

Real Time Face Mask Detection and Thermal Screening for Covid - 19

**Sathyabama Institute of Science and Technology
(Deemed to be University)**

Submitted in partial fulfilment of the requirements for the award of Bachelor
of Engineering Degree in Computer Science and Engineering

By

ROSHAN SAMUEL SATYA (REG.NO 38110467)

P.M. BALAJI (REG.NO 3811068)



**DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING SCHOOL
OF COMPUTING**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

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JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600119

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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 COMPUTER SCIENCE AND ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **ROSHAN SAMUEL SATYA**

(Reg. No: 38110467) who carried out the project entitled “ **Real Time Face Mask Detection and**

Thermal Screening for Covid – 19 ” under my supervision from June 2021 to November 2021 to **March 2022**

Internal Guide Name

Dr. J. Refonaa

Head of the Department
Dr. S. VIGNESHWARI

Submitted for Viva voce Examination held on _____

Internal Examiner

External Examiner

DECLARATION

Internal Examiner

External Examiner

DECLARATION

I, **ROSHAN SAMUEL SATYA**, hereby declare that the project report entitled “**Real Time Face Mask Detection and Thermal Screening for Covid – 19**” done by me under the guidance of **Dr. J.Refonaa** is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering Degree in Computer Science and Engineering.

DATE:

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SIGNATURE OF THE CANDIDATE

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ABSTRACT:

In this paper, we introduce an affordable “**Real Time Face Mask Detection and Thermal Screening for Covid – 19**” indoor and outdoor safety by covering several relevant aspects like mask detection etc., Mask detection check are performed by leveraging computer vision techniques on camera-equipped Raspberry Pi. It helps the organizations respect the COVID-19 safety rules and guidelines in order to reduce the disease spread. We decided to use other small devices due to their size and affordability which will detect the persons Temperature, Pulse and ensure whether he/she is vaccinated or not.

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CHAPTER 1

1. INTRODUCTION

1.1 COVID-19 DETECTION METHODS:

Since the end of 2019, infectious coronavirus disease (COVID-19) has been reported for the first time in Wuhan, and it has become a public damage fitness issue in China and even worldwide. The pandemic has devastating effects on societies and economies around the world causing a global health crisis. It is an emerging respiratory infectious disease caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). All over the world, especially in the third wave, COVID-19 has been a significant healthcare challenge. Many shutdowns in different industries have been caused by this pandemic. In addition, many sectors such as maintenance projects and infrastructure construction have not been suspended owing to their significant effect on people's routine life.

By now, the virus has rapidly spread to the majority of the countries worldwide. Last statistics (04/05/2021) provided by the World Health Organization (WHO) show 152,543,452 confirmed cases and 3,198,528 deaths. According to the Centers for Disease Control and Prevention (CDC), coronavirus infection is transmitted predominantly by respiratory droplets produced when people breathe, talk, cough, or sneeze with common droplet size 5–10 μm but, the aerosol emission increases when humans speak and shout loudly. Tomography (CT) and X-ray can lead to a more accurate detection of the COVID-19 and can help to control the problem of lack of specialized physicians in isolated villages. In this context, authors have suggested a novel convolutional neural network (AI)-based method for detecting COVID-19, with analyzing chest X-ray (CXR) images.

This method allows to detect patients with COVID- 19 at an accuracy of 91.34%. The authors introduced a new automatic COVID-19 detection model using CXR images. Model is called “Dark Covid Net.” For binary classes (COVID-19 VS no findings), the classification accuracy produced by this model is 98.08%, but, for multiclass cases (COVID-19 VS pneumonia VS no findings), the accuracy is 87.02%. Main objective is to use such models to diagnose supplementary chest-related diseases such as tuberculosis and pneumonia. For the COVID-19 case detection from X-ray images, a deep AI model is proposed in.

This model, denoted COVID-Net, is open source and accessible to the general public. The detection accuracy achieved by this model (93.3%) proves that the model makes good predictions in improved screening. Distinct deep learning techniques are introduced to differentiate CT scan images of both COVID-19 and non-COVID-19. From the different techniques, we list a self-developed model (CTnet-10), VGG-16, ResNet-50, InceptionV3, VGG-19, and DenseNet-169, which have, respectively, accuracy values of about 82.1%, 89%, 60%, 53.4%, 94.52%, and 93.15%. The accuracy of VGG-19 is the highest one as compared to other models. The Ctnet-10 method is a well-organized model, which is useful for doctors, especially in mass screening.

1.2 COVID-19 DETECTION MODELS:

In, two deep learning models as suggested: AI and a convolutional long short-term memory (ConvLSTM), two datasets are assumed to simulate them. A dataset includes CT images, and the other includes X-ray images. The models are tested four times. When they are examined on CT images, the dataset is split into 70% for the training set and 30% testing set. The accuracy value for the AI model and for the ConvLSTM is the same, equal to 99%. When tested on the augmented dataset A, the testing accuracy of the AI is 99%, but it is 100% for the ConvLSTM. When tested on the augmented dataset B, the testing accuracy of the AI is 100%, but it is 99% for the ConvLSTM. When both models are tested on the combined dataset, containing both X-ray and CT images, the testing accuracy is 99% for the AI and 98% for the ConvLSTM. Finally, when they are tested on the radiography dataset, the testing accuracy is 95% and 88% for the AI and the ConvLSTM, respectively.

We can consider this scenario as a challenging one, because it is called to distinguish between two diseases (COVID-19 and pneumonia) with a high closeness in features. Before coronavirus, some people put masks to protect themselves from air pollution, while other people put face masks to hide their faces and their emotions from others. Protection against coronavirus is a mandatory counter measure, according to The WHO. Indeed, wearing a mask is an effective method of blocking 80% of all respiratory infections. Also, the WHO recommends practicing physical distancing to mitigate the spread of the virus. All over the world, governments are struggling against this type of virus. Many organizations enforce face mask rules for the personal protection. Checking manually if individuals entering an organisation are wearing masks is cumbersome and possibly conflicting.

In this context, authors in proposed a deep learning-based model, named MobileNet Mask, to prevent human-to-human transmissions of the SARS-CoV-2 and detect faces with or without mask. Two different datasets (IDS1 and IDS2) with over 5200 images are used to train and test the model. All the experimental cases are controlled on Google Colab that runs in the

cloud. In IDS1, the proposed model achieved a testing accuracy of 93%. However, in IDS2, the accuracy achieved is almost 100%.

(3)

The authors aim to detect and delimit medical face masks in real images. The proposed model is composed of YOLO-V2 and ResNet-50. In the training phase, the authors used two optimizers which are Adam and SGDM. During this process, SGDM is better than Adam on validation root mean square error (RMSE), time, and validation loss. However, Adam is better than SGDM in loss and mini batch RMSE. The average precision (AP) of the Adam optimizer is 0.81, which is better than the AP of SGDM that is equal to 0.61. Moreover, the log-average miss rates of the Adam optimizer are 0.4, which are better than the log-average miss rates of the SGDM optimizer (0.6), in all the recall levels. From these studies, we found out that a system which triggers an alarm in the operating room when the healthcare personnel do not wear face masks is ideal. The system combines two detectors-one for the face and the other for the mask. In the testing phase, by utilizing images from the BAO dataset and from an own image dataset, above 95% of true positive and below 5% of false positive rates were achieved. Authors proposed a hybrid model utilizing deep learning with classical machine learning to detect masked faces.

The proposed model consists of two components: the feature extraction applying ResNet-50 and the classification process. The three classifiers used are the decision trees (DTs), support vector machine (SVM), and ensemble algorithm. Real-World Masked Face Dataset (RMFD), the Simulated Masked Face Dataset (SMFD), and the Labeled Faces in the Wild (LFW) are the three face masked datasets, selected for examination. The SVM classifier is greater than the other classifiers. It reached 99.64%, 99.46%, and 100% of testing accuracy, respectively, in RMFD, SMFD, and LFW.

In summary and without forgetting the legal side of AI, the deep learning technique inherently touches upon a full spectrum of legal fields, from legal philosophy, human rights, contract law, tort law, labor law, criminal law, tax law, procedural law, etc. While in practice, AI is just

beginning to come into its own in terms of its use by lawyers, and within the legal industry, legal scholars have been occupied with AI for a long time.

(4)

Furthermore, as collecting and analyzing data is progressively spreading from software companies to manufacturing companies, which have started to exploit the possibilities arising from collection and exploitation of potential data, so that added value can be created, this information deluge unlocks various legal concerns that could stimulate a regulatory backlash. Considering AI legal concerns and benefits in combating COVID-19 pandemic, AI technique-based solutions are still an open window for development and legal interpretation.

CHAPTER 2

2. AIM AND SCOPE OF THE PRESENT INVESTIGATION

2.1 AIM OF THE PROJECT:

- To build our own **face mask detection model using Raspberry Pi**. This project consists of three phases:
 - Data Gathering
 - Training the model
 - Face Mask Detection
- In the first phase, we will collect the images with and without the mask. This dataset consists of 500 images belonging to two classes.
- In the second phase, we will train the Recognizer for detecting people with and without masks, and in the last phase, we will use the trainer data to classify each face as with a mask or without a mask.

2.2 EXISTING SYSTEM

- This paper describes mask detection using Matlab when complex images are in the dataset. Matlab specified the Faster R-CNN algorithm and Dataset allotment for mask detection.

- This paper manages complex pictures using facial recognition packages. The Faster R-CNN methodology is used in the security system and in the medical system. The proposed work balanced face restriction, color changes, brightness changes, and contrast changes.
- Segmentation and feature extraction are used in face restriction of the person image. We chose RAI, Fast RAI, and Faster RAI algorithm for detecting Mask detection and Social distance.
- Regions with Convolutional neural network are based on Mixing pictures, pixel prediction, and specific enhancements.

(6)

2.3 BENEFIT OF PROPOSED SYSTEM

- The system consists of web camera and Raspberry Pi 4. The number of cameras depends on the size of the workspace.
- The algorithm below consists of several main steps: detection, perspective transformation, measurement and sending e-mail.
- It is Effective.
- It is of Low cost.
- Automatic character recognition.

Related Works

Deep learning is an important breakthrough in the AI field. It has recently shown enormous potential for extracting tiny features in image analysis. Due to the COVID-19 epidemic, some deep learning approaches have been proposed to detect patients infected with coronavirus. In this context, and unlike bacterial pneumonia, many other types of lung infections caused by viruses are called viral pneumonia. These viruses, such as the

COVID-19, infect the lungs by blocking the oxygen flow, which can be life-threatening. This motivated researchers, to develop many frameworks and schemes based on AI tools in the fight against this dangerous virus. Hence, we divide this section into two sections to provide an in-depth overview of the proposed techniques.

(7)

3. EXPERIMENTAL MATERIALS AND METHODS, ALGORITHMS USED

3.1 Artificial Intelligence

We can all agree that Artificial Intelligence has created a huge impact on the world's economy and will continue to do so since we're aiding its growth by producing an immeasurable amount of data. Thanks to the advancement in Artificial Intelligence Algorithms to deal with such humungous data.

