, Co-robotic cane-GPS based assistive device [2] etc. These existing systems succeed in object recognition, navigation [3] but haven't achieved much in determining the exact position of an object so that the user grabs it. We have arrived at a method for determining the position of an object with respect to user's hand. This method guides the user to move his hand and reach the object. It uses combined methods like deep learning based object detection, neural networks, image processing techniques (feature extraction, morphology).

The project helps visually impaired people by increasing their confidence level and making them more independent. The relevance of this system plays a vital role in the society. It can be used in blind training institutes, non - profit organizations and any indoor environments like home, office, schools.

2. METHODOLOGY

2.1. System Design

There are several modules in the system design which are depicted in Figure 1. First we have the user with the device i.e. an integrated hardware unit which is developed. The image is captured via live video stream through a camera module. The video is divided into frames which are resized and these frames are converted into *BLOB*s which is a collection of binary data stored as a single entity in a database management system. This data is then given to the deep learning neural network. Deep learning neural networks are different from single hidden layer neural networks because of their depth i.e the number of node layers through which data passes in a process of multiple steps. Previously neural networks had one input and one output layer, and at most one hidden layer in between. More than three layers including input and output is considered as deep learning. This is followed by the object detection module using OpenCV which detects all objects included in our dataset. Approaching further, we have the object mapping and positioning module. After detection of objects the system will assist the user what objects are there in front of him. The user via voice commands tell the system which object he wants to grab, his speech is converted into text. Next the required object is mapped with the real time input and it is the only object that is shown in the frame. Then distance calculations are done and the angle through which the user should move his hand to grab the object is computed. As our system is designed for objects within a vicinity of 1 meter, the system checks if the object is within an arm's length (1 meter) and accordingly text to speech conversion takes place. The system then guides the user by giving appropriate instructions via audio commands (i.e. angle and distance) for grabbing the object.

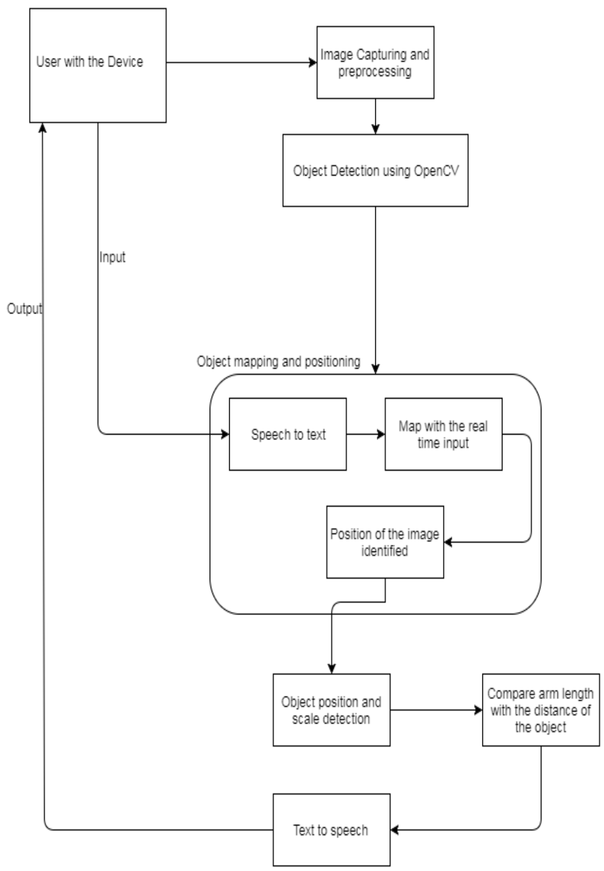

Fig. 1: System Design

2.2. Object Detection

Object Detection has been implemented using OpenCV which also supports deep learning frameworks, and an open source library for programming functions in python. The problem with traditional algorithms is that they do not give high accuracy results [4]. Hence the use of neural networks was initiated. SSD (Single Shot Detector) framework combined with MobileNet architecture was used to arrive at faster and efficient deep learning based method for object detection [5]. This network architecture was then trained to detect common objects that the blind person comes across in his daily life.

Figure 2 shows the mapped output of a bottle which is detected. Mapped output means that from a certain range of objects, only those objects appear in the frame which the user wants to grab.

