

Smart Walking Cane for the Specially Abled People

Submitted in partial fulfillment of the requirements for the award
of Bachelor of Technology Degree in
Information Technology

By

KUSHAL GOYAL M (Reg. No. 38120043)

PRAMOTH. R (Reg. No. 38120901)



**DEPARTMENT OF INFORMATION TECHNOLOGY
SCHOOL OF COMPUTING**

**SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Accredited with Grade “A” by NAAC
JEPPIAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600 119**

May - 2022



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(Established under Section 3 of UGC Act, 1956)
JEPPIAAR NAGAR, RAJIV GANDHI SALAI
CHENNAI- 600119
www.sathyabama.ac.in



DEPARTMENT OF INFORMATION TECHNOLOGY

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of Kushal Goyal M (Reg. No: 38120043) and Pramoth. R (Reg. No: 38120901) who carried out the project entitled "**SMART WALKING CANE FOR THE SPECIALLY ABLED PEOPLE**" under my supervision from December 2021 to May 2022.

Internal Guide

Dr. L. Mary Gladence, M.E., Ph.D.,

Head of the Department

Dr. R. Subhashini M.E., Ph.D.,

Submitted for Viva voce Examination held on _____

Internal Examiner

External Examiner

DECLARATION

I, **Kushal Goyal M** (Reg. No. 38120043) hereby declare that the project report entitled **“SMART WALKING CANE FOR THE SPECIALLY ABLED PEOPLE”** done by me under the guidance of **Dr. L. Mary Gladence, M.E., Ph.D.**, at Sathyabama Institute of Science and Technology (Deemed to be University), Jeppiar Nagar, Rajiv Gandhi Salai, Chennai - 600119 is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering Degree in Information Technology.

DATE: 11 / 04 / 2022

PLACE: CHENNAI

SIGNATURE OF THE CANDIDATE

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ABSTRACT

The optically impaired with walking disabilities or optically weakened, often find it very arduous to perform errands independently in their daily chores. Activities like walking down the road, knowing and recognizing the presence of an obstacle in front of them, reading road signs etc. Such activities and tasks are easy for us unimpaired people but for them these are the major hurdles of their lives and not being able to do them makes them feel emotionally low which increases their stress levels and affects their health. The suggested project is an effort to outline and build a smart walking cane for the blind to help them perform their daily errands independently and henceforth, over the time improving their morale. This work is split into two constituents with the hardware and software. The hardware constituent involves building a physical cane with Raspberry Pi, ultrasonic sensor and the software constituent involves the use of written programs based on Python and OpenCV to process images for object recognition in real time.

Obstacle detection and warning can improve the mobility as well as the safety of visually impaired people specially in unfamiliar environments. For this, firstly, obstacles are detected and localized and then the information of the obstacles will be sent to the visually impaired people by using different modalities such as audio feedback.

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LIST OF ABBREVIATIONS

ABBREVIATIONS	EXPANSION
GPS	Global Positioning System
WHO	World Health Organization
OpenCV	Open Source Computer Vision Library
SOS	Si Opus Sit
JS	JavaScript
SQL	Structured Query Language
CI	Continuous Integration
CD	Continuous Deployment

CHAPTER - 1

INTRODUCTION

The Optically impaired are the individuals whose poor eyesight makes it impossible to encompass the tiniest aspect. Masses with 5/50, the visual disproportionateness of 20 degree have the meridional radius with both pair of eyes broadly open. These personals are said to be unsighted. Individual who are optically weaken are leading an existential life of dependence over other human beings or visual aids. With sensorial disabilities it is almost unfeasible to glimpse with fine persons the tiniest particulars. Individuals with this disorder are cladding a lot of agony just to lead a casual; hustle-free life. They are mentally solitude and have believed themselves to be worthless. This dysfunctionality of theirs, plays a negative vital role in all their means of earnings. It shapes as an ailment in their intellect and makes them lose desire for living a life. Lately a lot of innovators have concocted devices to set out as an abet for the optically weaken people. Also, there are a few downsides set by the traditional and simple on-hand abets available for the optically disabled individuals. Some metamorphosis often incorporate a definite endow or wayfinder, the user to clutch it on the hand when strolling alfresco. These capacious designs are likely to intricate the user. Numerous efforts were planned to build a vision protector or an object-avoidance systems using compact utilization of technology. Hence, we are proposing to outline and build a cost-effective smart strolling cane with advanced tech functionalities like navigation, real time object detection, image recognition, voice guidance etc. for all the optically impaired who are in desperate need of succor to overcome the issues in outdoor and indoor walking.

1.1 BACKGROUND OF THE STUDY

In year 2017 the World Health Organization (WHO), released a global population statistical report noting that of the approximately 7.338 billion people in the world, approximately 285 million people were visually impaired as of the end of 2016. Among these visually impaired people, 39 million were blind, and 246 million had amblyopia, together accounting for 4.25% of the total population of the world. Whether due to congenital inheritance, acquired diseases, accidental injuries, or other reasons, visual impairment causes a certain level of inconvenience to these lives. For example, it is very difficult for visually impaired people to walk independently in strange and complex areas.

