Faculty Of Engineering Helwan University

Graduation Project Report of

SMART STICK FOR BLIND PEOPLE

Supervisor

Dr. Zaki B. Nossair

Presented by

Mahmoud Shaaban Esmail Abd Elhamid

Omar Yasser Abd Elsamea Gharib

Merna Azmy Attalla Khalil

Marina Magdy Rofael Botros

Mahmoud Salah Yehia Youssef

July 2021

Abstract:

Blind people find it more challenging to move about independently because of their compromised vision. Moreover, a blind person's capacity to navigate in a given setting, along with their ability to organize their daily activities are vital to their health and wellbeing.

-Organizing any commonplace activity can be especially difficult for a blind man/woman if he/she has not learned to distinguish between different items like drug containers and packaged goods, just by feeling with the hands. The more saddening fact is that there are tens of millions of visually impaired persons worldwide who must go through such experience and are dependent on others for their wellbeing and happiness.

-The encouraging news, however, is that the rapid advancement in technology has seen the innovation of better systems for assisting the disabled, including the blind, such as the AI glasses, which can provide intelligent navigation capabilities to the blind.

-This paper reviews the design of a smart stick, i.e., A smart stick for the blind, equipped with obstacle recognition using AI Technologies adds more virtual visibility in their journey. It shows that such a stick can be a significant boon to the blind.

AKNOWLEDGMENT

The success and outcome of this project required a lot of guidance and assistance from many people, and we are extremely privileged to have got this all along the completion of our project. All that we have done is only due to such supervision and assistance and I would not forget to thank them. In a try to express our gratitude to our esteemed doctor Dr. Zaki B. Nossair who directed us in each step in this project, we are thankful for his guidance, patience, enthusiasm, motivation, and generosity that kept providing us with the guidance we needed.

Mahmoud, Omar, Merna, Marina, Mahmoud

Table of Contents

Keywords

-Machine learning

-Deep learning

-Image processing

-Voice recognition

-Ultrasonic sensor

-Bluetooth Earphone

-Blind People

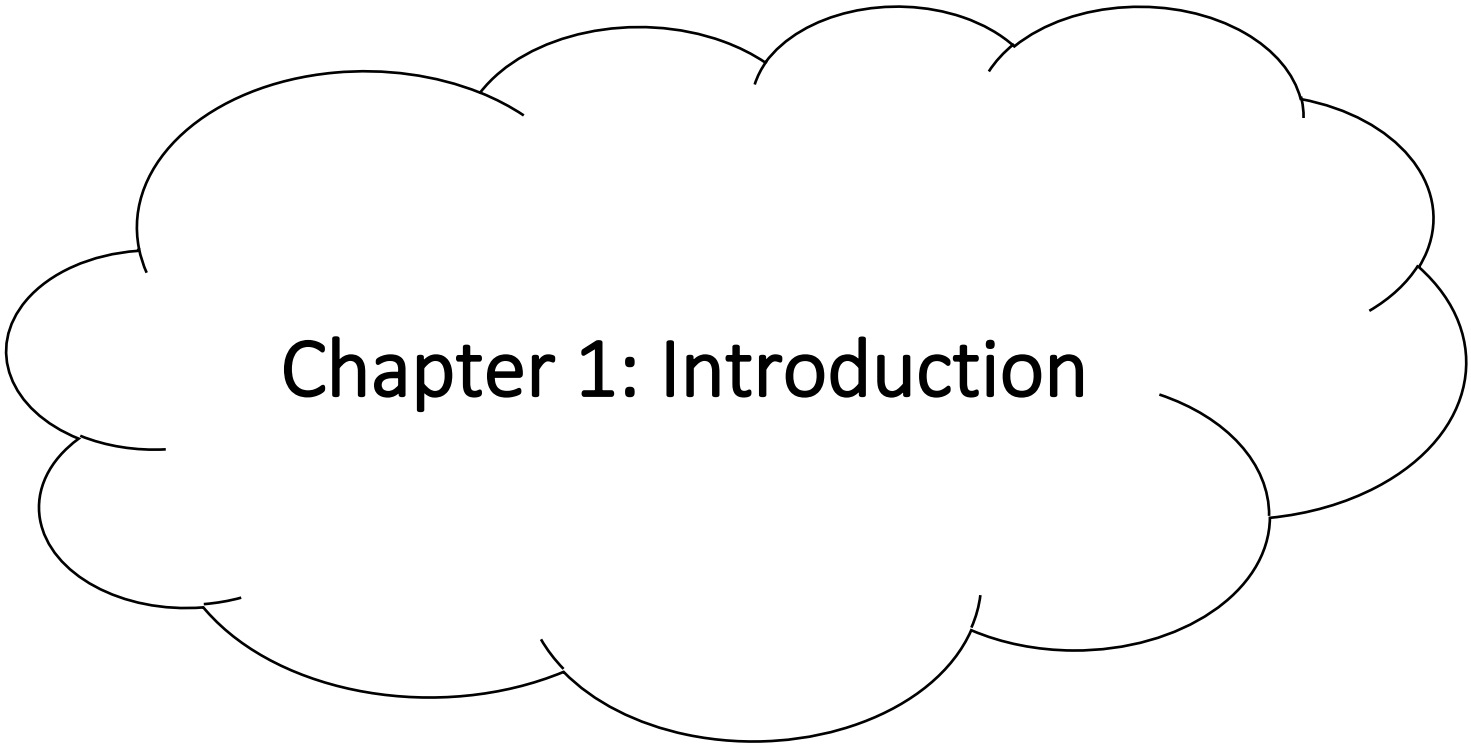
Abstract:

Blind people find it more challenging to move about independently because of their compromised vision. Moreover, a blind person's capacity to navigate in a given setting, along with their ability to organize their daily activities are vital to their health and wellbeing.

-Organizing any commonplace activity can be especially difficult for a blind man/woman if he/she has not learned to distinguish between different items like drug containers and packaged goods, just by feeling with the hands. The more saddening fact is that there are tens of millions of visually impaired persons worldwide who must go through such experience and are dependent on others for their wellbeing and happiness.

-The encouraging news, however, is that the rapid advancement in technology has seen the innovation of better systems for assisting the disabled, including the blind, such as the AI glasses, which can provide intelligent navigation capabilities to the blind.

-This paper reviews the design of a smart stick, i.e., A smart stick for the blind, equipped with obstacle recognition using AI Technologies adds more virtual visibility in their journey. It shows that such a stick can be a significant boon to the blind.


Chapter 1: Introduction

1.1: Introduction

Vision, to begin with, is the most crucial part of human psychology, considering that 83% of the information that a person obtains from the environment is through the sight. However, there are many people with serious visual impairments that prevent them from traveling individually. According to a 2018 report by the World Health Organization (WHO), there are roughly 1.3 billion people in the world who are visually impaired, 39 million of whom are blind, and 246 million have low vision. Accordingly, these individuals must use a range of techniques and tools to aid them in movement. Some of the oldest aids for the visually impaired have been the walking cane, also known as the white stick, and the guide dog. Though useful, these aids have significant setbacks, as will be discussed later in this paper. The rapid advancement of modern technology has, however, seen the advent of better systems such as the assisted vision smart glasses and the smart stick that can provide intelligent navigation capabilities to the blind. This paper reviews the design of a smart cane, i.e., an electronic supplementary eye stick, equipped with image recognition technologies that capture front, side, and backend images and use AI and machine learning to process them.

The smart stick is an alternative to the common/traditional walking stick, which is a purely mechanical device used to detect ground obstacles, including holes, steps, uneven surfaces, and other things that may pose a

danger. The traditional white cane is inexpensive and very lightweight and small, which makes it foldable able to fit in a pocket. Though useful, the traditional white cane has some critical setbacks, including the fact it takes hard training for one to be able to use them effectively. This is a significant “hidden” cost. Further, it only conveys a limited amount of information and allows a limited range of motion because the user can only scan the small area ahead of him/her and objects can only be detected through contact. This can be inconvenient to a traveler and those around him/her, for instance, if one is traveling in a crowded street. In the case of guide dogs, albeit these can be capable guides for the blind, they need extensive training.