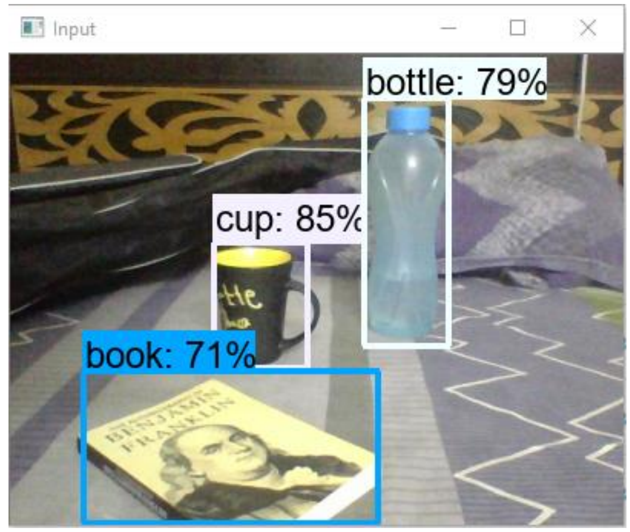

Fig. 2: Detection of dissimilar objects

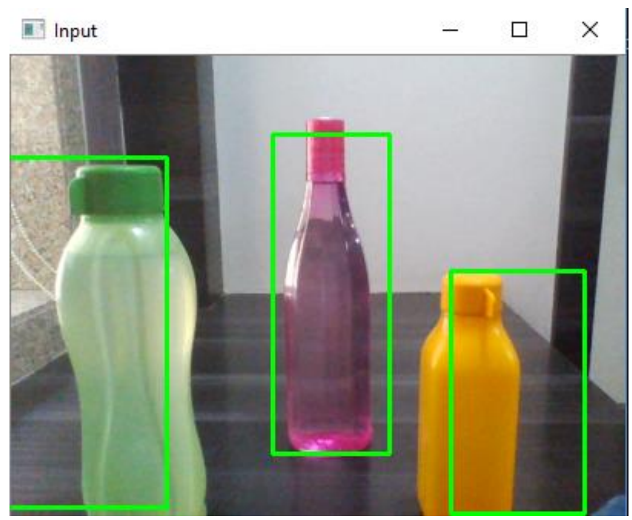

Fig. 3: Detection of similar objects

Figure 3 depicts detection of different objects present in front of the user. The user can now tell the system via voice commands which particular object he wants to grab. Figure 3 shows detection of similar objects in which bottles of different sizes and shapes are detected. The system tells the user how many bottles are present in front of him and also tells the distance and angle of each bottle with respect to user's hand. The user can now grab the bottle which is at least distance from his hand.

2.3. Band Detection

In order to give a unique identification to the user, a band of specific unique colour is used. This band is worn by the user on his wrist every time he wishes to grab an object. The restriction that comes into picture is that there should not be any other object having the same colour as that of the band, otherwise the system takes into consideration the object with larger surface area.

The live input stream is taken continuously and then divided into several frames. Further, these frames are converted from RGB to HSI. The reason for the conversion to HSI is that when light falls on a particular object the intensity changes and thus leads to change in the RGB value, hence it is not easily recognizable. Range of that unique band colour is provided. Minimum range to maximum range is given for the band. As a range is specified, all the objects (or colors) that lie in the frame will also be highlighted. If the band lies in that particular range, it is detected. Therefore a unique colour on the image of the band is detected.

On the image of the band detected, an open operation followed by close operation is then performed using 5*5 mask. It is used to enhance and aggregate all the separable objects and make it appear as one entity. Number of contours is counted in that frame. If the number of contours appeared to be 0 it indicates that the hand is not in the frame. It indicates the user by saying "Hand is not in frame". And if it appears to be greater than 0 then the hand is in the frame and it is detected. After the detection the center of the contour is found out, this tends to be the user band. After calculating the center position the distance to all the objects is then calculated by keeping it as the reference coordinate.

Figure 4 shows the band which is detected along with its centroid coordinates as (320, 222).