1.2 AIM

- Instead of incomprehensible sound, providing aid of earphones which give the speech warning message
- Providing integrated vibration motor that helps in giving feedback and equipped in the hand of the smart stick to keep it user friendly.
- To detect and speak aloud upward and downward stairs.

CHAPTER - 2

EXISTING SYSTEM

Numerous novel allied correlated papers for assisting and aiding the specially abled people were studied and reviewed. Unsafe mobility is the most dominant complication in the lives of the optically impaired. Wan-Jung Chang et al. [4] engineered a state-of-the-art wearable smart glass and a smart stick for front aerial object detection and fall avoidance system deployed on a cloud based mobile device application. Sreenu et al.

[5] implemented a hybrid approach using two ultrasonic sensors to determine the presence of inclined upward staircases. [6] programmed a mobile software application to read 3D data obtained from mobile vision to estimate the dimensions of potential objects ahead.

E. Cardillo et al. [7] tested the workability of electromagnetic sensor to assist the optically impaired in movement by mounting a white cane. [8] presented a substructure of context aware maneuver considering the semantic effect of the objects surrounding the user environment. Md. Milon Islam [9] carried out a full-fledged review study of about 100-odd papers in this discipline.

Dianne, Richard and Ryo [10] designed a haptic technology covering deeper areas of importance of blind individuals. Liupeng et al. [11] presented research on large sized vehicles and vessel containers for trail guidance during logistics. [12] constructed a guidance system based on mobile Kinect and electrode grid. Rakia et al. [13] proposed a detection algorithm using Khon Vogelious function abnormality. Villanueva and Farcy [14] designed a travel centric assistive tool worked on light-emitting diode and photodiode.

Presently, artificial intelligence methodologies are tried on ordinary walking canes to make smart walking canes [15], [16]. For instance, M. Gupta et al. [15] constructed a clever assistance aid that utilized artificial intelligence and sound echo sensors to assist in

navigation. Using the same technology object recognition and object detection were executed. Pruthvi et al. [16] proposed a cane that adopted a very well-known deep learning module called You Only Look Once to carry out object classification and detection. In present time, numerous preceding works of this discipline have been looked over for strolling and navigational purposes.

As adduce, S. Lian et al. [17] proposed a design in which a wearable smart glass was chosen a primary assist for outdoor travel. The presented designed has executed by adding an ultrasonic sensor with a depth sensor. In addition to this, they later altered and redesigned a sub landing routing stratagem [18] the aided the optically impaired in tackling through obstacles and guided them from point A to B safely.

Aladrén et al. [19] in this work, presented an assistive navigational gadget based on a custom RGB-Depth image sensor benefiting wider angles and colour correct data for determining a hurdle free pathway for the user. Croce et al. [20] developed a universal navigation structure in which a mobile phone was confederated with an inertial assessment sensor and a camera.

CHAPTER - 3

PROPOSED SYSTEM

The put forward smart cane system intents bring down the possibility of optically impaired people getting hurt from solid obstacles ahead in their way. On the contrary, if optically impaired weaken person stumbles and falls, an out of choice Save our Souls (SOS) emergency message notification shall be texted on the mobile phones of relatives (i.e., folks and caretakes) by a single press of the dedicated panic button. The design of this smart cane is efficient enough to detect terrestrial and aerial obstacles ahead. When a terrestrial or an aerial obstacle is ascertained, the smart cane will start buzzing to alert and escort the optically impaired person to avoid collision. In case, if the optically impaired person encounters a crash or stumbles down the ground, the incident can be immediately imparted to the concern person of the optically impaired through an application.