What Is Artificial Intelligence?

To simply put it, Artificial Intelligence is the science of getting machines to think and make decisions like human beings do.

Since the development of complex Artificial Intelligence Algorithms, it has been able to accomplish this by creating machines and robots that are applied in a wide range of fields including agriculture, healthcare, robotics, marketing, business analytics and many more.

Before we move any further let's try to understand what Machine Learning is and how it is related to AI.

What Is Machine Learning?

Generally, an algorithm takes some input and uses mathematics and logic to produce the output. In stark contrast, an Artificial Intelligence Algorithm takes a combination of both – inputs and outputs simultaneously in order to “learn” the data and produce outputs when given new inputs.

(8)

This process of making machines learn from data is what we call Machine Learning.

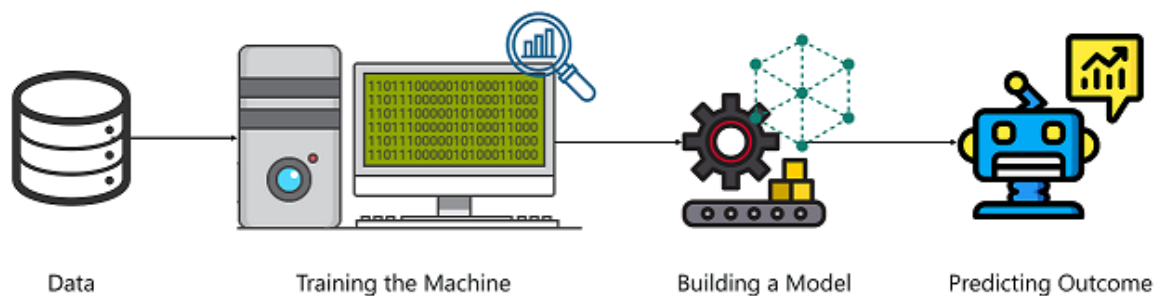


Fig 3.1 Diagram of the process of Machine Learning

Machine Learning is a sub-field of Artificial Intelligence, where we try to bring AI into the equation by learning the input data.

Machines can follow different approaches to learn, depending on the data set and the problem that is being solved.

Types of Machine Learning

Machine Learning can be done in the following ways:

- Supervised Learning
- Unsupervised Learning
- Reinforcement Learning
- Ensemble Learning

Let's briefly understand the idea behind each type of Machine Learning.

What Is Supervised Learning?

In **Supervised Learning**, as the name rightly suggests, it involves making the algorithm learn the data while providing the correct answers or the labels to the data. This essentially means that the classes or the values to be predicted are known and well defined for the algorithm from the very beginning.

(9)

What Is Unsupervised Learning?

The other class falls under **Unsupervised Learning**, where, unlike supervised methods the algorithm doesn't have correct answers or any answers at all, it is up to the algorithms discretion to bring together similar data and understand it.

What Is Reinforcement Learning?

Along with these two prominent classes, we also have a third class, called **Reinforcement Learning**. Just as children are generally “reinforced” certain ideas, principles by either rewarding them when doing the right thing or punishing upon doing something wrong, in Reinforcement Learning, there are rewards given to the algorithm upon every correct prediction thus driving the accuracy higher up.

What Is Ensemble Learning?

While the above three classes cover most fields comprehensively, we sometimes still land into the issue of having to bump up the performance of our model. In such cases it might make sense, to use **ensemble methods** (explained later) to get the accuracy higher up.

Now let’s understand how Artificial Intelligence algorithms can be used to solve different types of problems.

(11)

3.2 Types of Problems Solved Using Artificial Intelligence Algorithms:

Algorithms in each category, in essence, perform the same task of predicting outputs given unknown inputs, however, here data is the key driver when it comes to picking the right algorithm.

What follows is an outline of categories of Machine Learning problems with a brief overview of the same:

- Classification
- Regression
- Clustering

Here’s a table that effectively differentiates each of these categories of problems.

Regression	Classification	Clustering
• Supervised Learning • Output is a continuous quantity • Main aim is to forecast or predict • Eg: Predict stock market price • Algorithm: Linear Regression	• Supervised Learning • Output is a categorical quantity • Main aim is to compute the category of the data • Eg: Classify emails as spam or non-spam • Algorithm: Logistic Regression	• Unsupervised Learning • Assigns data points into clusters • Main aim is to group similar items clusters • Eg: Find all transactions which are fraudulent in nature • Algorithm: K-means

Table 3.1 (Categories of Problems)

For each category of tasks, we can use specific algorithms. In the below section we will understand how a category of algorithms can be used as a solution to complex problems.

Artificial Intelligence Algorithms

As mentioned above, different Artificial Intelligence algorithms can be used to solve a category of problems. Below we'll see the different types of algorithms that fall under Classification, Regression and Clustering problems.

Classification Algorithms

Classification, as the name suggests is the act of dividing the dependent variable (the one we try to predict) into classes and then predict a class for a given input. It falls into the category of Supervised Machine Learning, where the data set needs to have the classes, to begin with. Thus, classification comes into play at any place where we need to predict an outcome, from a set number of fixed, predefined outcomes.

Classification uses an array of algorithms, a few of them listed below

1. Naive Bayes
2. Decision Tree
3. Random Forest
4. Logistic Regression
5. Support Vector Machines
6. K Nearest Neighbors

Let us break them down and see where they fit in when it comes to application.

Naive Bayes

Naive Bayes algorithm follows the Bayes theorem, which unlike all the other algorithms in this list, follows a probabilistic approach. This essentially means, that instead of jumping straight into the data, the algorithm has a set of prior probabilities set for each of the classes for your target.

Once you feed in the data, the algorithm updates these prior probabilities to form something known as the posterior probability. Hence this can be extremely useful in cases where you need to predict whether your input belongs to either a given list of n classes or does it not belong to any of them. This can be made possible by using a probabilistic approach mainly because the probabilities thrown for all the n classes will be quite low.

Let us try to understand this with an example, of a person playing golf, depending on factors like the weather outside.

- We first try to generate the frequencies with which certain events occur, in this case, we try to find frequencies of the person playing golf -if it's sunny, rainy, etc., outside.
- Using these frequencies we generate our apriori or initial probabilities (eg, the probability of overcast is 0.29 while the general probability of playing is 0.64)

Next up, we generate the posterior probabilities, where we try to answer questions like “what would be the probability of it being sunny outside and the person would play golf?”

We use the Bayesian formula here,

$$P(\text{Yes} \mid \text{Sunny}) = P(\text{Sunny} \mid \text{Yes}) * P(\text{Yes}) / P(\text{Sunny})$$

$$\text{Here we have } P(\text{Sunny} \mid \text{Yes}) = 3/9 = 0.33, P(\text{Sunny}) = 5/14 = 0.36, P(\text{Yes}) = 9/14 = 0.64$$

Decision Tree

The Decision Tree can essentially be summarized as a flowchart-like tree structure where each external node denotes a test on an attribute and each branch represents the outcome of that test. The leaf nodes contain the actual predicted labels. We start from the root of the tree and keep comparing attribute values until we reach a leaf node.

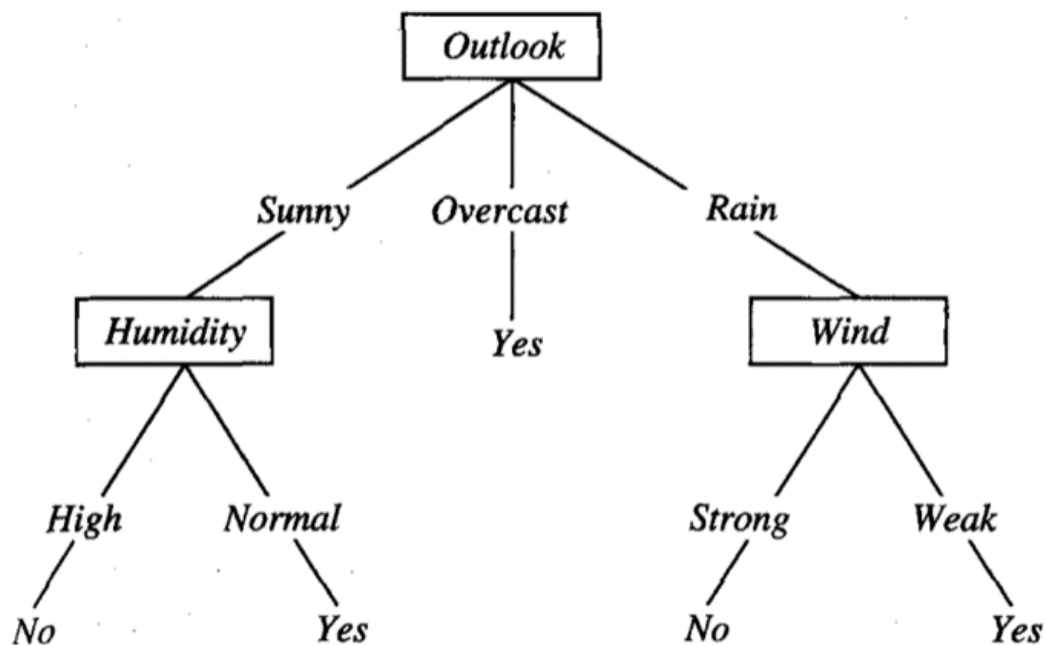


Fig 3.2 Decision Trees – Artificial Intelligence Algorithms

Random Forest

Think of this as a committee of Decision Trees, where each decision tree has been fed a subset of the attributes of data and predicts on the basis of that subset. The average of the votes of all decision trees are taken into account and the answer is given.

(15)

An advantage of using Random Forest is that it alleviates the problem of overfitting which was present in a standalone decision tree, leading to a much more robust and accurate classifier.

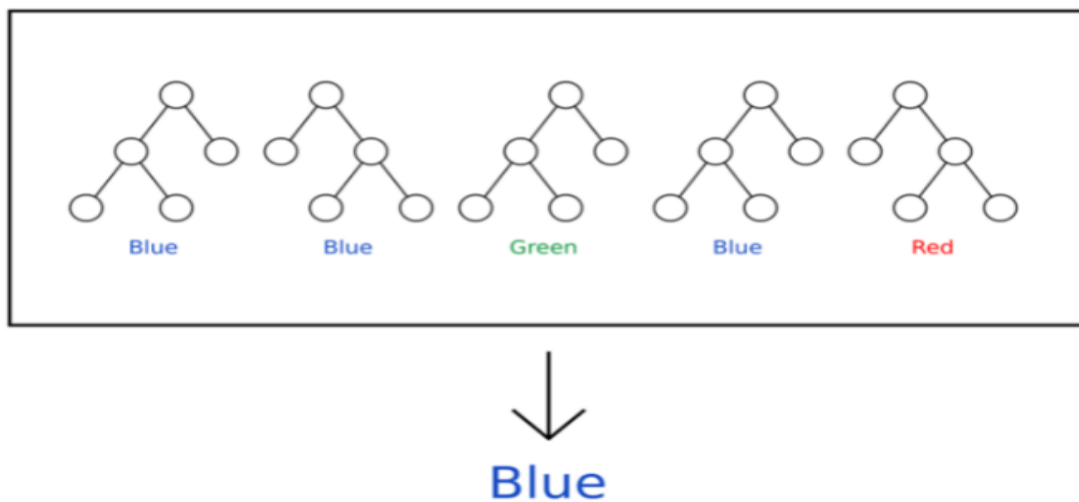


Fig 3.3 Random Forest – Artificial Intelligence Algorithms

As we can see in the above image, we have 5 decision trees trying to classify a color. Here 3 of these 5 decision trees predict blue and two have different outputs, namely green and red. In this case, we take the average of all the outputs, which gives blue as the highest weightage.