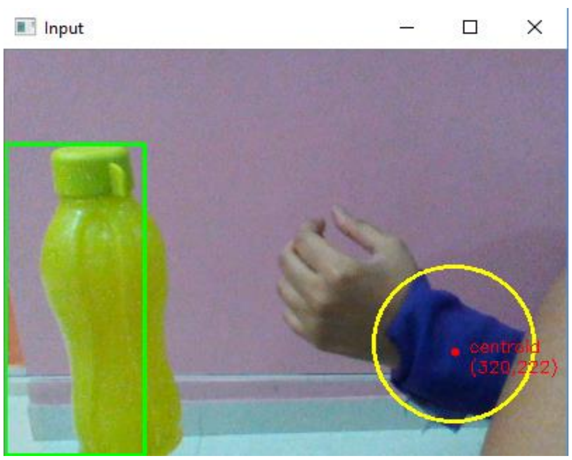

Fig. 4: Band Detection

2.4. Object Positioning

After detection of the object and the band (worn by user on his wrist), we have to position the object with respect to users hand. The position of the object is instructed to the user by telling him whether the object is to his right, left or center, at what angle and distance is the object from user's hand.

Among the captured band image and the mapped number of objects the centroid coordinates of each object is calculated. A line is drawn connecting the centroids and the Euclidean distance is computed. The result is obtained in pixel which is converted into centimeters and then multiplied by a scaling factor to get the real life distance. The scaling factor is computed for x and y axis by conducting an experiment. Using these values and trigonometry, scaling factor at any other angle was found out. Angle was found out using trigonometry and centroid coordinates.

Table 1 shows the results of an experiment performed. An experiment to find out the scaling factor between the image of an object on the paper and the object as it appears in real life was performed. Figure 5 shows the setup for our experiment in which an object was moved across different positions i.e. right, left, forward, and backward and the distance was noted from a fixed position.

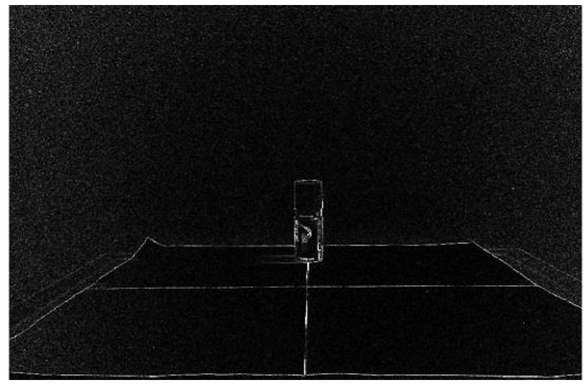

Fig. 5: Experimental setup

Table 1. Experimental Results

Position	Image to Real Life Distance
Centre to right	1 cm in image = 4.59 cm in real
Centre to left	1 cm in image = 4.5 cm in real
Centre to forward	1 cm in image = 18.89 cm in real
Centre to backward	1 cm in image = 12.5 cm in real

Scaling factor for x axis: (4.59+4.5)/2 = 4.5
Scaling factor for y axis: (12.5+18.89)/2 = 15.7

2.4.1 Finding the Angle

Let (ax, ay) and (bx, by) be the centroid coordinates of the object and the band. The following conditions were tested:

1. (bx-ax) not equal to zero: If the object lies on any other line other than vertical line then its slope is calculated using two-point form. This gives the angle with respect to horizontal axis. Then we find the angle with respect to vertical axis by subtracting it from ninety degrees.
2. (by-ay) equal to zero: If the object lies on horizontal axis, then it simply returns angle as 90 degrees.
3. (bx-ax) equal to zero: If the object lies on vertical axis, then it simply returns angle as zero degrees.

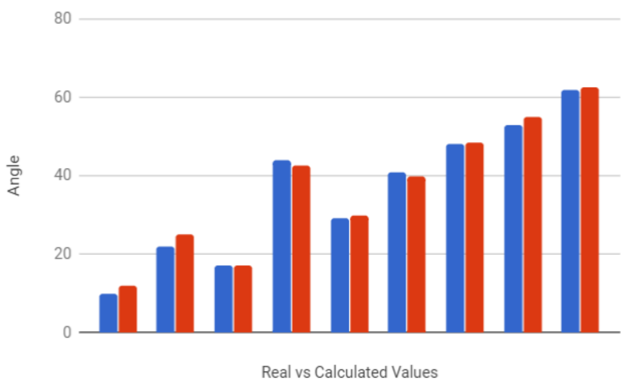

Fig. 6: Angle Error Calculation

Figure 6 shows the difference in angle computed in real life and by our system for different cases.

2.4.2 Finding the Distance

An image based technique had been developed earlier to compute the depth and lateral distance of different types of objects but it was restricted to few objects of shape rectangular, cylindrical and triangular [6]. This paper describes another method for distance calculations in an easier way. Euclidean distance between two points a and b is the length of the line segment joining them. If a = (*ax*, ay) and b = (bx, *by*) then the distance is given by

d(a, b) = $\sqrt{(ax-bx)2+(ay-by)2}$

The conditions mentioned above for angle computations are again tested for distance and the distance is multiplied by appropriate scaling factors to get the actual distance.