3.1 SYSTEM ARCHITECTURE

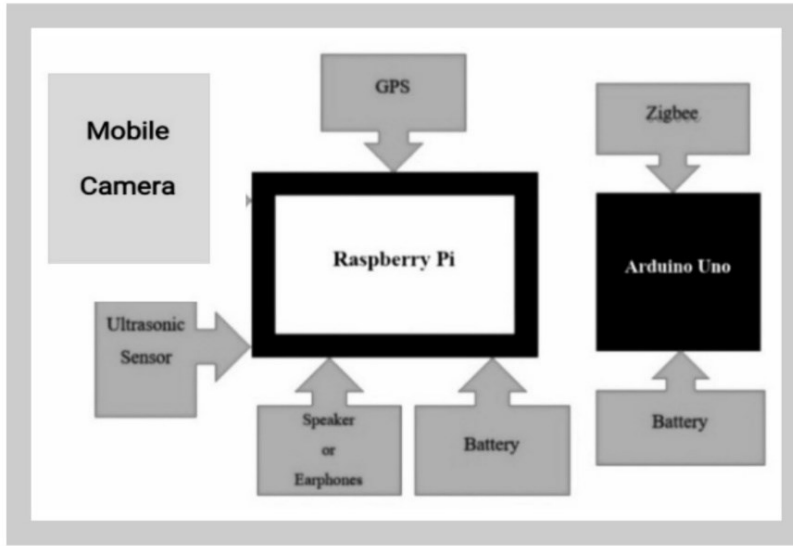


Fig. 3.1. Process Flow Diagram

The proposed smart walking stick does not have space limitations. Hence, some existing development boards (such as Raspberry Pi [41] and LinkIt™ ONE [42]) can be selected and used as an MPU for the proposed walking stick. Thus, we adopt the LinkIt™ One development board as the MPU for the walking stick. The LinkIt™ ONE development board integrates a BLE module, a LoRa-based LPWAN communication module, a GPS module, a 6-axis (gyro + accelerometer) MEMS motion tracking sensor, and a vibration motor module, where the BLE module is responsible for pairing and connecting with the proposed wearable smart glasses. When the intelligent walking stick detects an aerial obstacle from the proposed wearable smart glasses, the vibration motor is actuated to warn the visually impaired person via vibration. Moreover, the LoRa-based LPWAN module is responsible for uploading the fall information with GPS to the proposed cloud-based information management platform, in which the 6-axis (gyro + accelerometer) MEMS motion tracking sensor mounted on the proposed intelligent walking stick is responsible for co-recognition with the proposed wearable smart glasses. Hence, the current posture of the visually impaired person can be recognized to determine whether the person has truly fallen.

3.2 TECHNICAL FEASIBILITY

Smart Cane device is an electronic travel device that fits on the top of the white cane. It is more improved version of white cane as it eliminates the drawbacks of white cane by

detecting the hanging obstacles and knee above. Smart sticks record the information about the obstacles present in the way by using the location can be set by voice and the user can be further guided by the GPS to his/her destination. It uses ultrasonic sensors for detection and a micro-controller for controlling the system. It also contains GPS which has a memory card used to store various locations. The accuracy of the GPS signal is poor as it can be controlled within 5 meters radius only. However, this system is not made for indoor purposes due to poor GPS signals. A camera is fitted on the head of the person using it, which uses an algorithm to detect the obstacles ahead.

3.3 SYSTEM CONFIGURATION

HARDWARE COMPONENTS

Number	Description
1. Ultrasonic Sensor	HY-SRF005
2. Arduino UNO	ATMEGA 328P U 1820W6
3. Raspberry Pi	Raspberry Pi 4
4. Zigbee	ZMN2405HP

SOFTWARE COMPONENTS

Number	Description
1. Programming Platform	Windows
2. Programming Language	Python and C++
3. Programming Library	OpenCV