Logistic Regression

It's a go-to method mainly for binary classification tasks. The term 'logistic' comes from the legit function that is used in this method of classification. The logistic function, also called as

the sigmoid function is an S-shaped curve that can take any real-valued number and map it between 0 and 1 but never exactly at those limits.

(16)

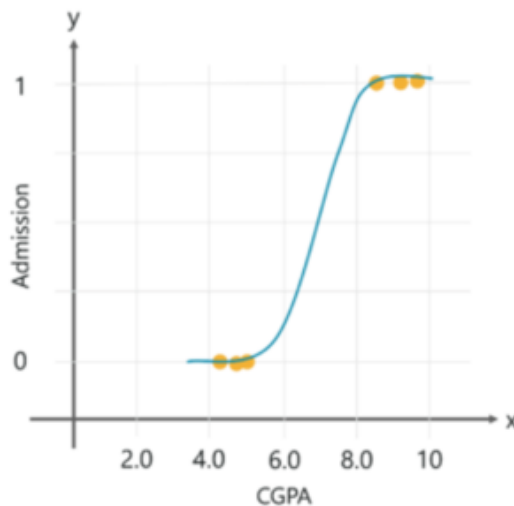


Fig 3.4 Logistic Regression – Artificial Intelligence Algorithms

Let's assume that your little brother is trying to get into grad school, and you want to predict whether he'll get admitted in his dream establishment. So, based on his CGPA and the past data, you can use Logistic Regression to foresee the outcome.

Logistic Regression allows you to analyze a set of variables and predict a categorical outcome. Since here we need to predict whether he will get into the school or not, which is a classification problem, logistic regression would be ideal.

Logistic Regression is used to predict house values, customer lifetime value in the insurance sector, etc.

Support Vector Machine

An SVM is unique, in the sense that it tries to sort the data with the margins between two classes as far apart as possible. This is called maximum margin separation.

(17)

Another thing to take note of here is the fact that SVM's take into account only the support vectors while plotting the hyper plane, unlike linear regression which uses the entire dataset for that purpose. This makes SVM's quite useful in situations when data is in high dimensions.

Let's try to understand this with an example. In the below figure we have to classify data points into two different classes (squares and triangles).

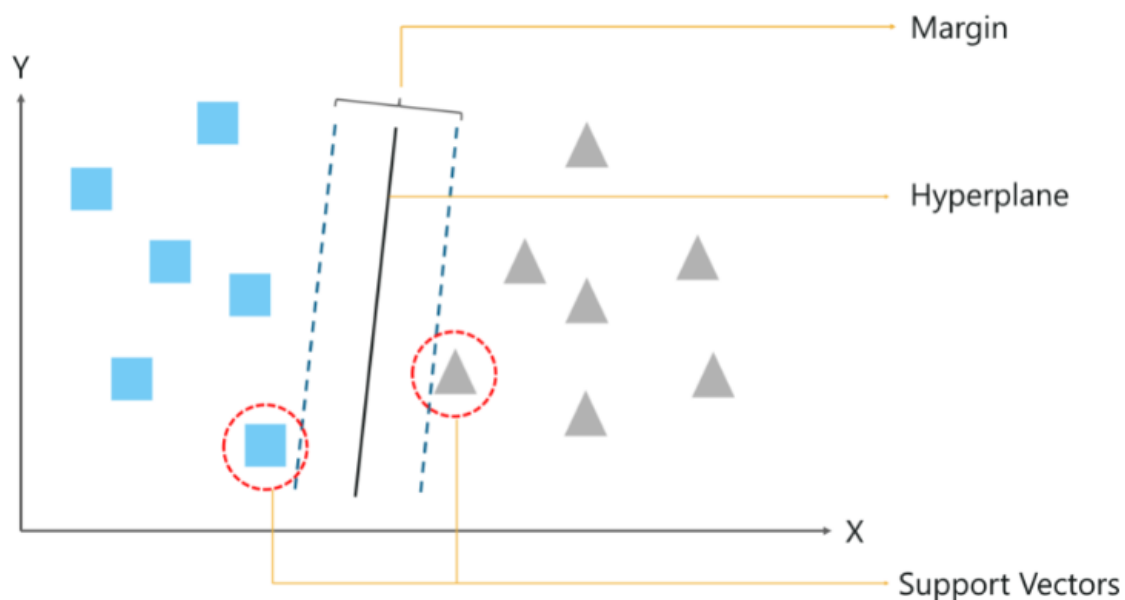


Fig 3.5 Support Vector Machine – Artificial Intelligence Algorithms

So, you start off by drawing a random hyperplane and then you check the distance between the hyperplane and the closest data points from each class. These closest data points to the hyperplane are known as **Support vectors**. And that's where the name comes from, Support Vector Machine.

The hyper plane is drawn based on these support vectors and an optimum hyper plane will have a maximum distance from each of the support vectors. And this distance between the hyper plane and the support vectors is known as the **margin**.

(18)

To sum it up, SVM is used to classify data by using a hyper plane, such that the distance between the hyper plane and the support vectors is maximum.

K Nearest Neighbors

KNN is a non-parametric (here non-parametric is just a fancy term which essentially means that KNN does not make any assumptions on the underlying data distribution), lazy learning algorithm (here lazy means that the “training” phase is fairly short).

Its purpose is to use a whole bunch of data points separated into several classes to predict the classification of a new sample point.

The following points serve as an overview of the general working of the algorithm:

- A positive integer N is specified, along with a new sample
- We select the N entries in our database which are closest to the new sample
- We find the most common classification of these entries
- This is the classification we give to the new sample

However, there are some downsides to using KNN. These downsides mainly revolve around the fact that KNN works on storing the entire dataset and comparing new points to existing

ones. This means that the storage space increases as our training set increases. This also means that the estimation time increases in proportion to the number of training points.

Now let's understand how regression problems can be solved by using regression algorithm

Regression Algorithms

In the case of regression problems, the output is a continuous quantity. Meaning that we can use regression algorithms in cases where the target variable is a continuous variable. It falls into the category of Supervised Machine Learning, where the data set needs to have the labels, to begin with.

(19)

Linear Regression

Linear Regression is the most simple and effective regression algorithm. It is utilized to gauge genuine qualities (cost of houses, number of calls, all out deals and so forth.) in view of the consistent variable(s). Here, we build up a connection between free and ward factors by fitting the best line. This best fit line is known as regression line and spoken to by a direct condition $Y = a * X + b$.

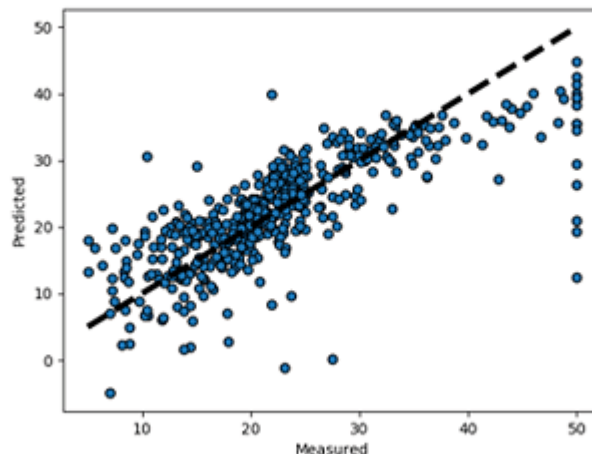


Fig 3.6 Linear Regression – Artificial Intelligence Algorithms

Let us take a simple example here to understand linear regression.

Consider that you are given the challenge to estimate an unknown person's weight by just looking at them. With no other values in hand, this might look like a fairly difficult task, however using your past experience you know that generally speaking the taller someone is, the heavier they are compared to a shorter person of the same build. This is linear regression, in actuality!

However, linear regression is best used in approaches involving a low number of dimensions. Also, not every problem is linearly separable. Some of the most popular applications of Linear regression are in financial portfolio prediction, salary forecasting, real estate predictions and in traffic in arriving at ETAs

(20)

Now let's discuss how clustering problems can be solved by using the K-means algorithm. Before that, let's understand what clustering is.

Clustering Algorithms

The basic idea behind clustering is to assign the input into two or more clusters based on feature similarity. It falls into the category of Unsupervised Machine Learning, where the algorithm learns the patterns and useful insights from data without any guidance (labeled data set).

For example, clustering viewers into similar groups based on their interests, age, geography, etc., can be done by using Unsupervised Learning algorithms like K-Means Clustering.

K-Means Clustering

K-means is probably the simplest unsupervised learning approach. The idea here is to gather similar data points together and bind them together in the form of a cluster. It does this by calculating the centroid of the group of data points.

To carry out effective clustering, k-means evaluates the distance between each point from the centroid of the cluster. Depending on the distance between the data point and the centroid, the data is assigned to the closest cluster. The goal of clustering is to determine the intrinsic grouping in a set of unlabelled data.

(21)

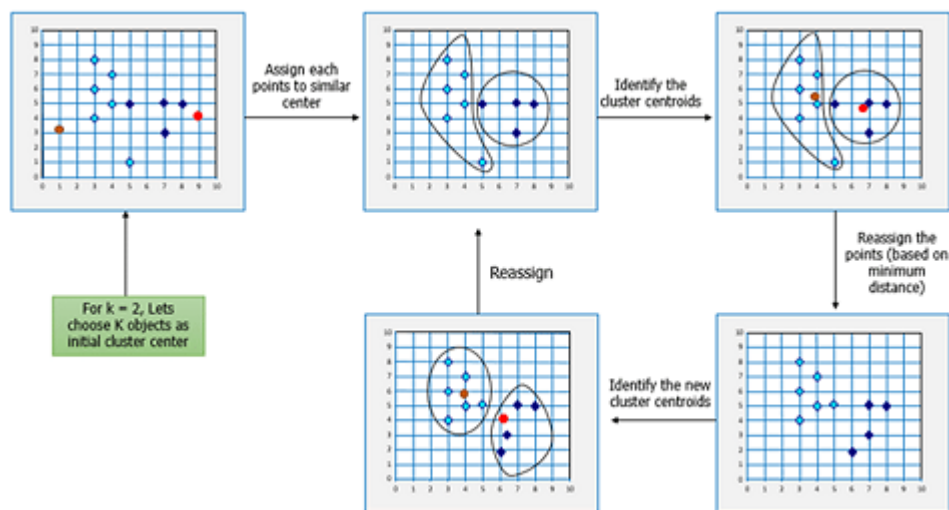


Fig 3.7 K-means – Artificial Intelligence Algorithms

The 'K' in K-means stands for the number of clusters formed. The number of clusters (basically the number of classes in which your new instances of data can fall into) is determined by the user.