Figure 1 : Blind person

1.2: Problem Definition

Visually Impaired people face a big problem to live normally as they always need an assistant to do many functions in their lives, they cannot do themselves.

First function they cannot do is that dealing with a device with buttons is so confusing as they forget the function of each button.

Second function is that they need to read books; the available books for their impairment are Braille-written books. But the problem is the book which is written in Braille is twice size the normal book and much expensive, also most of books are not found in Braille.

Third function is they cannot recognize objects that they are dealing with daily which makes interacting with area around them difficult.

Fourth function is that they need to take notes for their work, appointment or anything to remember them later which they cannot do.

The most common problem between Visually Impaired that they find a difficulty in using many devices as each device performs a separate function.

Figure 2: A caregiver helps a blind person

1.3: Objective

-We have many reasons to design smart stick for blind people; firstly, the blind person to feel free, is not surrounded by wires as in belt and its content. Secondly, is easy to use because it is familiar and affordable. Thirdly, to be able to detect obstacles that exist on the ground (this is not available in glasses), which he walks indoor and outdoor is faced by obstacles such as stairs, puddles, and sidewalks.

1.4: Current Solutions

-Mobile Applications

(Color Detection Application)

(Money Detection Application)

(Ask for an assistant Application)

- Traditional blind stick

-Braille System

1.5: Our Solution

- We propose to design an intelligent device which vibrates on occurrence of obstacles based on distance between the person and the obstacle.

-It will not only vibrate but also will tell what the obstacle is, and it will also tell the direction that the person should go. ”It gives them the confidence and allow them to integrate into society as equals.

- It has a small earphone connected to the stick to help the person to hear the voice.

-It has a sensitive sensor to give an alarm when it found fire.

Chapter 2: Market Study

2.1 Overview

This chapter to declare how we were able to find the best way to help the visually impaired we had to focus on some points to put our hands in the core of the problem and help them well.

2.2: History & Statistics of the Problem

The World Health Organization (WHO) estimates the number of people with visual impairments globally, based on recent studies, that some 285 million people with visual impairment (blindness or visual impairment) worldwide, including 246 million people with visual impairment and 39 million people are infected Blindness.

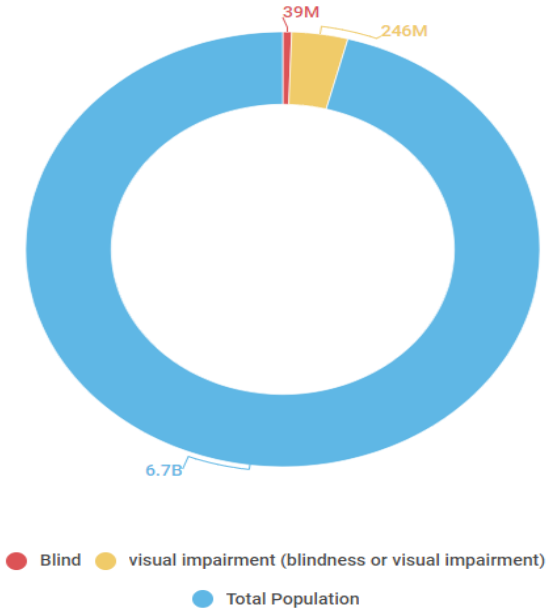


Figure 3: Visually impaired over the world

NEW YORK (Reuters Health) - Blind people will triple from about 39 million to 117 million in 2050 as the population expands and increases, according to a recent study conducted by US researchers.

According to the US medical site "MedicalXpress", the number of people with moderate to severe visual impairment and those who wore glasses or contact lenses or performed a process would triple, from about 246 million to 688 million during the same period.

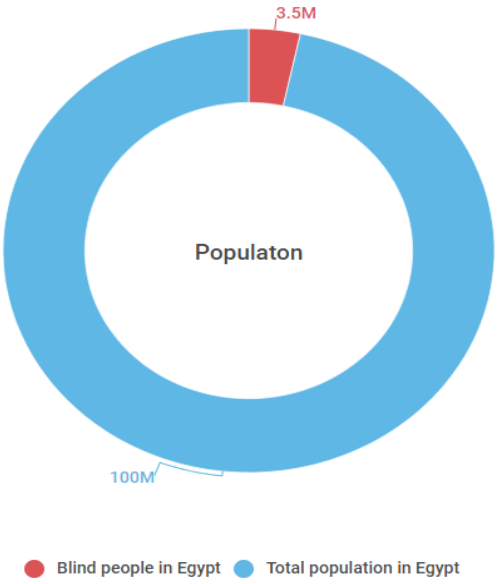


Figure 4: Visually impaired in Egypt

When we had a look to the statics of published books, we found that the number of books published annually in the Arab world is estimated at 5000 books of which only about 3% are available to the blind in an unorganized manner, compared to 10% in other countries of the world, according to UNESCO. Locally, the number of blind people in Egypt is estimated at 3.5 million.

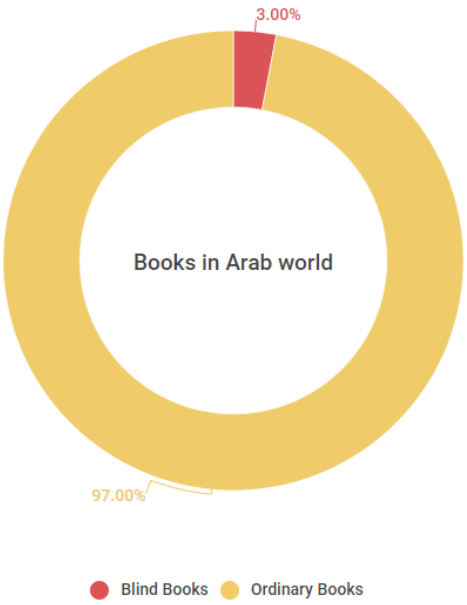


Figure 5: Visually impaired books in Arab world

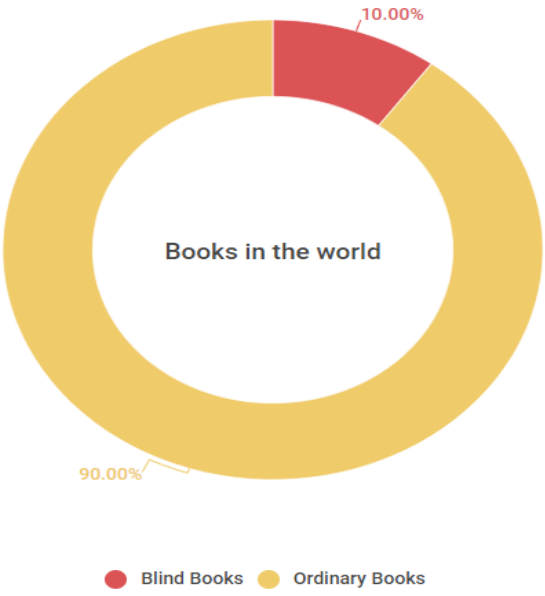


Figure 6: Visually impaired books over the world

2.3: Previous models

2.3.1: Project in AUS:

Figure 7: Project in AUS

-The main computing processing component, sensors and cameras are attached to the cane. -Imran Mojib, Special Correspondent - A team of students from the American University of Sharjah has designed an innovative smart cane to assist people with impaired vision as part of their graduation design project. -The design project features two parts – a smartphone application with a voice-alert feature that allows Google Maps to locate the user, and an adjustable cane that is connected to a wheeled chassis. -Using Internet of things (IoT) smart technology, the cane's handle has an emergency pushbutton that allows the user to send alert signals to a guardian's mobile phone to locate and assist the user. The

system is designed to help people with visual impairment move to specific locations indoors and outdoors while detecting and avoiding stationary obstacles along the way. -Computer science and engineering students Mariam Jamal Arshi, Reem Abdullah Al Amiri, Fatima Hussein Arab and Sarah Mohammed Al Mazmi aimed to demonstrate how IoT can be used to address challenges facing people with disability. -The students began work on their project in January 2020 and presented the prototype as part of their graduation design project in December. The team carried out in-depth research for their graduation project and reached out to various stakeholders. -The proposed smart cane design can provide several important functions useful in both private and public spaces, including airports, public parks and malls. “Firstly, it can detect and classify barriers for people with visual impairment at a specific distance. - In the event of an obstacle, the cameras intake pictures. Using artificial intelligence, the cane identifies the obstacle and informs the user via a loudspeaker about the type and nature of the obstacle ahead of them,” said team member Arshi. “Secondly, it can detect when the user is about to fall and warn the user’s guardian through the smart mobile application. Users can also activate an alarm by pressing a button that will send an alert signal to a guardian. Finally, the cane can track the user’s current location and locate them on Google Maps through the smart application. This is useful for

family members, who can access it anytime," she added. The project was funded by Sandooq Al Watan Fund and AUS.

2.3.2: Project in Khalifa University in Sharjah:

-Using Ultrasonic sensor to detect obstacles around it.

-Vibrates on occurrence of obstacles based on distance about 20 cm.

-Our smart stick design will greatly help blind people to detect obstacles that may hinder their movement such as bumps in the street, stones, water, and fires. It will enable them to know the things in front of them so that they can avoid these obstacles. It will help them to be more self-reliant while they are on the move at home or anywhere without the help of others.

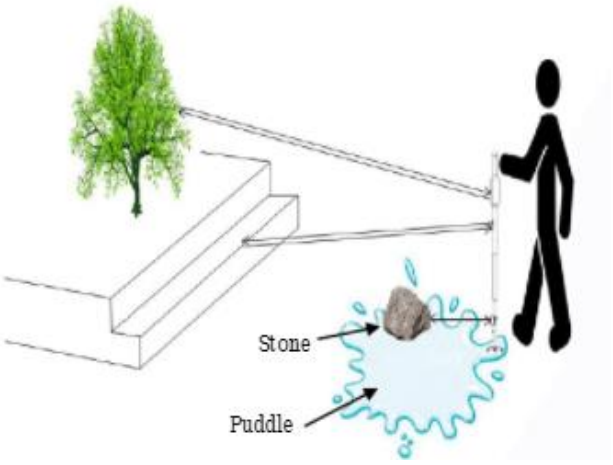


Figure 8: Smart stick detects obstacles in front of the blind

Chapter 3: Necessary Background

3.1: Overview

-In this chapter, we are going to discuss the scientific background of the software and the methods used in understanding the question to get most accurate results.

-This chapter discusses the algorithms and techniques we used to build our stick. We will illustrate the different backgrounds we used in building our project as: Image Processing, Deep Learning, and Machine Learning.

3.2: Digital Image Processing

-Image processing is a method to perform some operations on an image, to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image. Nowadays, image processing is among rapidly growing technologies.

-It forms core research area within engineering and computer science disciplines too.

- Image processing basically includes the following three steps:

Importing the image via image acquisition tools.

Analyzing and manipulating the image.

Output in which result can be altered image or report that is based on image analysis.

3.2.1: Tasks of Digital Image Processing

Digital image processing deal with:

-Classification

-Feature Extraction

-Multi-scale signal analysis

-Pattern recognition

-Projection

Techniques are used in image processing:

- Image restoration
- Independent component analysis
- Linear filtering
- Neural networks
- Partial differential equations
- Pixelation
- Point feature matching
- Principal components analysis
- Self-organizing maps

3.3: Deep Learning

Deep learning (also detected as deep hierarchical learning or structured learning) is a section of a fringe family of machine learning methods based on ANNs.

Learning can be unsupervised, supervised or semi-supervised Deep learning architectures such as deep belief networks, deep neural networks, convolutional neural networks and recurrent neural networks have been applied to fields including speech recognition, computer vision , audio recognition ,natural language processing, bioinformatics ,social network filtering,drug design, machine translation, material inspection, board game programs and medical image analysis where they have generated results comparable to and in some cases superior to individual scientist.

Artificial Neural Network (ANN) was motivated by information processing and distributed communication nodes in biological systems. ANN have many differences from biological brains. Specifically, neural networks tend to be symbolic and static, while the biological brain of most living organisms is

analog and dynamic.

3.3.1 Application of deep learning

3.3.1.1: Automatic Speech Recognition:

The automatic speech recognition is the first and most convincing successful case of deep learning. LSTM Recurrent Neural Networks can learn "Very Deep Learning" tasks that involve many-second intervals including speech events separated by many discrete time steps, that one time step corresponds to about 10 ms. LSTM with forget gates is competitive with traditional speech recognizers on many tasks.

The original success in speech recognition is based on small-scale recognition tasks based on TIMIT. The data set includes 630 speakers from eight major dialects of American English, where every speaker reads ten sentences. Its small size helps many configurations be tried. Most importantly, the TIMIT task contains phone-sequence recognition, which, is not the same as word-sequence recognition, allows weak phone bigram language models. This helps that the strength of the acoustic modeling aspects of speech recognition be analyzed in an easy way.

3.3.1.2: Image Recognition

A mutual evaluation set for image classification is the MNIST database data set. MNIST is composed of handwritten digits and includes sixteen thousand training examples and 10,000 test examples. As with TIMIT, its small size lets actors test many configurations. A comprehensive list of results on this set is available.

Deep learning-based image recognition has become "superhuman"; manufacture more valid results than human contestants. Deep learning-trained vehicles now interpret 360° camera views.

3.3.1.3: Virtual Art Recognition

Closely concerning to the progression that has been made in image recognition is the increasing application of deep learning techniques to different visual art tasks. Deep Neural Networks have proven themselves capable:

Identifying the form period of a given painting.

Neural Style Transfer - capturing the form of a given artwork and applying it in a visually pleasing method to an arbitrary photograph or video.

Producing striking imagery based on random visual input field.

3.3.1.4: Natural Language Recognition

Neural networks have been used for performing language models since the early 2000s. LSTM helped to ameliorate language modeling and machine translation Other key techniques in this domain are negative sampling and word embedding. Word embedding, such as word2vec, can be thought of as a representational layer in a deep learning architecture that converts an single word into a positional representation of the word related to other words in the dataset; the position is acted as a point in a vector space. Using word embedding as an Recurrent Neural Network input layer allows the network to parse sentences and phrases using an effective compositional vector grammar. A compositional vector grammar can be thought of as probabilistic context free grammar (PCFG) implemented by a Recurrent Neural Network. Recursive auto-encoders construct atop word embedding can assess sentence similarity and detect paraphrasing. Deep neural architectures provide the best results for information retrieval, spoken language understanding, writing style recognition, machine translation, constituency parsing, sentiment analysis, contextual entity linking, and Text classification.

Recent developments popularize word embedding to sentence embedding. Google Translate (GT) uses a big end-to-end long short-term memory network. Google Neural Machine Translation (GNMT) uses a translation

method of an example-based machine in which the system "learns from millions of examples. It translates the entire sentence rather than parts of the sentence. Google Translate provide over 100 languages.

3.3.1.5: Image Restoration Recognition

Deep learning has been successfully applied to inverse problems such as super- resolution imprinting, film colorization and denoising. These applications include learning methods such as Deep Image Prior which trains on the image that needs restoration and Shrinkage Fields for Effective Image Restoration which trains on an image dataset.