CHAPTER - 4

GENERAL OVERVIEW: DFD DIAGRAM

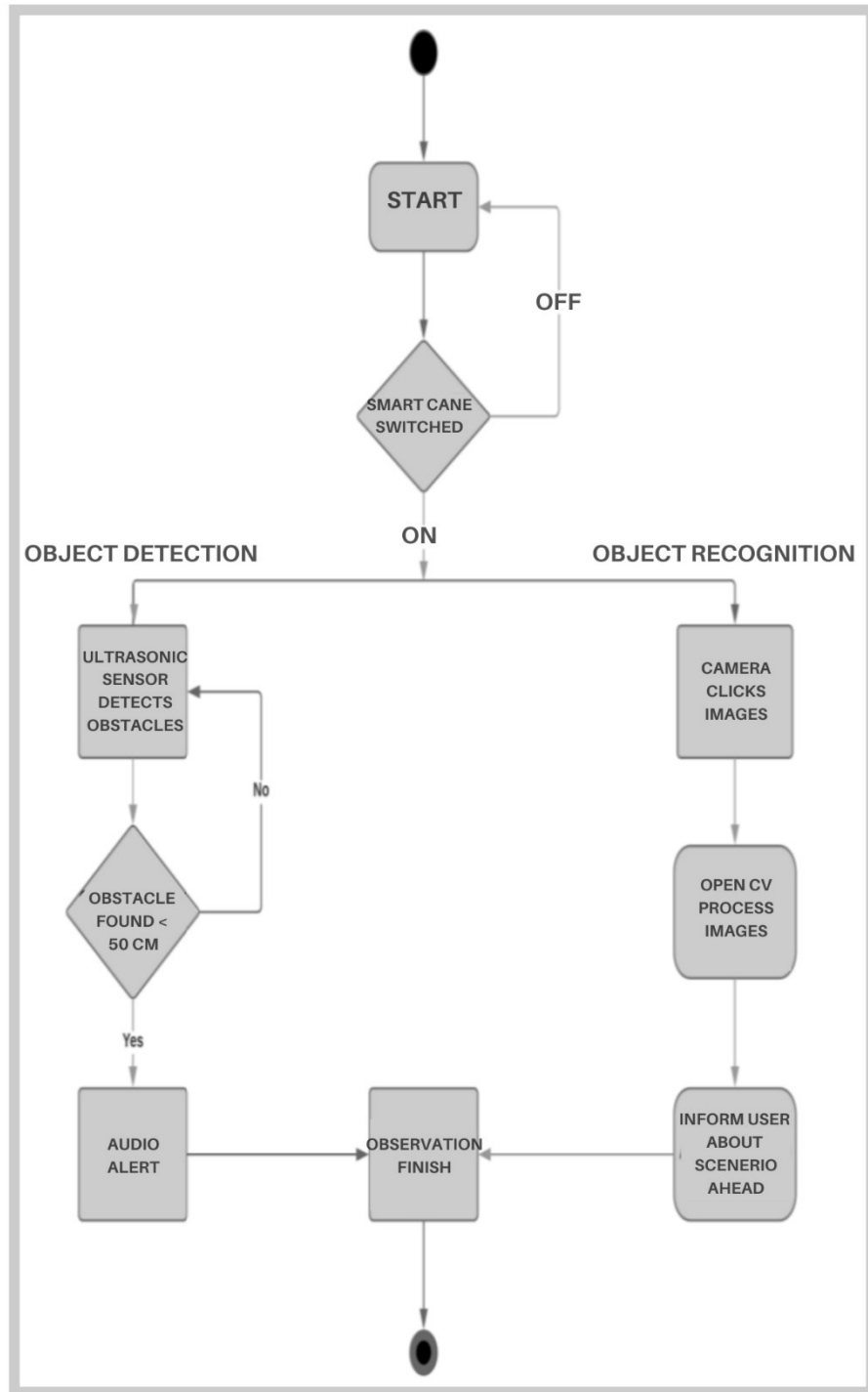


Fig. 4.1 Algorithmic Flowchart

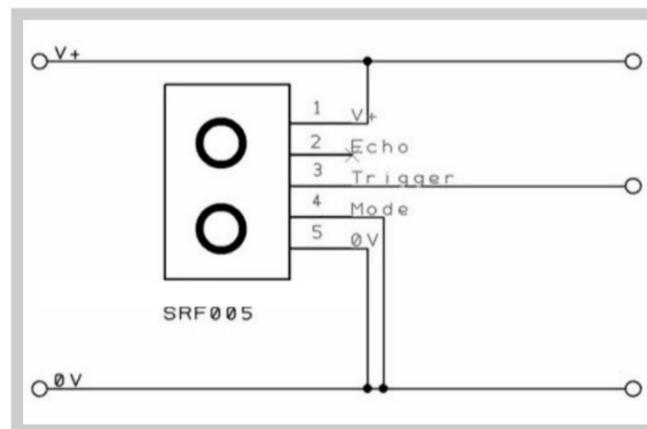
CHAPTER - 5

IMPLEMENTATION DETAILS

In this Section we will do Analysis of Technologies to use for implementing the project.

5.1 Ultrasonic Sensor

There are plenty of kinds of sensors for measuring distance between two objects available in retail, and the two most widely adopted sensors are IR transceiver and ultrasonic sensor. We have chosen the ultrasonic sensor for forward object detection because they are low-cost and the optically impairers aim at being as economical as possible because of financial restrictions. As a thought, we decided to go with ultrasonic sensor. We have adopted an ultrasonic SRF05 (HY-SRF005) which can proficiently measure the distance between two objects in range between 2cm-450cm. As laid out in In figure below, the voltage of the used ultrasonic SRF05 is in accordance with the detection range.



The dimensions of the ultrasonic SRF05 are 45 mm x 15 mm x 25 mm which is very compatible in terms of size for our proposed smart walking cane. This ultrasonic sensor is light weighted and its electric utilization is also less. Every ultrasonic sensor comprehends 4 or more pins aiming at pulse sensing. It is capable of accurately measuring the distance between two objects by calculating the reflected sound signals between sending time to come back time and then converting them to electric signals. calculate distance between two objects is depicted below.

5.2 Arduino UNO

It is both an open source software (Integrated Development Environment) and a hardware which has a single board microcontroller (physical programmable circuit board). The Arduino board's design is established on an arrangement of controllers and microprocessors. Arduino is aimed at circuit prototyping which means that it identifies, accepts and allows inputs from the ultrasonic sensor and camera into the circuit and then passes them on to the next hardware component in the connection. These boards are implanted with a set of pins which are fundamentally utilized for digital inputs and cognate outputs. These pins can be configured with diverse varieties of expansion boards and other electric circuit boards for forming parallel and serial communication interfaces as well as with Universal Serial Bus.

The microcontroller largely use a preprogrammed boot loader to abet the running and compilation of programs on the chip flash volatile memory. On the other hand, the Arduino IDE is foundational on the simplified version of C++ language making it easier to transfer programming codes on another systems. By default, Avrdude is used as a transfer tool to any of the Arduino boards.