Actual distance = Euclidean distance*scaling factor* 0.0265 (for pixel to centimeters)

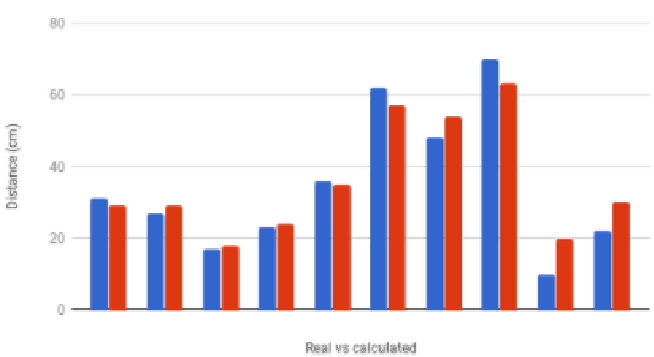

Fig.7: Distance Error Calculation

Figure 7 shows the difference in distance measured in real life and by our system for different cases.

Figure 8 shows the prototype of our system consisting of a raspberry pi, raspberry pi camera module, wrist band, earphones along with microphones. This is a lightweight system which is easily wearable by the user.

Fig. 8: Prototype of the system

3. CHALLENGES

The distance accuracy is one of the major challenges faced. As we move from a three dimensional space to a two dimensional space, there is no concrete algorithm which exists for three dimensional to two dimensional mapping. The system does not take into consideration the height of the object and height at which our hand is from the base. In case of a taller or shorter object, the user will have to adjust the height of his hand to grab the object. The user should have basic distance and trigonometry knowledge in order to interpret how much he should move his hand after hearing the angle and distance.
The band worn by user on his wrist is detected based on its unique colour. If any other object appears in the frame with the same unique colour, the system takes into consideration the unique colour object which has a larger surface area. This leads to misinterpretation by the system and hence affects further calculations.

4. FUTURE SCOPE AND CONCLUSION

This project has a great scope for further development. Adding sensors to the system could help in detecting the temperature of the object from which we can conclude object is hot or cold to touch. This would prevent any harm to the user. This project can be further extended for navigation purpose by adding GPS feature. The system can also be used in robotics which can act and behave the same like human and also can be further extended for the outdoor environment purpose in which it can not only detect objects but also detect any obstacles that come in their way [7].

Technology transforms people's lives. The visually impaired group of people isn't able to make full utilization of the technology. There is a need and responsibility for the society and community to explore technologies to help them. This paper has described the design of a prototype which is a small step towards helping the visually impaired group of people. Overall our system is low cost, lightweight, simple to use and works well with the objects with the definite shape.

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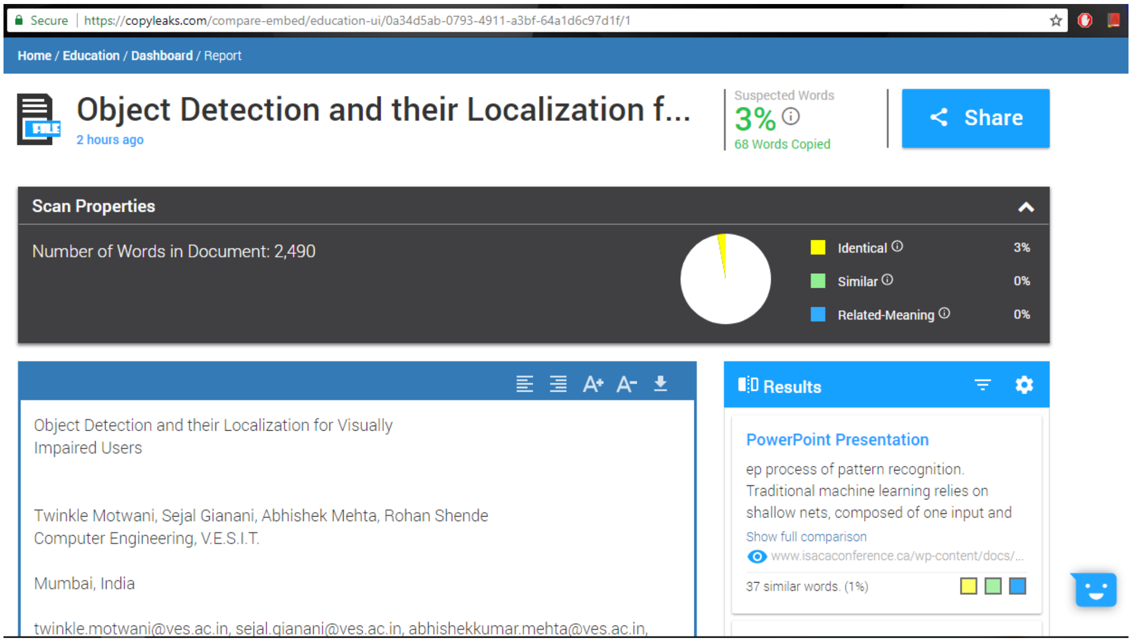