3.4: Neural Network

3.4.1: Artificial Neural Network

Artificial neural network (connectionist systems) is computing Systems motivated by the biological neural network that constitute animal brains. Such systems learn (progressively improve their ability) to make tasks taking into consideration examples, generally without task-specific programming.

For example, in image recognition, they might learn to detect images that have cats by analyzing example images that have been manually categorized as no cat or cat and using the analytic results to detect cats in other images.

They have found most use in applications difficult to express with a classic computer algorithm using rule-based programming.

An ANN is based on a combination of connected units called artificial neurons. Each connection (synapse) between neurons can transfer a signal to another neuron. The receiving (postsynaptic) neuron can process the signal and then signal downstream neurons connected to it. Neurons may have state, generally represented by real numbers, typically between zero and one. Neurons and synapses may have a weight also that differ as learning proceeds, that can decrease or increase the strength of the signal that it sends downstream.

Typically, neurons are well-planned in layers. Various layers may perform different kinds of transformations on their inputs. Signals transmit from the first (input), to the last (output) layer, possibly after traversing the layers multiple times.

The original objective of the neural network approach was to solve problems in the same way that a human brain solve it. Over time, attention focused on

matching specific mental abilities, leading to deviations from biology such as passing information in the reverse direction or back-propagation and adjusting the network to reflect that information.

As of 2017, neural networks typically have a range from thousand to million units and millions of connections. Regardless of this number being several orders of magnitude less than the number of neurons on a human brain, these networks can perform a lot of tasks at a level beyond that of humans

3.4.1: Artificial Neural Network

A deep neural network is an artificial neural network with many layers between the first (input) and last (output) layers. The DNN finds the right mathematical handling to turn the input into the output, so it can be a non-linear relationship or a linear relationship. The network moves between the layers calculating the probability of every output. For example, a deep neural network that is drilled to recognize dog breeds will go over the given image and calculate the probability that the dog in the image is a certain breed. The actor can check the results and select which probabilities that the network should display (above a certain threshold, etc.) and return the chosen label. Each mathematical manipulation as such is considered a layer, and complex DNN have multiple layers.

DNN can pattern complex non-linear relationships. DNN architectures produce compositional models where the object is expressed as layered composition of primitives. The extra layers enable composition of features from the further downs layers, potentially modeling complex data with fewer units than a similarly performing shallow network.

Deep architectures contain many different of a little basic approach.

Every architecture has found success in specific fields. It is not always possible to compare the performance of much architecture, except if they have been evaluated on the same data sets.

DNNs.0 are typically feedforward networks in which data flows from the first (input) layer to the last (output) layer without returning back. At first, the DNN creates a map of virtual neurons and assigns random weights, or numerical values, to connections between them. The weights and inputs are multiplied and return an output between zero and one. If the network didn’t carefully recognize a particular pattern, an algorithm would correct the weights. That way the algorithm can make many parameters more influential, until it determines the right mathematical manipulation to fully process the data.

3.5: Machine Learning

It is the study of statistical models and algorithms that computer systems use to implement a special function effectively without using explicit instructions, relying on patterns and inference instead. It is displayed as a subset of AI. Machine learning algorithms construct a mathematical model based on training data, known as "sample data", in order to make guesses or decisions without being explicitly programmed to implement the function.

Machine learning algorithms are used in a large variety of applications, such as computer vision and email filtering where it is infeasible to develop an algorithm of specific instructions for implementing the task. Machine learning is relative to computational statistics, which focuses on applying predictions using computers. The study of mathematical optimization delivers theory, application domains and methods to the domain of machine learning. Data mining is a domain of study within machine learning, and focuses on exploratory data analysis through unsupervised learning. Machine learning is also referred to as predictive analytics in its application across business problems.

3.5: Types of Learning Algorithm

3.5.1: Supervised Learning

-Supervised learning algorithms construct a mathematical model of a set of data that include both the inputs and the desired outputs the data is known as sampled data and consists of a set of training examples. Each training example has one or many inputs and a desired output, also known as a supervisory signal. In the mathematical model, each training example is displayed by a vector or array, at sometimes it is called a feature vector, and the training data is displayed by a matrix. Through reduplicate optimization of an objective function, supervised learning algorithms learn a function that can be used to guess the output associated with new inputs. An optimal task will allow the algorithm to correctly determine the output for inputs that were not a piece of the training data. An algorithm that enhances the accuracy of its outputs or predictions over time is said to have learned to implement that task.

Similarity learning is a wide range of supervised machine learning relative to regression and classification, but the objective is to learn from examples using a common function that measures how similar or related two objects are. It has applications in recommendation systems, visual identity tracking, and face verification and ranking.

3.5.2: Reinforcement learning

Reinforcement learning is a wide range of machine learning included the way that the software agents have to take actions in an environment so as to increase some notion of additional reward. The domain is studied in many other disciplines, such as control theory, game theory, information theory, operations research, multi-agent systems, simulation-based optimization, statistics, genetic algorithms and swarm intelligence due to its generality.

In machine learning, the environment is typically displayed as a Markov Decision Process Multiple reinforcement learning algorithms use dynamic programming techniques. Reinforcement learning algorithms do not assume knowledge of an typical mathematical model of the Markov Decision Process and are used when typical models are infeasible. Reinforcement

learning algorithms are used in autonomous vehicles or in learning to play a game versus a human opponent.

3.5.3: Feature learning

Many learning algorithms have the goal of discovering better representations of the inputs provided during training. Classic examples contain principal components analysis and cluster analysis. Feature learning algorithms, also known as representation learning algorithms, always fails to preserve the information in their input but also convert it in a way that makes it useful always as a pre-processing step before implementing classification or predictions. This technique helps in reconstruction of the inputs coming from the unknown data- generating distribution, while not being necessarily loyal to configurations that are improbable under that distribution.

3.5.4: Decision Trees

Decision tree learning uses a decision tree as a predictive model to go to conclusions about the target value of the item (represented in the leaves) from observations about an item (represented in the branches). It is one of the

predictive modeling approaches used in data mining, machine learning and statistics. Tree models where the target variable can take a discrete set of values are called classification trees; in these tree structures, leaves represent class labels and branches represent conjunctions of features that direct to those class labels. Decision trees where the target variable can take continuous values (typically real numbers) are called regression trees. In decision analysis, a decision tree can be used to show and explicitly display decisions and decision making.

3.5.5: Support Vector Machines

Support vector machines (SVM), also defined as support vector network, are a set of combined supervised learning methods used for classification and regression. Given a set of training examples, every marked as belonging to one of two groups, a Support Vector Machine training algorithm constructs a model that guess if a new example falls into one group or the other. A Support vector machines training algorithm is a non-probabilistic, binary, linear classifier, although methods such as Platt scaling exist to use Support vector machines in a probabilistic classification setting. Support vector machines can efficiently perform a non-linear classification using what is

called the kernel trick, implicitly mapping their inputs into high-dimensional feature spaces to performing linear classification.

3.5.6: Bayesian Networks

Bayesian network, belief network or directed acyclic graphical model is a probabilistic graphical model that displays a group of random variables and their conditional independence with a directed acyclic graph (DAG). For example, a Bayesian network could display the probabilistic relationships between symptoms and sickness. Given symptoms, the network can be used to compute the probabilities of the presence of different sickness. Efficient algorithms have an existence that implements inference and learning. Bayesian networks that model sequences of variables, like speech signals or protein sequences are known as dynamic Bayesian networks. Generalizations of Bayesian networks that can display and solve decision problems under uncertainty are known as influence diagrams.