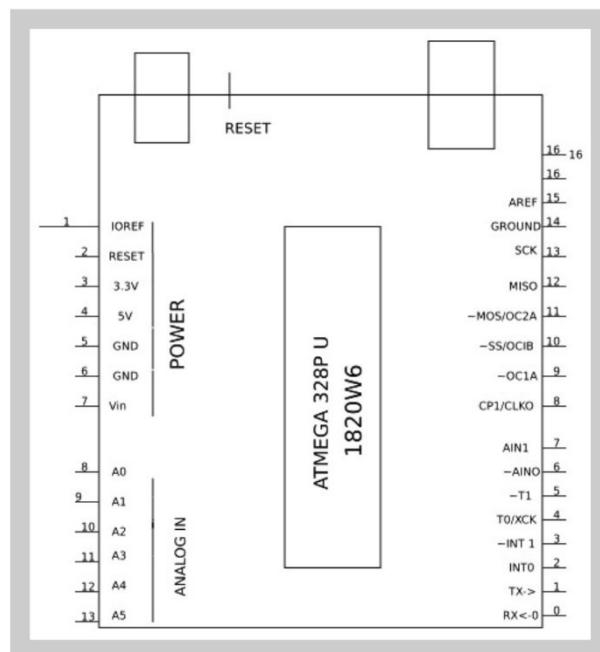


Fig. 5.2 Arduino UNO

5.3 Raspberry Pi

Raspberry Pi is an unified circuit board that integrates various computer elements onto a single chip. Fig. 6. It is basically a mini computer and the brain of all modules contrivance in this system. It does the quick programming and performs arithmetically operations for the proposed smart walking cane system. The Broadcom BCM28XX processor is at the heart of the Raspberry Pi. General-Purpose Input and Output pins are allied with the ultrasonic sensor and other hardware components to provide functionality to the system [2]. The Raspberry Pi-3 variant has 26 pins and B+ variant has 40 pins. These pins can be utilized to attach peripherals on the surface of the Raspberry Pi. The processor speed ranges from 0.007 GHz to 1.35 GHz. In Raspberry Pi OS the bootstrap compress can be executed by running a software command “sudo raspi-config”. The Raspberry Pi can also be employed to produce 576i/25 and 480i/30 analogy video signals.

Raspberry Pi Foundation officially provides Debian based Raspbian OS. Also, they provide NOOBS OS for Raspberry Pi. We can install several Third-Party versions of OS like Ubuntu, Archlinux, RISC OS, Windows 10 IOT Core, etc. The CPU speed of Raspberry Pi varies from 700 MHz to 1.2 GHz. Also, it has on-board SDRAM that ranges from 256 MB to 1 GB. Raspberry Pi also provides on-chip SPI, I2C, I2S and UART modules.

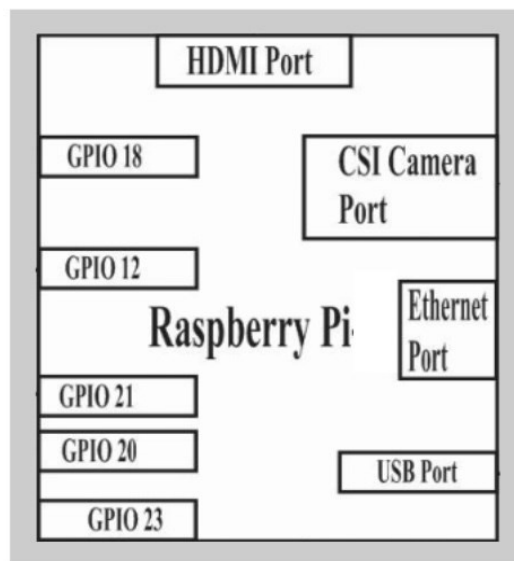


Fig. 5.3 Raspberry Pi

5.4 Zigbee

To suit the requirements of low power and low cost IoT networks an open global standard wireless technology called Zigbee was developed. Data in loud Radio Frequency (RF) environment can be easily communicated through the Zigbee protocol. The essential element of Zigbee is its capability to support mesh networks because of which it can potentially transmit data over longer distances. The Zigbee module efficiently runs on minimum power and generates uninterrupted transferences of data between remote devices. A network of various devices that inhabit within separate Zigbee nodes are distributed work, equally. Another advantage of using Zigbee is that its networks are extendable and its nodes can be interconnected with each other constructing a wide area network. Its protocol features include sustenance network topologies like mesh, point to multipoint and point to point. Zigbee's data transmission latency rate is also known to be less as shown below.

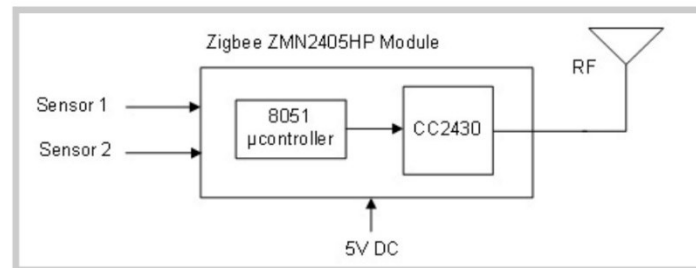


Fig. 5.4 Zigbee

Zigbee communication is specially built for control and sensor networks on IEEE 802.15.4 standard for wireless personal area networks (WPANs), and it is the product from Zigbee alliance. This communication standard defines physical and Media Access Control (MAC) layers to handle many devices at low-data rates. These Zigbee's WPANs operate at 868 MHz, 902-928MHz, and 2.4 GHz frequencies. The data rate of 250 kbps is best suited for periodic as well as intermediate two-way transmission of data between sensors and controllers.

CHAPTER - 6

6.1 Scope of Future Enhancement

The stick empowers the visually impaired man to wind up distinctly autonomous and furthermore lead their existence with less support from others. A handful of companies are creating these kind of technologies that will serve the needs of these frequently overlooked people. For further improved accuracy, we plan on integrating deep learning methodologies for detection and recognition of critical obstacles and images respectively. As an extension to the proposed work a futuristic system needs to be developed which is advanced enough to identify the presence of a wet and slippery ground surfaces for assistance during the monsoon season.