K-means is used majorly in cases where the data set has points which are distinct and well separated from each other, otherwise, the clusters won't be far apart, rendering them inaccurate. Also, K-means should be avoided in cases where the data set contains a high amount of outliers or the data set is non-linear.

Ensemble Learning Algorithms

In cases where data is of abundance and prediction precision is of high value, boosting algorithms come into the picture.

Consider the scenario, a decision tree trained on a data set along with a whole bunch of hyperparameter tuning already performed, however, the final accuracy is still slightly off. In this case, while it might seem that you have run out of possible things to try, ensemble learning comes to the rescue.

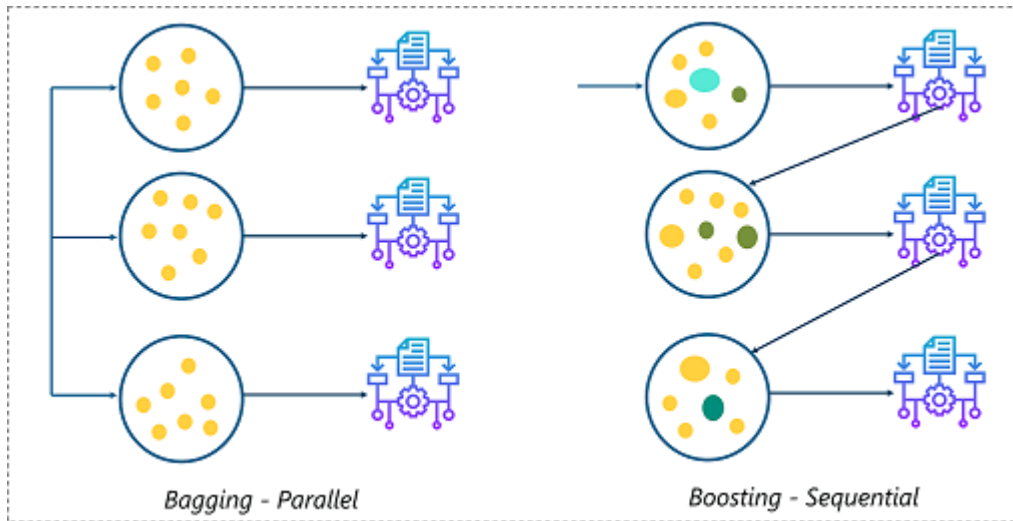


Fig 3.7 Ensemble Learning – Artificial Intelligence Algorithms

We have two different ways in which you can use ensemble learning, in this case, to bump up your accuracy. Let us say the decision tree was failing on a set of input test values, then have to train a new decision tree model and give a higher weighting to those input test values that the previous model struggled with. This is also called as Boosting, where our initial tree can be formally stated as a weak learner, and the mistakes caused by that model pave way for a better and stronger model.

Another way to approach this is by simply training a whole bunch of trees at once (this can be done fairly quickly and in a parallel fashion) and then taking outputs from each tree and averaging them out. So this way, if after training 10 trees, let's say 6 trees reply positive to input and 4 trees reply negative, the output considered is positive. This is formally known as Bagging.

They are used to reduce the bias and variance in supervised learning techniques. There are a host of boosting algorithms available, a few of them discussed below:

Gradient Boosting

Gradient Boosting is a boosting algorithm used when we deal with plenty of data to make a prediction with high prediction power. It combines multiple weak or average predictors to build strong predictor. These boosting algorithms are heavily used to refine the models in data science competitions.

Here, we consider an “optimal” or best model, so essentially our model is at some distance from that “optimal” model. What we now do is, use gradient mathematics and try to get our model closer to the optimal space.

XGBoost

Pertaining to its extremely high predictive power, XGBoost is one of the go-to algorithms when it comes to increasing accuracy as it contains both linear & tree learning algorithms making it 10 times faster than most boosting techniques.

It is the holy grail algorithm when it comes to hackathons, it is no wonder CERN used it in the model for classification of signals from the Large Hadron Collider.

3.3 PROPOSED SYSTEM

Therefore, this research paper focuses on implementing a Face Mask Detection model as an embedded vision system. The pretrained models such as the MobileNet, ResNet Classifier, and VGG are used in our context. People violating wearing masks were detected. After implementing and deploying the models, the selected one achieved a confidence score of 100%. This paper also provides a comparative study of different face detection and face mask classification models. The system performance is evaluated in terms of precision, recall, F1-score, support, sensitivity, specificity, and accuracy that demonstrate the practical applicability. The system performs with F1-score of 99%, sensitivity of 99%, specificity of 99%, and an accuracy of 100%. Hence, this solution tracks the people with or without masks in a real-time scenario by generating an alarm if there is a violation in the scene or in public places. This can be used with the existing embedded camera infrastructure to enable these analytics which can be applied to various verticals, as well as in an office building or at airport terminals/gates.

3.3 BLOCK DIAGRAM:

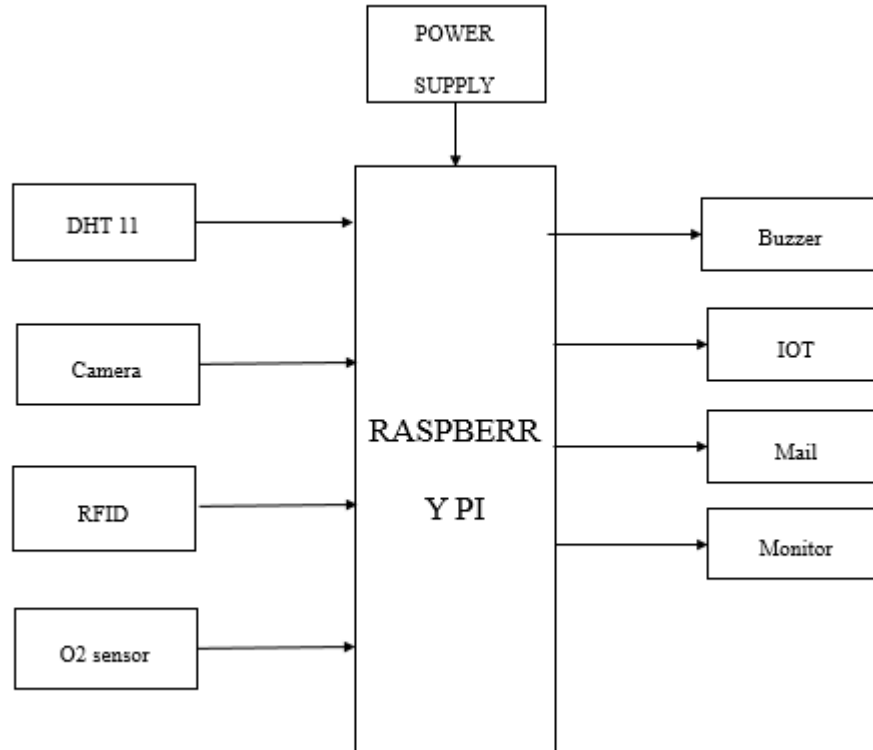


Fig 3.8. Block Diagram

Hardware

- Raspberry Pi
- Web Camera
- DHT 11
- RFID
- O2 sensor

Software

- Raspian OS
- Python
- Open CV

CHAPTER 4

HARDWARE DESCRIPTION

4.1 RASPBERRY PI

4.1 Overview

Raspberry Pi seems to be new in the world and many people really don't know what the Raspberry Pi is. Raspberry Pi can be defined as 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's capable of doing 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. It is great bonding with Arduino and can do a lot with Arduino.

4.2 Exploring the Raspberry Pi Board

There are two models of Raspberry Pi, model A and model B. These two are bit similar with few advance features on model B compared to model A. Model B has 512 MB RAM, two USB port where as Model A has 256 MB RAM and just a USB port. Besides, Model B has Ethernet port while Model A does not.

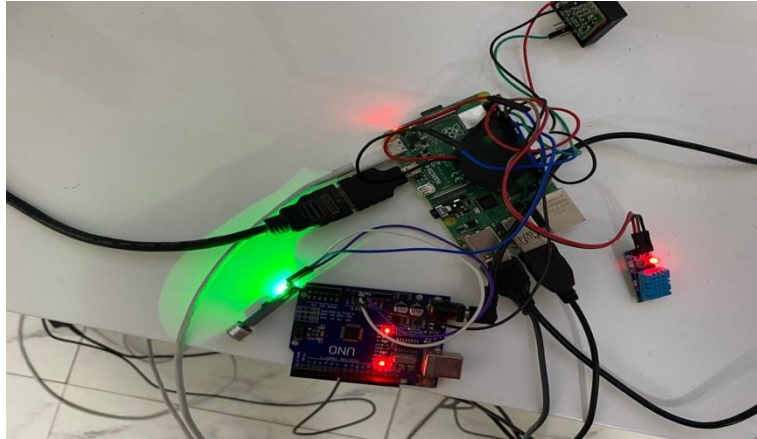


Figure 5-1: Raspberry Pi Model B

Different components of the Pi are named in the Figure 5-1 and brief description on each component is given in following sections.

4.2.1 SD Card Slot

Raspberry Pi doesn't have the real hard drive as in laptop and computer, SD card is taken as solid state drive (SSD) which is used to install operating system and all others software and store everything. This card is needed to insert into the slot for using the Raspberry Pi. SD card may be 2GB, 4GB or 16GB.

4.2.2 Micro USB Power

The power port is a 5V micro-USB input and supply should be exactly 5v as it doesn't have onboard power regulator. So, power supply shouldn't exceed than 5V.

4.2.3 HDMI Out

This output port is used to connect the Raspberry Pi with a monitor via HDMI (High Definition Multimedia Interface). Hence, any screen or TV can be connected to it which consists of HDMI port.

4.2.4 Ethernet and USB port

Both the Ethernet port and USB port on Model B are supplied via the onboard LAN9512 chip. It is a high-speed USB 2.0 hub with a 10/100 Ethernet controller (Donat, 2014). USB ports are used to connect the inputs (keyboard, mouse). Almost everything that can connect to computer via USB also can connect with Raspberry Pi.

4.2.5 RCA Video Out and Audio Out

Audio and RCA video jacks are present on the board for audio and video out.

The Raspberry Pi does support sound over its HDMI output, but there is a standard 3.5-mm audio jack to plug in headphones but USM mikes may work or not.

For video, the RCA jack sends video to any connected RCA video device.

4.2.6 GPIO Headers(Pins)

GPIO pins stands for general purpose of input output pins. These pins are used to connect any number of physical extensions with the Raspberry Pi. Raspberry Pi has pre-installed libraries that allow us to access the pins using programming languages like C, C++ or python

4.2.7 Chips (Broadcom)

The most important component in a Raspberry Pi is chip that is Broadcom which is placed at the middle of the board. The chip consists of ARM11 processor running at 700 MHz and a Videocore4 GPU and can be over clocked to at least 800 MHz without a problem.