3.6: Classifications

Classification techniques in data mining have the ability of processing a large amount of data. It can be used to predict a set of class labels and classifies data based on training set and class labels and it can be used for classifying a new available data. This definition could cover any context in which some decision or forecast is made on the basis of existence available information. Classification procedure is a detected method for repeatedly making such decisions in new situations. Here if we suppose that problem is a concern with the construction of a procedure that will be applied to a continual sequence of cases in which each new case must be assigned to one of a set of predefined classes on the basis of observed features of data. Generation of a classification procedure from a set of data for which the exact classes are defined in advance is termed as pattern recognition or supervised learning. Contexts in which a classification function is essential include, for example, assigning individuals to credit status on the basis of financial and other personal information, and the initial diagnosis of a patient's disease in order to select immediate treatment while awaiting right test results.

Many of the most serious problems arising in industry, commerce and science can be named as classification or decision problems. Three main historical strands of research can be identified as statistical, machine learning

and neural network. All groups have some objectives in common. They have all attempted to create procedures that would be able to handle a lot of problems and to be extremely general used in practical settings with proven success.

3.6.1: Algorithms of classification technique

3.6.1.1: K-nearest Neighbors Algorithm

The closest neighbor (Nearest Neighbors) rule distinguishes the classification of unknown data point on the basis of its closest neighbor whose class is already known. M. Cover and P. E. Hart purpose k nearest neighbor (K Nearest Neighbors) in which nearest neighbor is computed on the basis of estimation of k that indicates how many nearest neighbors are to be considered to characterize class of a sample data point. It makes employment of the more than one closest neighbor to determine the class in which the given data point belongs to and consequently it is called as K Nearest Neighbors. These data samples are needed to be in the memory at the run time and hence they are referred to as memory-based technique. T. Bailey and A. K. Jain enhance K Nearest Neighbors which is concentrated on

weights. The training points are allocated weights depended on their distances from sample data point. But at the same time the computational complexity and memory requirements vestige the primary concern dependably. To overcome memory limitation size of data set is decreased. For this the repeated patterns which don't include extra data are also discarded from training data set. To further improve the information focuses which don't influence the result are additionally deleted from training data set. The nearest neighbor training data set can be organized utilizing various systems to improve over memory limit of k nearest neighbor. The k nearest neighbor implementation can be done using ball tree, k-d tree, nearest feature line (Nearest Feature Line), principal axis search tree and orthogonal search tree.

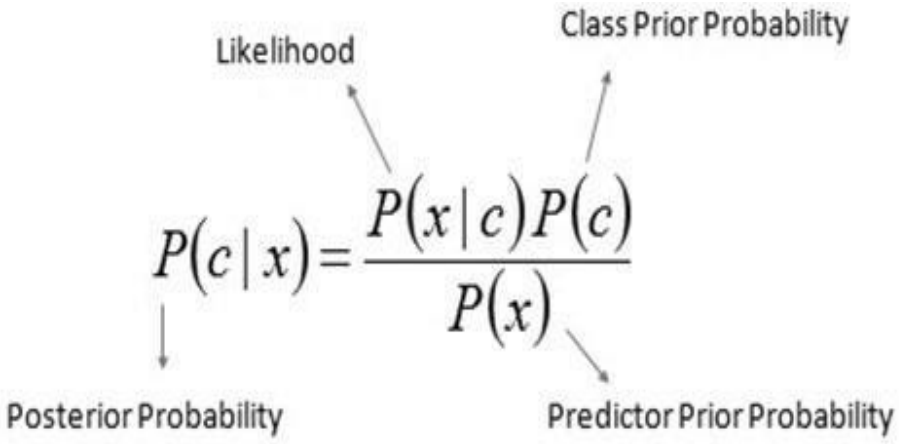
The structure training data of the tree is further divided into nodes and techniques like Nearest Feature Line and tunable metric divide the training data set depending on planes.

3.6.1.2: Naïve Bayes Algorithm

The Naive Bayes Classifier technique is based on Bayesian theorem and is particularly used when the dimension of the inputs is high.

The Bayesian Classifier is able to calculate the most possible output based on the input. It is also possible to add new raw data at runtime and have an improved probabilistic classifier. A naive Bayes classifier considers that the existence (or absence) of a particular attribute of a class is not related to the existence (or absence) of any other feature when the class variable is given. As an example, a fruit may be assigned to be an apple if it is red, round. Although if these features depend on each other or upon the presence of other features of a class, a naive Bayes classifier considers all of these properties to not dependent contribute to the probability that this fruit is an apple.

Calculating the posterior Probability as follows:



$$P(c \mid \mathrm{X}) = P(x_1 \mid c) \times P(x_2 \mid c) \times \cdots \times P(x_n \mid c) \times P(c)$$

3.6.1.3: Adaptive decision boundary

A decision boundary or decision surface is a hyper surface that split the underlying vector space into two groups; each class has one group in a statistical-classification problem with two classes. The classifier will classify all the points at one side of the decision boundary as belonging to one class and all those data on the other side as belonging to the other class.

3.7: Regression

Regression analysis is a set of statistical processes for estimating the relationships between variables in statistical modeling, . It contains a lot of techniques for modeling and analyzing many variables, when the constraint is on the relationship between a dependent variable and one or more independent variables (or 'predictor'). More particularly, regression analysis aids one understands how the typical value of the dependent variable (or 'criterion variable') changes when any one of the independent variables is varied, while the other independent variables are held fixed.

Most mutually, regression analysis estimates the subjunctive expectations of the non -independent variable given the independent variables – that is, the average value of the non -independent variable when the independent variables are fixed. Less mutually, the constraint is on a quantile, or another location parameter of the conditional allocation of the dependent variable given the independent variables. A function of the independent variables called the regression function is to be estimated in all cases. It is also of interest to characterize the variation of the dependent variable around the prediction of the regression function using a probability distribution in regression analysis, A relative but different approach is Necessary Condition Analysis (Necessary Condition Analysis), which estimates the maximum (better than average) value of the dependent variable for a given value of the independent variable (ceiling line rather than central line) in order to identify what value of the independent variable is necessary but not sufficient for a given value of the dependent variable.

Regression analysis has a use for forecasting and prediction where its use has fundamental overlap with the domain of machine learning. Regression analysis is also used to understand which between the independent variables are related to the dependent variable, and to develop the forms of these relationships. Regression analysis can be used to infer causal relationships

between the independent and dependent variables in restricted circumstances. So, this can lead to illusions or artificial relationships, so caution is advisable.

A lot of techniques for carrying out regression analysis have been created. Mutual methods such as linear regression and ordinary least squares regression are parametric, in that the regression function is defined in terms of a finite number of unknown parameters that are predicted from the data.

Nonparametric regression indicates to techniques that help the regression function to lie in a specified group of functions, which may be infinite-dimensional.

The performance of regression analysis methods in practice depends on the style of the data producing process, and the way that it relates to the regression approach being used. Since the true form of the data-generating process is generally not known, regression analysis often depends to some extent on making assumptions about this process. These assumptions are always testable if a better quantity of data is available.

Chapter4: Design & Components

4.1: Our Design

We tried as much as possible to make our design as simple as possible to be easy to use and easy to carry around. In this chapter, we will talk in detail about the components that were used in the design of the stick.

4.2: Main Components

we used many components to Design this stick for example:

Raspberry pi, Ultrasonic Sensor, NTC Sensor, Camera, Earphone.

4.2.1: Raspberry pi

The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It can do everything you would expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games.

What is more, the Raspberry Pi has the ability to interact with the outside world and has been used in a wide array of digital maker projects, from music machines and parent detectors to weather stations and tweeting birdhouses with infra-red cameras. We want to see the Raspberry Pi being used by kids all over the world to learn to program and understand how computers work.

Figure 9: Raspberry pi

Advantages of Raspberry pi:

Low-cost high-performance computer which can be plugged in TV and monitor and can be used as computer which is very small as credit card.