6.2 Result and Conclusion

	Standing	Sitting	Walking	Running	Falling	Average
Success (times)	4	4	4	3	3	18 (total)
Total (times)	5	5	5	5	5	25 (total)
Accuracy	80.00%	80.00%	80.00%	60.00%	60.00%	72.00%

Fig. 6.1 Observation Table

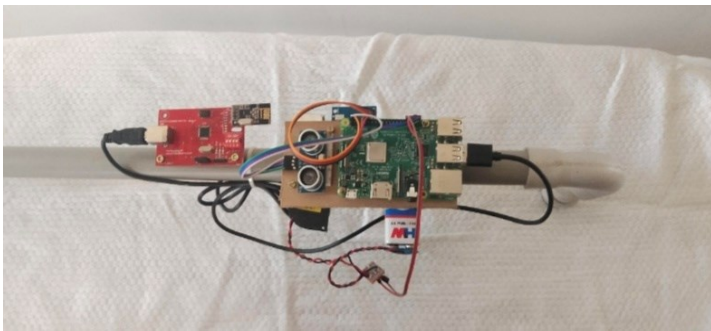


Fig. 6.2 Smart Walking Cane

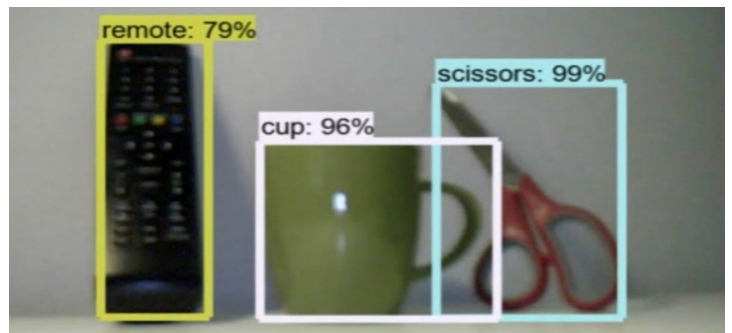


Fig. 6.3 Object Recognition

The proposed smart walking/strolling cane system can be really helpful to optically impaired for assistance in navigating in both internal and external habitats. All the three modules are tested with inducement in real time. Experiments of obstacle scenario such as human body, street animals, walls, trees, etc. were examined. The results of the observation examinations carried out on the system of movement actions like stand, sit, walk, run and fall shows efficient and satisfactory outcomes. The adaptability of the

modules of smart walking cane makes it a perfect fit for people of all age groups. Although, the smart cane is completely hardwired, it is light weighted, durable and has a comfortable grip to hold and walk around with efficient power consumption abilities.

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SOURCE CODE :

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    }
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  attr {
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        dim {
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        dim {
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      }
    }
  }
}
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  op: "Conv2D"
  input: "normalized_input_image_tensor"
  input: "FeatureExtractor/MobilenetV3/Conv/weights"
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    key: "data_format"
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    }
  }
  attr {
```

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        i: 1
        i: 1
      }
    }
  }
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      list {
      }
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  input: "FeatureExtractor/MobilenetV3/Conv/BatchNorm/gamma"
  input: "FeatureExtractor/MobilenetV3/Conv/BatchNorm/beta"
  input: "FeatureExtractor/MobilenetV3/Conv/BatchNorm/moving_mean"
  input: "FeatureExtractor/MobilenetV3/Conv/BatchNorm/moving_variance"
  attr {

```

```

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      s: "NHWC"
    }
  }
  attr {
    key: "epsilon"
    value {
      f: 0.001
    }
  }
  attr {
    key: "U"
    value {
      type: DT_FLOAT
    }
  }
}
node {
  name: "FeatureExtractor/MobilenetV3/Conv/hard_swish/add"
  op: "AddV2"
  input: "FeatureExtractor/MobilenetV3/Conv/BatchNorm/FusedBatchNormV3"
  input: "FeatureExtractor/MobilenetV3/Conv/hard_swish/add/y"
}
node {
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  input: "FeatureExtractor/MobilenetV3/Conv/hard_swish/add"
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  op: "Mul"
  input: "FeatureExtractor/MobilenetV3/Conv/BatchNorm/FusedBatchNormV3"
  input: "FeatureExtractor/MobilenetV3/Conv/hard_swish/Relu6"
}
node {
  name: "FeatureExtractor/MobilenetV3/Conv/hard_swish/mul_1"
  op: "Mul"
  input: "FeatureExtractor/MobilenetV3/Conv/hard_swish/mul"
  input: "FeatureExtractor/MobilenetV3/Conv/hard_swish/mul_1/y"
}
node {
  name: "FeatureExtractor/MobilenetV3/expanded_conv/depthwise/depthwise"
  op: "DepthwiseConv2dNative"