4.3 Raspberry Pi 2 Model B

Recently, Raspberry Pi 2 Model B has been launched recently which Broadcom BCM2836 ARM Cortex-A7 Quad Core Processor has powered Single Board Computer running at

900MHz, 1GB RAM and 4 Quad USB ports. It is the advanced version of Model B and is 6 times faster than Model B Raspberry Pi. In addition, it has combined 4-pole jack for connecting your stereo audio out and composite video out and advanced power management.

Figure 5-2 shows the top view of the board with labels of some important



Figure 5-2: Raspberry Pi 2 Model B components

4.4 Hardware Required for Raspberry Pi

Raspberry Pi can't start alone, it needs many others peripherals (hardware). There is brief description of the hardware requirements.

4.4.1 Power Supply

As mentioned already in above theory portion, Raspberry Pi needs 5V power supply. If supply exceeds 5V then it can't guaranteed to work properly. And the power supply also need to supply at least 500 milliamps (mA), and preferably more like 1 amp (A). If the supply is 500 mA or less, it is likely to have the mal-function of keyboard and mouse. It is not good idea to power the Raspberry Pi from USB port of computer and hub as they mostly provide current less than required. Hence, the Raspberry Pi requires a Micro-USB connection which is capable of supplying at least 700 mA (or 0.7 A) at 5V.

4.4.2 Storage

A separate hardware is required for the storage purpose in Raspberry Pi. For this, SD card is used, mostly 4 GB and 8 GB if needed. The operating system and all files are stored in the card. We can buy blank SD card and install operating system or buy a pre-installed one.

4.4.3 Input

External keyboard and mouse are required to provide input to the Raspberry Pi. No any additional software is needed to use the keyboard and mouse.

4.4.4 Monitor

We can use monitor or TV with HDMI port or DVI inputs as the screen for the Raspberry Pi. For DVI inputs, HDMI-to-DVI converters are required which can be finding easily in a market. Monitor is most important for the Raspberry Pi as it is the only way to see what we have done on it.

4.4.5 Network

As in laptop or computer, we can access to internet and network in Raspberry Pi as well. For that, we can use wired Ethernet connection which is easier option or Wi-Fi module to access Wi-Fi in the Raspberry Pi.

4.5 Power supply unit

A power supply (sometimes known as a power supply unit or PSU) is a device or system that supplies electrical or other types of energy to an output load or group of loads. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others.

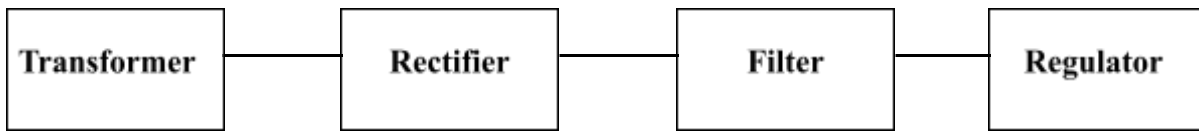
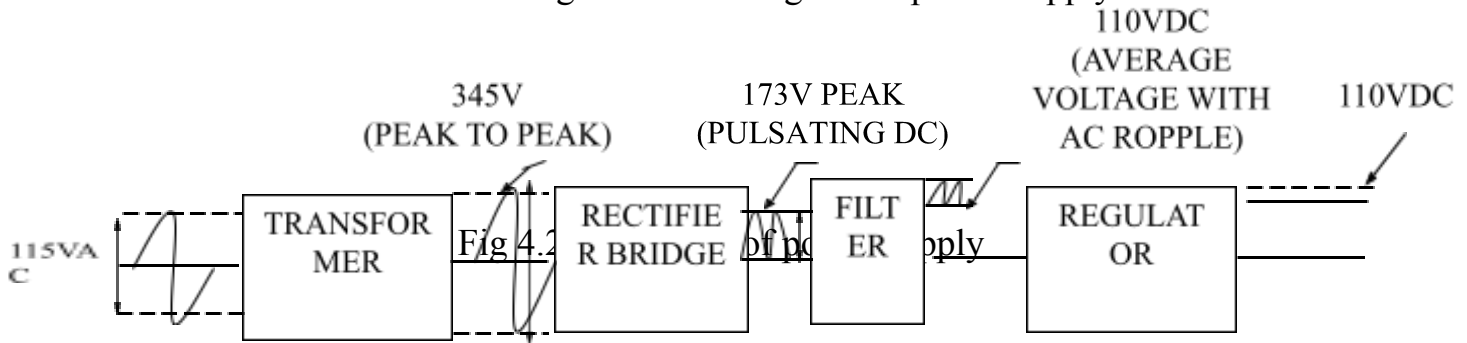


Fig 4.1 Block diagram of power supply



The transformer steps up or steps down the input line voltage and isolates the power supply from the power line. The RECTIFIER section converts the alternating current input signal to a pulsating direct current. However, as you proceed in this chapter you will learn that pulsating dc is not desirable. For this reason a FILTER section is used to convert pulsating dc to a purer, more desirable form of dc voltage.

The final section, the REGULATOR, does just what the name implies. It maintains the output of the power supply at a constant level in spite of large changes in load current or input line voltages. Now that you know what each section does, let's trace an ac signal through the power supply. At this point we need to see how this signal is altered within each section of the power supply. Later on in the chapter we will see how these changes take place. An input signal of 115 volts ac is applied to the primary of the transformer.

The transformer is a step-up transformer with a turns ratio of 1:3. We can calculate the output for this transformer by multiplying the input voltage by the ratio of turns in the primary to the ratio of turns in the secondary; therefore, 115 volts ac $\times 3 = 345$ volts ac (peak-to-peak) at the output. Because each diode in the rectifier section conducts for 180 degrees of the 360-degree input, the output of the rectifier will be one-half, or approximately 173 volts of pulsating dc. The filter section, a network of resistors, capacitors, or inductors, controls the rise and fall time of the varying signal; consequently, the signal remains at a more constant dc level. We will see the filter process more clearly in the discussion of the actual filter circuits. The output of the filter is a signal of 110 volts dc, with ac ripple riding on the dc. The reason for the lower voltage (average voltage) will be explained later in this chapter. The regulator maintains its output at a constant 110-volt dc level, which is used by the electronic equipment (more commonly called the load).

4.5.1 Simple 5V power supply for digital circuits

- Brief description of operation: Gives out well-regulated +5V output, output current capability of 100 mA
- Circuit protection: Built-in overheating protection shuts down output when regulator IC gets too hot
- Circuit complexity: Very simple and easy to build
- Circuit performance: Very stable +5V output voltage, reliable operation
- Availability of components: Easy to get, uses only very common basic components

- Design testing: Based on datasheet example circuit used successfully as part of many electronics projects
- Applications: Part of electronics devices, small laboratory power supply
- Power supply voltage: Unregulated DC 8-18V power supply
- Power supply current: Needed output current + 5 mA
- Component costs: Few dollars for the electronics components + the input transformer cost

4.6 WEBCAM:-

A **webcam** is a video camera which feeds its images in real time to a computer or computer network, often via USB, Ethernet or Wi-Fi. Their most popular use is the establishment of video links, permitting computers to act as videophones or videoconference stations. This common use as a video camera for the World Wide Web gave the webcam its name. Other popular uses include security surveillance and computer vision. Webcams are known for their low manufacturing cost and flexibility, making them the lowest cost form of video telephony. They have also become a source of security and privacy issues, as some built-in webcams can be remotely activated via spyware.

4.6.1 LENS

Webcams typically include a lens, an image sensor, support electronics, and may also include a microphone for sound. Various lenses are available, the most common in consumer-grade webcams being a plastic lens that can be screwed in and out to focus the camera. Fixed focus lenses, which have no provision for adjustment, are also available. As a camera system's depth of field is greater for small image formats and is greater for lenses with a large f-number (small aperture), the systems used in webcams have a sufficiently large depth of field that the use of a fixed focus lens does not impact image sharpness to a great extent.

Image sensors can be CMOS or CCD, the former being dominant for low-cost cameras, but CCD cameras do not necessarily outperform CMOS-based cameras in the low cost price

range. Most consumer webcams are capable of providing VGA resolution video at a frame rate of 30 frames per second. Many newer devices can produce video in multi-megapixel resolutions, and a few can run at high frame rates such as the PlayStation Eye, which can produce 320×240 video at 120 frames per second.

Support electronics read the image from the sensor and transmit it to the host computer. The camera pictured to the right, for example, uses a Sonix SN9C101 to transmit its image over USB. Typically, each frame is transmitted uncompressed in RGB or YUV or compressed as JPEG. Some cameras, such as mobile phone cameras, use a CMOS sensor with supporting electronics "on die", i.e. the sensor and the support electronics are built on a single silicochip to save space and manufacturing costs.

4.6.2 PORTABILITY:

Most webcams feature built-in microphones to make video calling and videoconferencing more convenient. The USB video device class (UVC) specification allows for interconnectivity of webcams to computers without the need for proprietary device drivers. Microsoft Windows XP SP2, Linux and Mac OS X (since October 2005) have UVC support built in and do not require extra device drivers, although they are often installed to add additional features.

4.6.3 FEATURES (LOGITECH WEBCAM C100):-

- Plug-and-play setup (UVC)

- Video capture: Up to 640 x 480 pixels

- Photos: Up to 1.3 megapixels (software enhanced)
- Frame rate: Up to 30 frames per second (with recommended system)
- Hi-Speed USB 2.0 certified
- Fixed focus
- Universal clip fits notebooks, LCD or CRT monitor



Webcam

4.7 Image Processing on Raspberry Pi

Today image processing are used in various techniques, this paper presents the implementation of image processing operations on Raspberry Pi. The Raspberry Pi is a basic embedded system and being a low cost a single board computer used to reduce the complexity of systems in real time applications. This platform is mainly based on python. Raspberry pi consist of Camera slot Interface (CSI) to interface the raspberry pi camera. Here, the Dark and Low contrast images captured by using the Raspberry Pi camera module are enhanced in order to identify the particular region of image. This concept is used in the real time application of MAV, The MAVs are basically used to capture images and videos through the Raspberry pi camera module. Because of its credit card sized (small) and less weight in the design. However, the image captured by MAVs will consist of unwanted things due to atmospheric conditions; hence it is necessary to remove noise present in the MAVs images.