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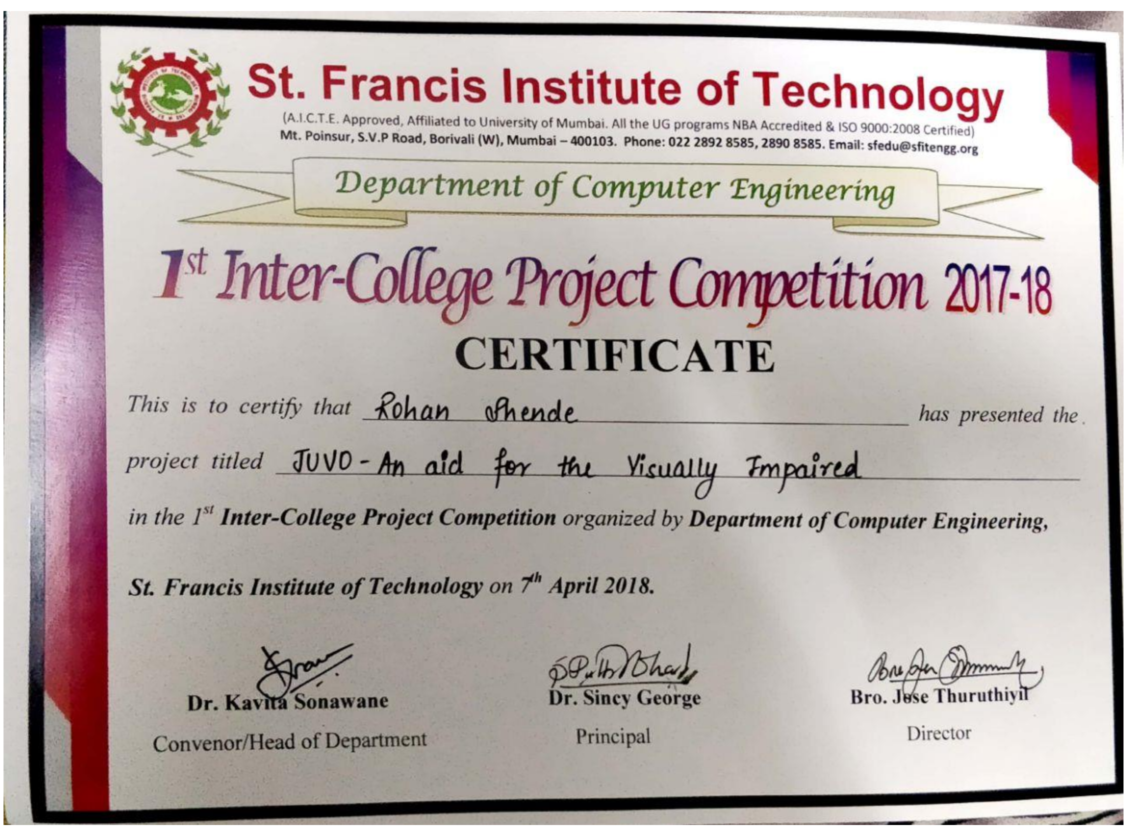
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Department of Computer Engineering

1st Inter-College Project Competition 2017-18

CERTIFICATE

This is to certify that Rohan Shende has presented the project titled JUVO - An aid for the Visually Impaired in the 1st **Inter-College Project Competition** organized by **Department of Computer Engineering, St. Francis Institute of Technology** on 7th **April 2018.**

Dr. Kavita Sonawane
Convenor/Head of Department

Dr. Sincy George
Principal

Bro. Jose Thuruthiyil
Director