```

```

input: "FeatureExtractor/MobilenetV3/Conv/hard_swish/mul_1"
input: "FeatureExtractor/MobilenetV3/expanded_conv/depthwise/depthwise_weights"
attr {
  key: "data_format"
  value {
    s: "NHWC"
  }
}
attr {
  key: "dilations"
  value {
    list {
      i: 1
      i: 1
      i: 1
      i: 1
    }
  }
}
attr {
  key: "padding"
  value {
    s: "SAME"
  }
}
attr {
  key: "strides"
  value {
    list {
      i: 1
      i: 1
      i: 1
      i: 1
    }
  }
}
}
node {
  name: "FeatureExtractor/MobilenetV3/expanded_conv/depthwise/BatchNorm/FusedBatchNormV3"
  op: "FusedBatchNormV3"
  input: "FeatureExtractor/MobilenetV3/expanded_conv/depthwise/depthwise"
  input: "FeatureExtractor/MobilenetV3/expanded_conv/depthwise/BatchNorm/gamma"
  input: "FeatureExtractor/MobilenetV3/expanded_conv/depthwise/BatchNorm/beta"
  input: "FeatureExtractor/MobilenetV3/expanded_conv/depthwise/BatchNorm/moving_mean"

```

```

input: "FeatureExtractor/MobilenetV3/expanded_conv/depthwise/BatchNorm/moving_variance"
attr {
  key: "data_format"
  value {
    s: "NHWC"
  }
}
attr {
  key: "epsilon"
  value {
    f: 0.001
  }
}
attr {
  key: "U"
  value {
    type: DT_FLOAT
  }
}
}
node {
  name: "FeatureExtractor/MobilenetV3/expanded_conv/depthwise/Relu"
  op: "Relu"
  input: "FeatureExtractor/MobilenetV3/expanded_conv/depthwise/BatchNorm/FusedBatchNormV3"
}
node {
  name: "FeatureExtractor/MobilenetV3/expanded_conv/project/Conv2D"
  op: "Conv2D"
  input: "FeatureExtractor/MobilenetV3/expanded_conv/depthwise/Relu"
  input: "FeatureExtractor/MobilenetV3/expanded_conv/project/weights"
  attr {
    key: "data_format"
    value {
      s: "NHWC"
    }
  }
  attr {
    key: "dilations"
    value {
      list {
        i: 1
        i: 1
        i: 1
        i: 1
      }
    }
  }
}

```

```

    }
  }
}
attr {
  key: "explicit_paddings"
  value {
    list {
    }
  }
}
attr {
  key: "padding"
  value {
    s: "SAME"
  }
}
attr {
  key: "strides"
  value {
    list {
      i: 1
      i: 1
      i: 1
      i: 1
    }
  }
}
}
}
node {
  name: "FeatureExtractor/MobilenetV3/expanded_conv/project/BatchNorm/FusedBatchNormV3"
  op: "FusedBatchNormV3"
  input: "FeatureExtractor/MobilenetV3/expanded_conv/project/Conv2D"
  input: "FeatureExtractor/MobilenetV3/expanded_conv/project/BatchNorm/gamma"
  input: "FeatureExtractor/MobilenetV3/expanded_conv/project/BatchNorm/beta"
  input: "FeatureExtractor/MobilenetV3/expanded_conv/project/BatchNorm/moving_mean"
  input: "FeatureExtractor/MobilenetV3/expanded_conv/project/BatchNorm/moving_variance"
  attr {
    key: "data_format"
    value {
      s: "NHWC"
    }
  }
  attr {
    key: "epsilon"

```

```

        value {
            f: 0.001
        }
    }
    attr {
        key: "U"
        value {
            type: DT_FLOAT
        }
    }
}
node {
    name: "FeatureExtractor/MobilenetV3/expanded_conv/add"
    op: "AddV2"
    input: "FeatureExtractor/MobilenetV3/expanded_conv/project/BatchNorm/FusedBatchNormV3"
    input: "FeatureExtractor/MobilenetV3/Conv/hard_swish/mul_1"
}
node {
    name: "FeatureExtractor/MobilenetV3/expanded_conv_1/input"
    op: "Identity"
    input: "FeatureExtractor/MobilenetV3/expanded_conv/add"
}
node {
    name: "FeatureExtractor/MobilenetV3/expanded_conv_1/expand/Conv2D"
    op: "Conv2D"
    input: "FeatureExtractor/MobilenetV3/expanded_conv_1/input"
    input: "FeatureExtractor/MobilenetV3/expanded_conv_1/expand/weights"
    attr {
        key: "data_format"
        value {
            s: "NHWC"
        }
    }
}
attr {
    key: "dilations"
    value {
        list {
            i: 1
            i: 1
            i: 1
            i: 1
        }
    }
}
}

```

```

attr {
  key: "explicit_paddings"
  value {
    list {
    }
  }
}
attr {
  key: "padding"
  value {
    s: "SAME"
  }
}
attr {
  key: "strides"
  value {
    list {
      i: 1
      i: 1
      i: 1
      i: 1
    }
  }
}
}
node {
  name: "FeatureExtractor/MobilenetV3/expanded_conv_1/expand/BatchNorm/FusedBatchNormV3"
  op: "FusedBatchNormV3"
  input: "FeatureExtractor/MobilenetV3/expanded_conv_1/expand/Conv2D"
  input: "FeatureExtractor/MobilenetV3/expanded_conv_1/expand/BatchNorm/gamma"
  input: "FeatureExtractor/MobilenetV3/expanded_conv_1/expand/BatchNorm/beta"
  input: "FeatureExtractor/MobilenetV3/expanded_conv_1/expand/BatchNorm/moving_mean"
  input: "FeatureExtractor/MobilenetV3/expanded_conv_1/expand/BatchNorm/moving_variance"
  attr {
    key: "data_format"
    value {
      s: "NHWC"
    }
  }
  attr {
    key: "epsilon"
    value {
      f: 0.001
    }
  }
}