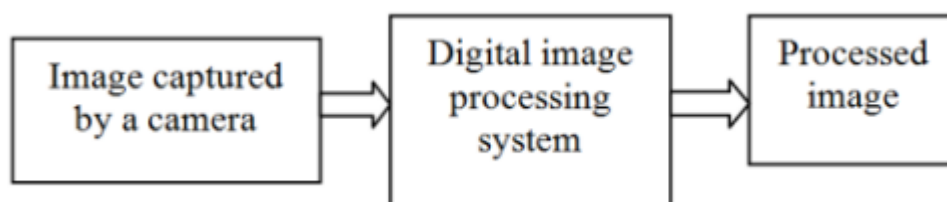
4.8 INTRODUCTION

The image processing is a form of signal processing where the input is an image, photograph or video frame, the output of an image processing may be either an image or a video frame or a set of characteristics or parameters related to the image. The acquisition of digital image usually suffers from undesirable camera shakes and due to unstable random camera motions. Hence image enhancement algorithms are required to remove these unwanted camera shakes. This image processing concepts are implemented in Raspberry pi in the application of MAV. The Raspberry Pi is a basic embedded system having a credit card-sized single board

computers developed in the UK by the Raspberry Pi Foundation. The Raspberry Pi is based on the Broadcom BCM2835 system on a chip (SOC) which includes an ARM1176JZF-S Core (ARM V6K)700 MHz CPU processor, Broadcom Video Core IV GPU having 17 pins, 3.5W of power, and 512 MB of RAM memory. The Raspberry Pi system has Secure SD card reader (models A and B) or Micro SD card reader (models A+ and B+) sockets for boot media and persistent storage. The system provides Debian Linux operating system Raspbian image for download. Python is used as main programming language for raspberry pi. A micro air vehicle (MAV) is a remote-controlled, Unmanned Aircraft Vehicle (UAV) significantly smaller than typical UAVs that have a size restriction. UAV is an aircraft without a human pilot. Its flight is controlled either autonomously on board computers or by the remote control of a pilot on the ground or in another vehicle. By having a Raspberry Pi camera module available on a MAV the efficiency of this air vehicle increases and new fields of applications are available. It is needed in military Operations, in which targets have to be identified. Such identification is often done by a human on ground, to reduce the probability of mistakes. But a Raspberry Pi camera module is also helpful if a MAV shall autonomously fly through an arch.

4.9 BASIC CONCEPT OF IMAGE PROCESSING

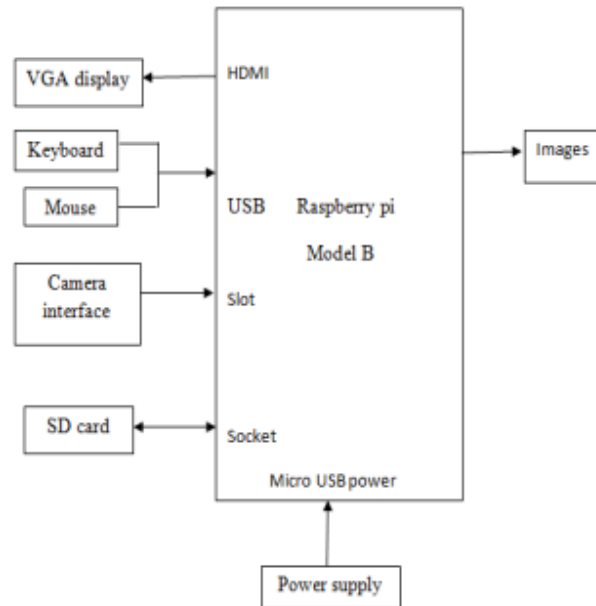
In general, any digital image processing algorithm consists of three stages: input, processor and output. In the input stage image is captured by a camera. It sent to a particular system to focus on a pixel of image that's gives, its output as a processed image.



General Block diagram of image processing

4.10 SYSTEM HARDWARE DESIGN

The Raspberry Pi board is the central module of the whole embedded image capturing and processing system as given in **fig. 2**. Its main parts include: main processing chip unit, memory, power supply HDMI Out i.e VGA display, Ethernet port, and USB ports.



System Block Diagram

Ultrasonic sensing

Ultrasonic sensing is one of the best ways to sense proximity and detect levels with high reliability.

Our technical support gets emails all of the time about how our sensors work and what environments our sensors work (or don't work) in.

This guide was created as an introduction to ultrasonic sensing, its principles, and how ultrasonic sensors work in applications.

At a top level, we need to know what an ultrasonic sensor is...

What is an ultrasonic sensor?

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves.

An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity.

High-frequency sound waves reflect from boundaries to produce distinct echo patterns.

How Ultrasonic Sensors Work

Ultrasonic sensors work by sending out a sound wave at a frequency above the range of human hearing. The transducer of the sensor acts as a microphone to receive and send the ultrasonic sound. Our ultrasonic sensors, like many others, use a single transducer to send a pulse and to receive the echo. The sensor determines the distance to a target by measuring time lapses between the sending and receiving of the ultrasonic pulse.

The working principle of this module is simple. It sends an ultrasonic pulse out at 40kHz which travels through the air and if there is an obstacle or object, it will bounce back to the sensor. By calculating the travel time and the speed of sound, the distance can be calculated.

Ultrasonic sensors are a great solution for the detection of clear objects. For liquid level measurement, applications that use infrared sensors, for instance, struggle with this particular use case because of target translucence.

For presence detection, ultrasonic sensors detect objects regardless of the color, surface, or material (unless the material is very soft like wool, as it would absorb sound.)

To detect transparent and other items where optical technologies may fail, ultrasonic sensors are a reliable choice.

Using Multiple Sensors & Avoiding Disruption

When using multiple sensors in an application, it's important to connect them in a way that will allow you to avoid issues like crosstalk or any other interference.

To prevent the disruption of the ultrasonic signals coming from the sensor, it's important to keep the face of the ultrasonic transducer clear of any obstructions.

Common obstructions include:

- Dirt
- Snow
- Ice

Other Condensation

For this particular use case, we offer our Self Cleaning sensors.

They are intended specifically for applications requiring the resistance of condensation in high moisture environments, our self-cleaning function is designed to run continuously in order for the self-cleaning feature to be active.

How are Ultrasonic Sensors used?

Our ultrasonic distance, level, and proximity sensors are commonly used with microcontroller platforms like Raspberry Pi, ARM, PIC, Arduino, Beagle Board, and more.

Ultrasonic sensors transmit sound waves toward a target and will determine its distance by measuring the time it took for the reflected waves to return to the receiver.

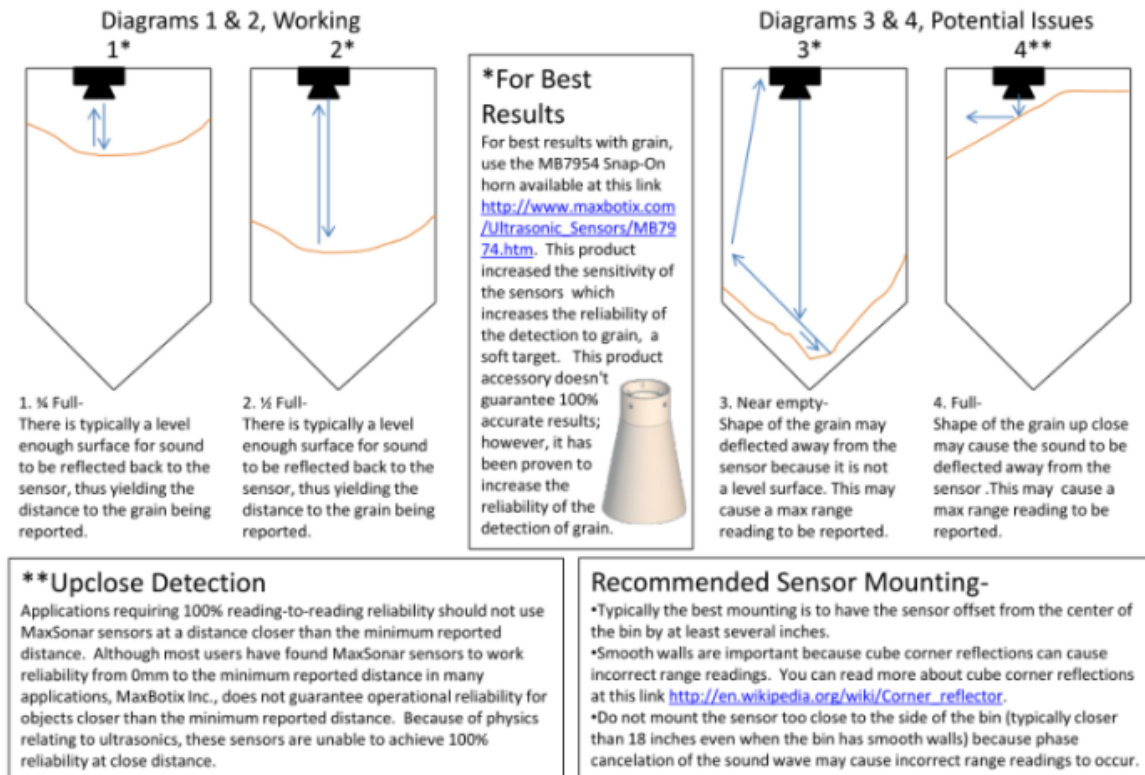
This sensor is an electronic device that will measure the distance of a target by transmitting ultrasonic sound waves, and then will convert the reflected sound into an electrical signal.

Our sensors are often used as proximity sensors.

Ultrasonic sensors are also used in obstacle avoidance systems, as well as in manufacturing.

Our ShortRange sensors offer the opportunity for closer range detection where you may need a sensor that ranges objects as close to 2 cm. These are also built with very low power requirements in mind, as well as environments where noise rejection is necessary.

Grain Detection



Humidity sensor

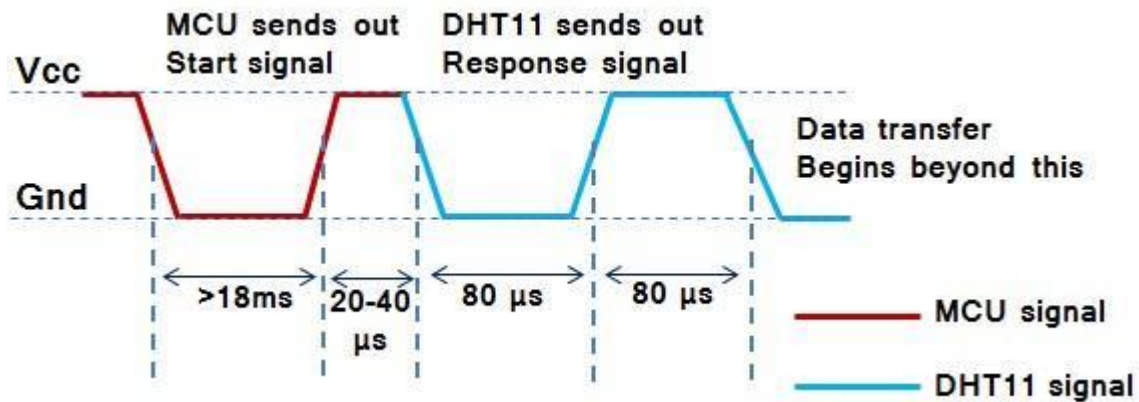
Measurement and control of temperature and relative humidity finds applications in numerous areas. These days devices are available which have both temperature and humidity sensors with signal conditioning, ADC, calibration and communication interface all built inside them. The use of such smart sensors greatly simplify the design and reduces the overall cost. We discussed in past about [Humidity and temperature measurements with Sensirion's SHT1x/SHT7x sensors](#). These sensors are capable of measuring both temperature and relative humidity and provide fully calibrated digital outputs. While SHT1x/SHT7x are very accurate sensors, they are still expensive for hobbyists use. This articles discusses the

DHT11 sensor which also provides calibrated digital outputs for temperature and humidity but is relatively lot cheaper than the Sensirion sensors. The DHT11 sensor uses a proprietary 1-wire protocol which we will be exploring here and implementing with the PIC16F628A microcontroller that will receive the temperature and humidity values from the sensor and display them on a 16×2 character LCD.