- Its CPU is 700Mhz single core ARM1176JZF-S,
- It has 4 USB ports.
- It has dual core video core iv multimedia coprocessor.
- Size of its RAM is 512mb.
- It has micro SDHC plot for storage.
- Power rating of raspberry pi is 600mA i.e, 3.0W
- It has 17*GPIO plus the same specific functions.

This raspberry pi works as the computer of the smart walking stick.

4.2.2Ultrasonic Sensor

Ultrasonic is the production of sound waves above the frequency of human hearing and can be used in a variety of applications such as, sonic rulers, proximity detectors, movement detectors, liquid level measurement. Ultrasonic

Ranging ModuleHC - SR04. F Ultrasonic ranging module HC -SR04 provides 2cm - 400cm non-contact measurement

function, the ranging accuracy can reach to 3mm. The

modules includes ultrasonic transmitters, receiver and

control circuit. Ultrasonic sensors send sound waves which

get reflected form obstacle and come back to him and send this signal to microcontroller for further processing

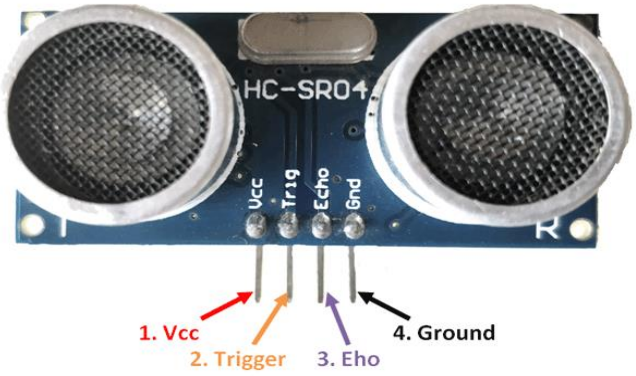


Figure 10: Ultrasonic Sensor HC SR04 Pin Diagram

4.2.2.1 Ultrasonic Sensor Pin Configuration

Pin Number	Pin Name	Description
1	Vcc	The Vcc pin powers the sensor, typically with +5V
2	Trigger	Trigger pin is an Input pin. This pin has to be kept high for 10us to initialize measurement by sending US wave.
3	Echo	Echo pin is an Output pin. This pin goes high for a period of time which will be equal to the time taken for the US wave to return back to the sensor.
4	Ground	This pin is connected to the Ground of the system.

4.2.2.2: HC-SR04 Sensor Features:

-Operating voltage: +5V

-Theoretical Measuring Distance: 2cm to 450cm

-Practical Measuring Distance: 2cm to 80cm

-Accuracy: 3mm

-Measuring angle covered: <15°

-Operating Current: <15mA

-Operating Frequency: 40Hz

4.2.2.3: Equivalent distance measuring Sensors

US transmitter Receiver pair, IR sensor module, IR sensor pair, IR Analog distance senso,

4.2.2.4: HC-SR04 Ultrasonic Sensor – Working

As shown above the HC-SR04 Ultrasonic (US) sensor is a 4-pin module, whose pin names are Vcc, Trigger, Echo and Ground, respectively. This sensor is a very popular sensor used in many applications where measuring distance or sensing objects are required. The module has two eyes like projects in the front which forms the Ultrasonic transmitter and Receiver. The sensor works with the simple high school formula that.

Distance = Speed × Time

The Ultrasonic transmitter transmits an ultrasonic wave, this wave travels in air and when it gets objected by any material it gets reflected back toward the sensor this reflected wave is observed by the Ultrasonic receiver module as shown in the figure 4.3

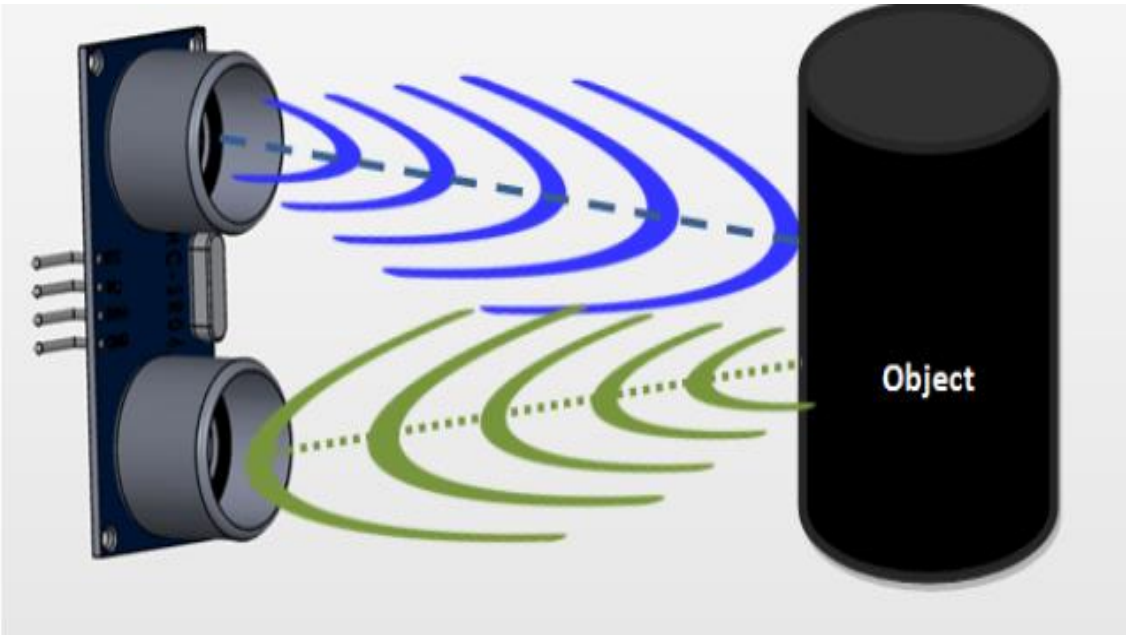


Figure 11: HC-SR04 Ultrasonic Sensor – Working

4.2.2.5: How to use the HC-SR04 Ultrasonic Sensor

-HC-SR04 distance sensor is commonly used with both microcontroller and microprocessor platforms like Arduino, ARM, PIC, Raspberry Pie etc. The following guide is universally since it has to be followed irrespective of the type of computational device used.

-Power the Sensor using a regulated +5V through the Vcc ad Ground pins of the sensor.

-The current consumed by the sensor is less than 15mA and hence can be directly powered by the on board 5V pins (If available). The Trigger and the Echo pins are both I/O pins and hence they can be connected to I/O pins of the microcontroller. To start the measurement, the trigger pin has to be made high for 10uS and then turned off. This action will trigger an ultrasonic wave at frequency of 40Hz from the transmitter and the receiver will wait for the wave to return. Once the wave is returned after it getting reflected by any object the Echo pin goes high for a particular amount of time which will be equal to the time taken for the wave to return back to the sensor.

-The amount of time during which the Echo pin stays high is measured by the MCU/MPU as it gives the information about the time taken for the wave to return back to the Sensor. Using this information, 22the distance is measured as explained in the above heading.

4.2.2.6: Applications

Used to avoid and detect obstacles with robots like biped robot, obstacle avoider robot, path finding robot etc.

Used to measure the distance within a wide range of 2cm to 400cm.

Can be used to map the objects surrounding the sensor by rotating it.

-Depth of certain places like wells, pits etc can be measured since the waves can penetrate through water.

4.2.3: NTC Sensor

use NTC sensors to measure temperature in building controls and processes, resulting in increased efficiency and control. Automotive and aerospace industries use NTC thermistors for test and measurement as well as production applications.

Figure 12: NTC Sensor

4.2.4: Pi Camera

The Raspberry Pi camera (PI Camera) module can be used to take high-definition video, as well as photographs.