```

```

    }
    attr {
      key: "U"
      value {
        type: DT_FLOAT
      }
    }
  }
}
node {
  name: "FeatureExtractor/MobilenetV3/expanded_conv_1/expand/Relu"
  op: "Relu"
  input: "FeatureExtractor/MobilenetV3/expanded_conv_1/expand/BatchNorm/FusedBatchNormV3"
}
node {
  name: "FeatureExtractor/MobilenetV3/expanded_conv_1/depthwise/depthwise"
  op: "DepthwiseConv2dNative"
  input: "FeatureExtractor/MobilenetV3/expanded_conv_1/expand/Relu"
  input: "FeatureExtractor/MobilenetV3/expanded_conv_1/depthwise/depthwise_weights"
  attr {
    key: "data_format"
    value {
      s: "NHWC"
    }
  }
}
attr {
  key: "dilations"
  value {
    list {
      i: 1
      i: 1
      i: 1
      i: 1
    }
  }
}
attr {
  key: "padding"
  value {
    s: "SAME"
  }
}
attr {
  key: "strides"
  value {

```

```

        list {
            i: 1
            i: 2
            i: 2
            i: 1
        }
    }
}
}
node {
    name: "FeatureExtractor/MobilenetV3/expanded_conv_1/depthwise/BatchNorm/FusedBatchNormV3"
    op: "FusedBatchNormV3"
    input: "FeatureExtractor/MobilenetV3/expanded_conv_1/depthwise/depthwise"
    input: "FeatureExtractor/MobilenetV3/expanded_conv_1/depthwise/BatchNorm/gamma"
    input: "FeatureExtractor/MobilenetV3/expanded_conv_1/depthwise/BatchNorm/beta"
    input: "FeatureExtractor/MobilenetV3/expanded_conv_1/depthwise/BatchNorm/moving_mean"
    input: "FeatureExtractor/MobilenetV3/expanded_conv_1/depthwise/BatchNorm/moving_variance"
    attr {
        key: "data_format"
        value {
            s: "NHWC"
        }
    }
    attr {
        key: "epsilon"
        value {
            f: 0.001
        }
    }
    attr {
        key: "U"
        value {
            type: DT_FLOAT
        }
    }
}
node {
    name: "FeatureExtractor/MobilenetV3/expanded_conv_1/depthwise/Relu"
    op: "Relu"
    input: "FeatureExtractor/MobilenetV3/expanded_conv_1/depthwise/BatchNorm/FusedBatchNormV3"
}
node {
    name: "FeatureExtractor/MobilenetV3/expanded_conv_1/project/Conv2D"
    op: "Conv2D"

```

```

input: "FeatureExtractor/MobilenetV3/expanded_conv_1/depthwise/Relu"
input: "FeatureExtractor/MobilenetV3/expanded_conv_1/project/weights"
attr {
  key: "data_format"
  value {
    s: "NHWC"
  }
}
attr {
  key: "dilations"
  value {
    list {
      i: 1
      i: 1
      i: 1
      i: 1
    }
  }
}
attr {
  key: "explicit_paddings"
  value {
    list {
    }
  }
}
attr {
  key: "padding"
  value {
    s: "SAME"
  }
}
attr {
  key: "strides"
  value {
    list {
      i: 1
      i: 1
      i: 1
      i: 1
    }
  }
}
}
}

```

```

node {
  name: "FeatureExtractor/MobilenetV3/expanded_conv_1/project/BatchNorm/FusedBatchNormV3"
  op: "FusedBatchNormV3"
  input: "FeatureExtractor/MobilenetV3/expanded_conv_1/project/Conv2D"
  input: "FeatureExtractor/MobilenetV3/expanded_conv_1/project/BatchNorm/gamma"
  input: "FeatureExtractor/MobilenetV3/expanded_conv_1/project/BatchNorm/beta"
  input: "FeatureExtractor/MobilenetV3/expanded_conv_1/project/BatchNorm/moving_mean"
  input: "FeatureExtractor/MobilenetV3/expanded_conv_1/project/BatchNorm/moving_variance"
  attr {
    key: "data_format"
    value {
      s: "NHWC"
    }
  }
  attr {
    key: "epsilon"
    value {
      f: 0.001
    }
  }
  attr {
    key: "U"
    value {
      type: DT_FLOAT
    }
  }
}
node {
  name: "FeatureExtractor/MobilenetV3/expanded_conv_1/output"
  op: "Identity"
  input: "FeatureExtractor/MobilenetV3/expanded_conv_1/project/BatchNorm/FusedBatchNormV3"
}
node {
  name: "FeatureExtractor/MobilenetV3/expanded_conv_2/expand/Conv2D"
  op: "Conv2D"
  input: "FeatureExtractor/MobilenetV3/expanded_conv_1/output"
  input: "FeatureExtractor/MobilenetV3/expanded_conv_2/expand/weights"
  attr {
    key: "data_format"
    value {
      s: "NHWC"
    }
  }
}
}

```