About DHT11 sensor

The DHT11 sensor comes in a single row 4-pin package and operates from 3.5 to 5.5V power supply. It can measure temperature from 0-50 °C with an accuracy of $\pm 2^{\circ}\text{C}$ and relative humidity ranging from 20-95% with an accuracy of $\pm 5\%$. The sensor provides fully calibrated digital outputs for the two measurements. It has got its own proprietary 1-wire protocol, and therefore, the communication between the sensor and a microcontroller is not possible through a direct interface with any of its peripherals. The protocol must be implemented in the firmware of the MCU with precise timing required by the sensor. The following timing diagrams describe the data transfer protocol between a MCU and the DHT11 sensor. The MCU initiates data transmission by issuing a “Start” signal. The MCU pin must be configured as output for this purpose. The MCU first pulls the data line low for at least 18 **us** and then pulls it high for next 20-40 **us** before it releases it.

Next, the sensor responds to the MCU “Start“ signal by pulling the line low for 80 **us** followed by a logic high signal that also lasts for 80 **us**. Remember that the MCU pin must be configured to input after finishing the “Start“ signal. Once detecting the response signal from the sensor, the MCU should be ready to receive data from the sensor. The sensor then sends 40 bits (5 bytes) of data continuously in the data line. Note that while transmitting bytes, the sensor sends the most significant bit first.



"Start" and "Response" signals

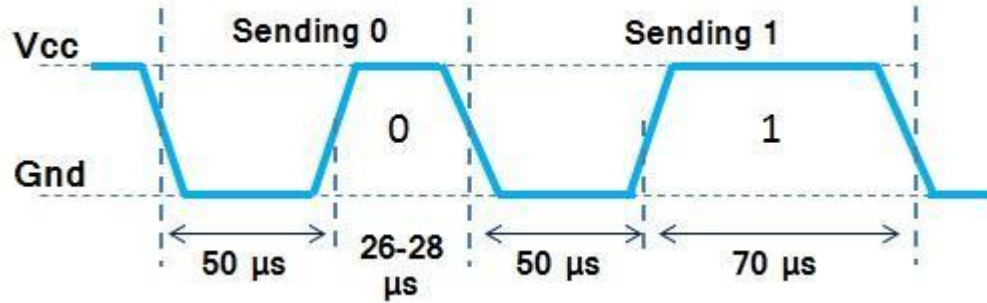
The 40-bit data from the sensor has the following structure.

Data (40-bit) = Integer Byte of RH + Decimal Byte of RH + Integer Byte of Temp. + Decimal Byte of Temp. + Checksum Byte

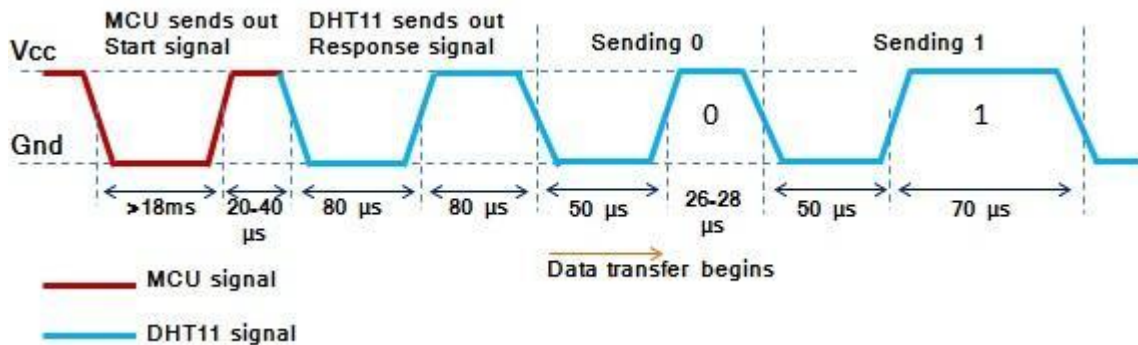
For DHT11 sensor, the decimal bytes of temperature and humidity measurements are always zero. Therefore, the first and third bytes of received data actually give the numeric values of the measured relative humidity (%) and temperature (°C). The last byte is the checksum byte which is used to make sure that the data transfer has happened without any error. If all the five bytes are transferred successfully then the checksum byte must be equal to the last 8 bits of the sum of the first four bytes, i.e.,

Checksum = Last 8 bits of (Integer Byte of RH + Decimal Byte of RH + Integer Byte of Temp. + Decimal Byte of Temp.)

Now let's talk about the most important thing, which is signalling for transmitting "0" and "1". In order to send a bit of data, the sensor first pulls the line low for 50 μs. Then it raises the line to high for 26-28 μs if it has to send "0", or for 70 μs if the bit to be transmitted is "1". So it is the width of the positive pulse that carries information about 1 and 0.



Timing difference for transmitting "1s" and "0s"



Start, Response and Data signals in sequence

At the end of the last transmitted bit, the sensor pulls the data line low for 50 μs and then releases it. The DHT11 sensor requires an external pull-up resistor to be connected between its Vcc and the data line so that under idle condition, the data line is always pulled high. After finishing the data transmission and releasing the data line, the DHT11 sensor goes to the low-power consumption mode until a new “Start” signal arrives from the MCU.

O2 Sensor

The carbon monoxide sensor we will use is the MQ-7 sensor. This is a sensor that is sensitive to effects of CO.

Carbon monoxide (CO) is a very dangerous gas which is odorless, colorless, and tasteless, so it cannot be smelt, seen, or tasted. A person really would have no idea that they are breathing in CO besides the fact that they would start to feel horrible. The most common symptoms of CO poisoning is headache, nausea, vomiting, dizziness, **fatigue, and a feeling** of weakness. Neurological signs include confusion, disorientation, visual disturbance, syncope, and seizures.

Carbon monoxide is produced from the partial oxidation of carbon-containing compounds; it forms when there is not enough oxygen to produce carbon dioxide (CO₂), such as when operating a stove or an internal combustion engine in an enclosed space. In the presence of oxygen, including atmospheric concentrations, carbon monoxide burns with a blue flame, producing carbon dioxide. So it is really in enclosed spaces with partial oxidation of carbon products that creates the danger of carbon monoxide production in homes or in businesses.

Carbon monoxide poisoning is the most common type of fatal air poisoning in many countries. Being colorless, odorless, and tasteless, it is very hard to detect but highly toxic. Carbon monoxide is absorbed through breathing and enters the bloodstream through gas exchange in the lungs. CO combines with haemoglobin to produce carboxyhaemoglobin, which usurps the space in haemoglobin that normally carries oxygen, but is ineffective for delivering oxygen to bodily tissues. This leads to oxygen deprivation, which can be deadly.

CO is measured in parts per million (ppm). To give you some perspective, the natural atmosphere is composed of 0.1ppm. The average level in homes is 0.5-5ppm. The level near properly adjusted gas stoves in homes and from modern vehicle exhaust emissions is 5-15ppm. The exhaust from automobiles in Mexico City central area is 100-200ppm. The amount of CO that can be created from the exhaust from a home wood fire is 5000ppm. Concentrations as low as 667ppm may cause up to 50% of the body's hemoglobin to convert to carboxyhaemoglobin. A level of 50% carboxyhaemoglobin may result in seizure, coma, and fatality.

In the United States, OSHA limits long-term workplace exposure levels above 50ppm.

According to the Florida Department of Health, every year more than 500 people in the United States die every year from accidental exposure to carbon monoxide and thousands

more across the US require emergency medical care for non-fatal CO poisoning. These products include malfunctioning fuel-burning appliances such as furnaces, ranges, water heaters, gas and kerosene room heaters, fireplaces, and charcoal that is burned in homes and other enclosed areas. Still others die from CO produced by non-home products, such as cars left running in a garage. The Centers for Disease Control and Prevention estimates that several thousand people go to hospital emergency rooms every year to be treated for carbon monoxide poisoning. Carbon monoxide can be measured through laboratory testing

requiring a blood sample (arterial or venous) and can also be analyzed on a CO-oximeter.

Having this overview of carbon monoxide gives some background to how it is created and the real severe dangers it can pose. It creates context to just how important it is to be able to detect and measure the amount of CO that may be present in the environment during any given time.

Knowing this, let's go to building our carbon monoxide sensor circuit.

RFID (radio-frequency identification)

Radio Frequency Identification (RFID) refers to a wireless system comprised of two components: tags and readers. ... Tags, which use radio waves to communicate their identity and other information to nearby readers, can be passive or active. Passive RFID tags are powered by the reader and do not have a battery.

Passive tags are powered by energy from the RFID reader's interrogating radio waves. Active tags are powered by a battery and thus can be read at a greater range from the RFID reader, up to hundreds of meters.

Unlike a barcode, the tag does not need to be within the line of sight of the reader, so it may be embedded in the tracked object. RFID is one method of automatic identification and data capture (AIDC).

RFID tags are used in many industries. For example, an RFID tag attached to an automobile during production can be used to track its progress through the assembly line, RFID-tagged pharmaceuticals can be tracked through warehouses, and implanting RFID microchips in

livestock and pets enables positive identification of animals. Tags can also be used in shops to expedite checkout, and to prevent theft by customers and employees.

Since RFID tags can be attached to physical money, clothing, and possessions, or implanted in animals and people, the possibility of reading personally-linked information without consent has raised serious privacy concerns. These concerns resulted in standard specifications development addressing privacy and security issues.

Tags

RFID tags are made out of three pieces: a microchip (an integrated circuit which stores and processes information and modulates and demodulates radio-frequency (RF) signals), an antenna for receiving and transmitting the signal and a substrate. The tag information is stored in a non-volatile memory. The RFID tag includes either fixed or programmable logic for processing the transmission and sensor data, respectively.

RFID tags can be either passive, active or battery-assisted passive. An active tag has an on-board battery and periodically transmits its ID signal. A battery-assisted passive tag has a small battery on board and is activated when in the presence of an RFID reader. A passive tag is cheaper and smaller because it has no battery; instead, the tag uses the radio energy transmitted by the reader. However, to operate a passive tag, it must be illuminated with a power level roughly a thousand times stronger than an active tag for signal transmission. This makes a difference in interference and in exposure to radiation.

Tags may either be read-only, having a factory-assigned serial number that is used as a key into a database, or may be read/write, where object-specific data can be written into the tag by the system user. Field programmable tags may be write-once, read-multiple; "blank" tags may be written with an electronic product code by the user.

The RFID tag receives the message and then responds with its identification and other information. This may be only a unique tag serial number, or may be product-related information such as a stock number, lot or batch number, production date, or other specific

information. Since tags have individual serial numbers, the RFID system design can discriminate among several tags that might be within the range of the RFID reader and read them simultaneously.