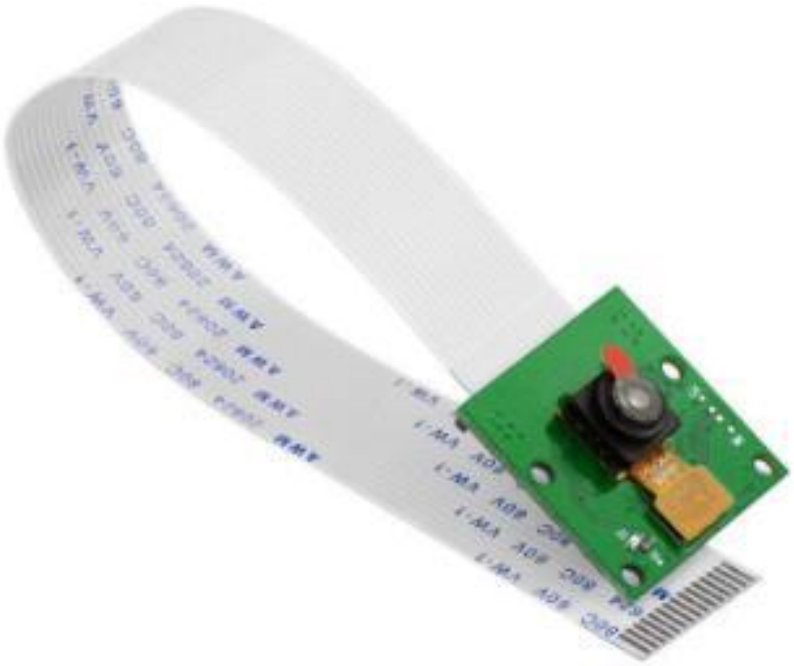


Figure 13: Pi Camera

4.2.5: Power Bank

Power bank role is to be the power supply of the Raspberry Pi.

Figure 14: Power Bank

4.2.6: Bluetooth earphone

- used to hear the sound from camera

Figure 15: Bluetooth earphone

Chapter 5: YOLO

5.1: Overview

As we have progressed in this time of innovation, the attainability and openness of web has turned out to be simpler on the Personal Computers (PCs) yet in addition on cell phones, for example, Smartphones! Likewise, in the ongoing years, online life sites have turned out to be tremendously mainstream. Because of this, the measure of pictures/picture information on the web has expanded quickly. The quantity of pictures being transferred each day on these internet-based life sites/cloud stages are in the scope of millions. We as individuals, can't recognize and process these a large number of pictures effectively.

Thus, it is required to do this information preparing naturally with the guide of PC to tackle substantial scale visual issues.

Visual Problems may incorporate recognition of a specific article from a picture or recognizing the area in the picture. A superior comprehension of the picture handling innovation, extensive comprehension of the picture and precise recognizable proof of the objective object(s) in the picture ends up conceivable. Picture acknowledgment innovation plans to recognize the objective items utilizing the speculations and different strategies for picture preparing and design acknowledgment, decide the semantic classifications of these articles, and imprint the particular

position of the objective article in the picture. Additionally, the picture acknowledgment methods are valuable in an assortment of utilizations, for example, facial acknowledgment for security purposes, characterization of pictures in cloud administrations and sites having huge visual databases, for example, stock photo sites. In any case, for all intents and purposes it is a troublesome errand to utilize the processing innovation for the programmed recognition of the objective object(s) in the picture. An expansive number of components, for example, complex foundation, loud picture, lower goals of the picture and other such factors to a great extent influence and make the picture discovery process significantly progressively mind boggling.

An assortment of strategies has been proposed throughout the years for giving enhancements in the picture acknowledgment field. Convolutional Neural Network (CNN) [1] is one of the techniques that has been fruitful to help improve the picture acknowledgment process. Along these lines, in this paper we propose a framework that would execute the innovation of PC vision dependent on Convolutional Neural Network actualized with OpenCV library, conceivable of distinguishing target object(s) from the given picture. The picture discovery system can be additionally utilized for different applications.

5.2: CONVOLUTIONAL NEURAL NETWORK (CNN)

A Convolution Neural Network (CNN) is a class/sort of Deep Neural Network (DNN) which is ordinarily utilized in the field of examining pictures and acquiring valuable data from the broke down image (s, for example, acknowledgment of an article, perceiving the area in the picture, etc. CNNs are valuable in recognizing the articles in the pictures without requiring a substantial number of parameters for example it is appropriate for perceiving the articles utilizing restricted parameters with respect to the objective item. Because of this component, CNNs have turned into the proper decision notwithstanding for pictures with high measurements.

-In the period of enormous information, stockpiling and preparing isn't at all an issue in the field of calculation. CNN has a multi-layered engineering. Making of Convolutional Neural Network is a costly issue as far as the skill included, the measure of information and gear required. A regular CNN is made from a layered structure having diverse layers, for example, a convolutional layer, a pooling layer and a completely associated layer.

-CNN is essentially prepared by utilizing the forward proliferation and back engendering calculation to gain proficiency with the layer-association loads, inclination and other such parameters. The preparation is a directed procedure that requires picture informational collections and their relating marks as info which streamlines the system parameters. It at that point at last gets an enhanced weight display that can be utilized for distinguishing the objective items from the provided picture.

5.3: THE FUNDAMENTAL STRUCTURE OF CNN

A common CNN structure comprises of an info layer, the convolutional layer, a pooling layer pursued by a completely associated layer and a yield layer. The figure underneath demonstrates the common structure of a CNN.

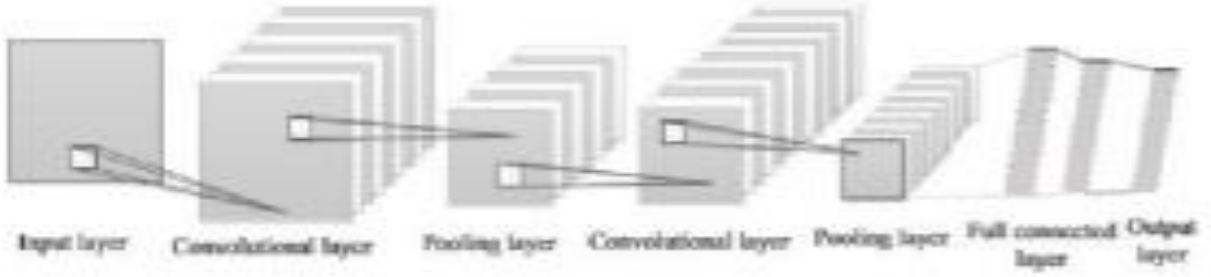


Figure 16: Typical CNN architecture

5.3.1: Convolutional Layer

The convolutional layer is the center piece of the Convolutional Neural Network. It comprises of nearby associations inside the convolutional layer and furthermore comprises of loads of the mutual attributes. The essential point of the convolutional layer is to find out about the component portrayal of the pictures. The convolutional layer comprises of a few element maps, which comprises of explicit number of neurons. Every neuron of an element map is utilized to extricate nearby qualities of various positions in the previous layer.[3] In request to get another element, the info include maps are first convolved with a scholarly part and afterward the outcomes are passed into a nonlinear enactment function.[3] Different element maps are gotten by applying distinctive pieces. Sigmoid, tanh and Relu are the run of the mill actuation capacities.

5.3.2: Pooling Layer

Convolutional Neural Networks comprise of pooling layer which joins the yields of the neuron at one layer into a solitary neuron in the

following layer. We can say that it diminishes the elements of the component maps and increment the strength of highlight extraction. The pooling layer is normally situated between two Convolutional layers. The span of the component maps in the pooling layer is resolved by the parts. Activities of a pooling layer incorporate max pooling and normal pooling. In max pooling, the most extreme incentive from every one of the group of neurons from the earlier layer is utilized. While in normal pooling, the normal incentive from the group of neurons of the past layer is utilized. Abnormal state attributes of data sources can be acquired by the way toward stacking a few Convolutional layer and pooling layer.

5.3.3: Fully Connected Layer

The completely associated layer in the Convolutional Neural Network takes every one of the neurons from the past layer and interfaces them to each and every neuron of the present layer. No spatial data is saved in these completely associated layers. The last completely associated layer is constantly trailed by a yield layer.

5.4: OBJECT DETECTION USING YOLO

YOLO (You Only Look Once) is a technique/approach to do question discovery. It is the calculation/technique behind how the code will identify protests in the picture. It takes the whole picture in a solitary occurrence and predicts the bouncing box organizes and class probabilities for these cases. The greatest preferred standpoint of utilizing YOLO is its heavenly speed – it's staggeringly quick and can process 45 outlines for each second. YOLO likewise comprehends summed up item portrayal. This methodology is moderate and wasteful. YOLO adopts completely unique strategy.

- It takes a gander at the whole picture just once and experiences the system once and distinguishes objects. Consequently the name. It is quick. That is the reason it has so well known. There are other mainstream object location structures like Faster R-CNN and SSD that are likewise generally utilized. Since we have handle on why YOLO is such a valuable structure, how about we bounce into how it really functions. In this area, I have referenced the means pursued by YOLO for recognizing objects in a given picture.

1. YOLO first takes an input image

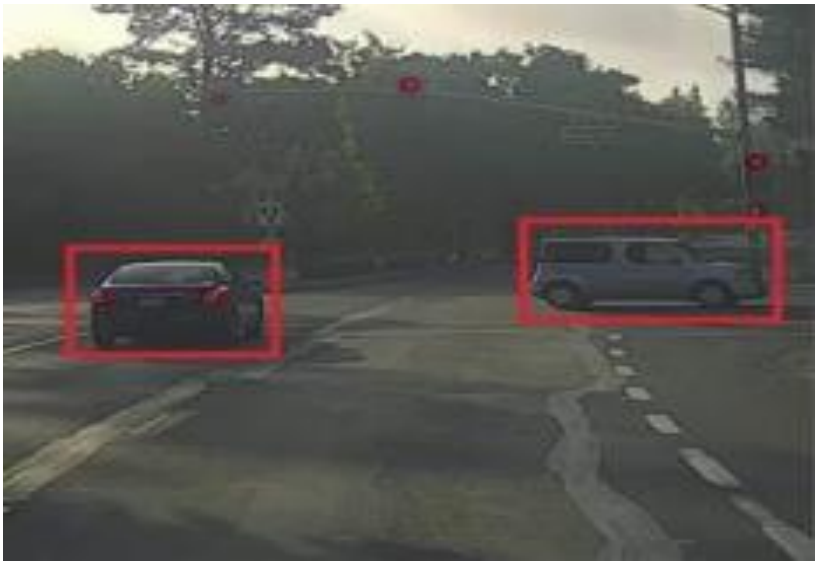


Figure 17: Input images

2.The framework then divides the input image into grids (say a 3 X 3 grid):

Figure 18: Processing image

3. Image classification and localization are applied on each grid. YOLO then predicts the bounding boxes and their corresponding class probabilities for objects.

-We send an info picture to a CNN which yields a 19 X 19 X 5 X 85 measurement volume. We channel through all the crates utilizing Non-Max Suppression, keep just the exact boxes, and furthermore dispense with covering boxes.

4. OpenCV is an open-source programming library which is created by Intel. OpenCV is utilized for an assortment of numerical calculations and is presently utilized by an expansive number of associations for different applications. The most essential motivation behind OpenCV is for PC vision applications. An interface for AI calculations is made with the assistance of OpenCV. A count which is communicated utilizing OpenCV, can be completed with next to zero changes at all for a wide scope of frameworks, including cell phones, for example, telephones and tablets, to substantial scale circulated frameworks of many machines.

Alongside item discovery in pictures, OpenCV additionally gives the innovation to question identification in recordings too. The OpenCV

structure is utilized over different systems because of the accompanying preferences:

• Easy organization.

• Better support for GPUs.

• High Level APIs.

• Easy to make changes

Figure 19: Object detection using YOLO

5.5: BASIC ARCHITECTURE

This segment characterizes the fundamental engineering and the progression of our proposed picture acknowledgment show. Consider the class following class chart. The accompanying advances are associated with the procedure:

5.5.1: Accept the picture

In this progression the client gives the picture which is utilized for the picture acknowledgment process.

5.5.2: Object Detection

Here the different articles in the picture are distinguished utilizing the Convolution Neural Network Which is applied using the OpenCV.

Figure 20: Object detection using YOLO-1

5.5.3: Object Detection API

5.5.3.1: Labeling

-In this progression the items which are distinguished in the above advance are named in like manner.

5.5.3.2: Display

This is the last advance where the perceived named questions in the picture given by the client is shown by means of a simple to utilize interface.

5.6: CONCLUSION AND FUTURE SCOPE

The paper concentrated on Convolutional Neural Networks, the fundamental structure of Convolutional Neural Network, object location dependent on YOLO and library utilized in executing this task. YOLO is executed with the assistance of the open-source OpenCV library utilizing CNN.

-CNN has a solid capacity in removing the highlights and has more points of interest over the traditional item discovery strategies. Despite the fact that we have made some amazing progress in the item location with assistance of picture dissecting field, there is still a ton of opportunity to get better the extent that exactness is concerned. We can forestall the loss of highlight data by improving the structure of CNN. The article acknowledgment innovation has an assortment of use, for example, recognizing the deformities in the mechanical production system, it can likewise be utilized for creating instructive and learning applications. We infer that the item acknowledgment field has a brilliant future ahead and trust that it keeps on creating with an expanded pace.

Chapter 6: Conclusion and Future Work

6.1: Overview

In this chapter we share and summarize our steps, results, knowledge, and experience while developing Smart stick for blind people.

6.2 Phases of the Project

Phase 1: Getting ready for the project by searching for the best idea to help many people as possible.
Phase 2: After finding the idea, we started searching to study the basic knowledge we need to learn
Phase 3: starts to search for the libraries and frameworks that will achieve the target of each feature.
Phase 4 For long time of working we build the feature their separately.
Phase 5: All the features were integrated to be working together with the core feature, the voice commands

6.3: Conclusion

Smart stick for blind people is built up for people who have problems in vision. The system's main purpose is to help blind people to live their live normally without needing help from anybody.

- We propose to design an intelligent device which vibrates on occurrence of obstacles based on distance between the person and the obstacle.

-It will not only vibrate but also will tell what the obstacle is, and it will also tell the direction that the person should go. "It gives them the confidence and allow them to integrate into society as equals.

- It has a small earphone connected to the stick to help the person to hear the voice.

-It has a sensitive sensor to give an alarm when it found fire.

6.4: Future work

Our goal is to blind Person can live without any help from the other people.

So we suggest:

1: Provide Arabic language support for both voice recognition.

2: Improve the performance and reduce response time of the device.

3: Add smart home commands by which user can control lights, air condition and other home appliances; so the home will be more controllable and cozy.

4. Add a GPS feature to the device to guide the user outside home.

References

1- Wang Zhiqiang and Liu Jun ”A Review of Object Detection Based on Convolutional Neural Network”,Proceedings of the 36th Chinese Control Conference July 26-28, 2017

2- Aiswarya S Kumar and Elizabeth Sherly ”A convolutional neural network for visual object recognition in marine sector”,2017 2 nd International Conference for Convergence in Technology (I2CT)

3- TianmeiGuo, Jiwen Dong ,HenjianLiYunxingGao ”Simple Convolutional Neural Network on Image Classification ”,2017 IEEE 2 nd International Conference on Big Data Analysis

4-https://tutorials-raspberrypi.com/raspberry-pi-ultrasonic-sensor-hc-sr04/

5-https://www.maxbotix.com/articles/how-ultrasonic-sensors-work.htm