Readers

RFID systems can be classified by the type of tag and reader. There are 3 types:

A Passive Reader Active Tag (PRAT) system has a passive reader which only receives radio signals from active tags (battery operated, transmit only). The reception range of a PRAT system reader can be adjusted from 1–2,000 feet (0–600 m), allowing flexibility in applications such as asset protection and supervision.

An Active Reader Passive Tag (ARPT) system has an active reader, which transmits interrogator signals and also receives authentication replies from passive tags.

An Active Reader Active Tag (ARAT) system uses active tags activated with an interrogator signal from the active reader. A variation of this system could also use a Battery-Assisted Passive (BAP) tag which acts like a passive tag but has a small battery to power the tag's return reporting signal.

Fixed readers are set up to create a specific interrogation zone which can be tightly controlled. This allows a highly defined reading area for when tags go in and out of the interrogation zone. Mobile readers may be handheld or mounted on carts or vehicles.

CHAPTER 5

5. SOFTWARE DESCRIPTION

5.1 Start up with Raspberry Pi

5.1.1 Installation of operating system on Raspberry Pi

Raspberry Pi is a small computer; hence operating system (OS) should be installed. As the Raspberry doesn't have hard drive, OS is installed in the external memory. For that, memory card (SD card) is used for the installation of operating system and all the required software and supporting files are stored in the same SD card.

There are different types of operating system but we preferred to talk about NOOBS (New Out of the Box Software) as it is suitable for the beginners. We can either buy a preinstalled SD card or empty SD card. In pre-installed SD card, NOOBS is already copied and ready to boot. The detail description of installation of operating system in a blank SD card in step wise is given in [Appendix B](#).

5.1.2 Use of laptop screen, keyboard and mouse for Raspberry Pi

If you don't have suitable screen for the Raspberry Pi, we can use the monitor of a laptop. Besides, we can use keyboard and mouse of laptop as well for Raspberry Pi. For that, two software are needed to install in a laptop which screen is going to use for Raspberry Pi. Installation and configuration of the software is discussed briefly in the following sections. Xming

This is the first software need to be installed which can be downloaded from the link, [Download_Xming](#) and install it in the laptop. After completion of installation, run the application called 'XLaunch' and verify that the settings are as shown in three following figures; [Figure 12-1](#), [Figure 12-2](#) and [Figure 12-3](#).

Finally, click "Next" button shown in [Figure 12-3](#), it goes to last configuration dialogue box where "Finish" button is needed to click for the completion of the setting. After Completion of configuration, double click the application named as "Xming".

1 5.2 PuTTY

This is the primary software need to be installed. It can be downloaded in the provided link as follow, [Download Putty](#). As, it is downloaded, it needs to be installed following some few normal steps of installation. For Configuration, double click the icon of Putty after the completion of installation and enter the IP address of Raspberry Pi as shown in [Figure 12-4](#).

Finally, click on "open" button and as a result; window will be displayed as shown in [Figure 12-6](#).

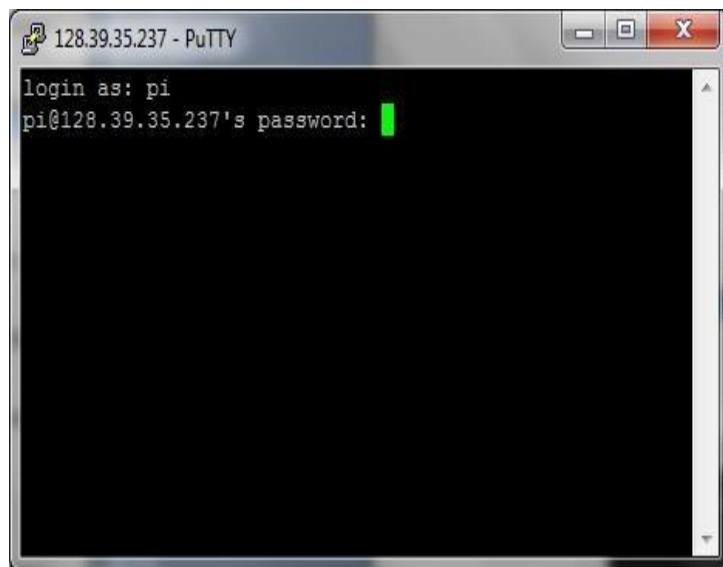
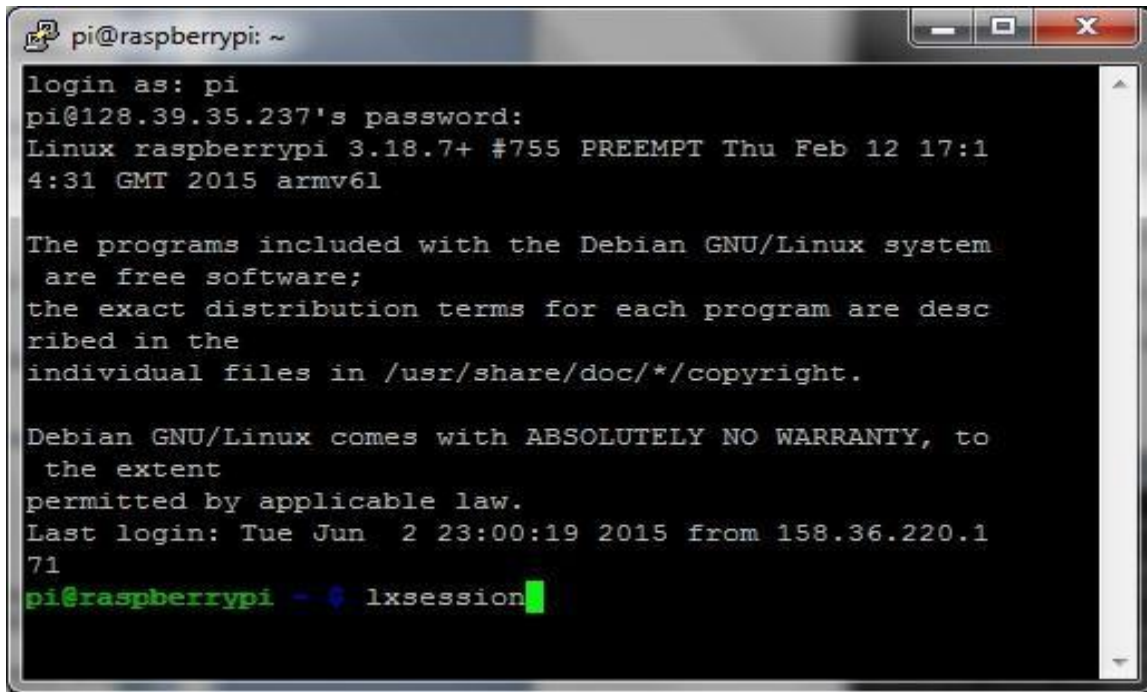


Figure 12-6: PuTTY login windows

In this window, username and password of the Raspberry Pi should be entered. The default username for a Raspberry Pi is pi. Press enter after entering correct username

and password and you will see the windows where you should enter the text "lesson" as shown in Figure 12-7.



```
pi@raspberrypi: ~
login as: pi
pi@128.39.35.237's password:
Linux raspberrypi 3.18.7+ #755 PREEMPT Thu Feb 12 17:14:31 GMT 2015 armv6l

The programs included with the Debian GNU/Linux system
are free software;
the exact distribution terms for each program are desc
ribed in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to
the extent
permitted by applicable law.
Last login: Tue Jun  2 23:00:19 2015 from 158.36.220.171
pi@raspberrypi ~$ lxsession
```

Figure 12-7: PuTTY success windows

Then, you will be able to see the desktop of Raspberry Pi in the laptop as shown in Figure 12-8 and mouse and keyboard can be used for the Raspberry Pi.

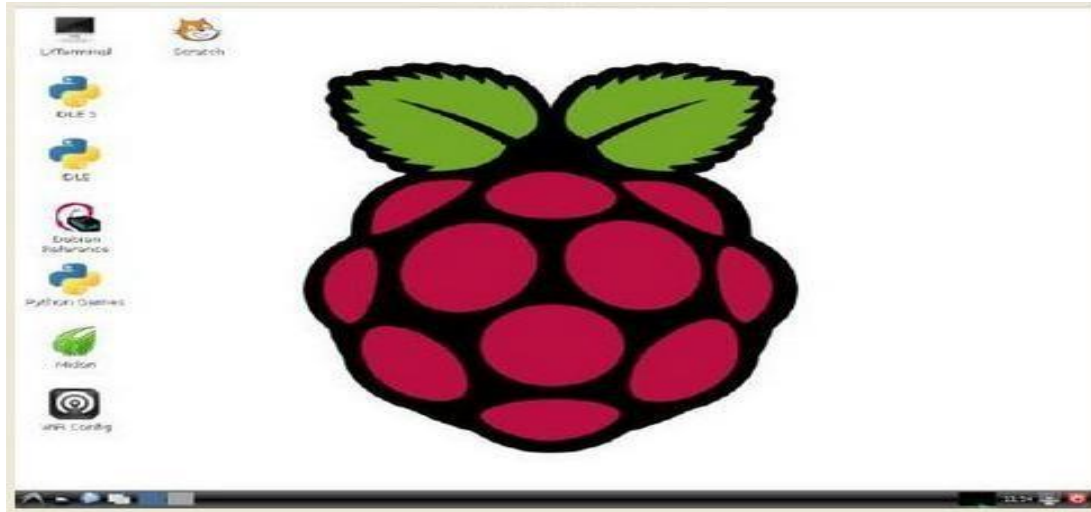


Figure 12-8: Raspberry Pi Desktop on your Laptop Display

5.3 Installation of required applications on Raspberry Pi

There are many applications that are needed to install in the Raspberry Pi for the completion of the thesis. For data logging, MySQL apache5 and php my admin are needed to install whereas for the web-page development, PHP is needed to install. Web page is used for the monitoring and managing purpose

Raspbian OS

Raspberr Pi OS (formerly Raspbian) is a Debian-based operating system for Raspberry Pi. Since 2015, it has been officially provided by the Raspberry Pi Foundation as the primary operating system for the Raspberry Pi family of compact single-board computers. The first version of Raspbian was created by Mike Thompson and Peter Green as an independent project. The initial released build was completed on July 15, 2012.

Raspberry Pi OS is highly optimized for the Raspberry Pi line of compact single-board computers with ARM CPUs. It runs on every Raspberry Pi except the Pico microcontroller. Raspberry Pi OS uses a modified LXDE as its desktop environment with the Openbox stacking window manager, along with a unique theme. The distribution is shipped with a copy of the algebra program Wolfram Mathematica and a version of Minecraft called Minecraft: Pi

Edition (note that Minecraft: Pi Edition is no longer installed as of the Debian bullseye update) as well as a lightweight version of the Chromium web browser.

User Interface

Raspberry Pi OS's desktop environment, PIXEL, looks similar to many common desktops, such as macOS, Microsoft Windows, and is based on LXDE. The menu bar is positioned at the top and contains an application menu and shortcuts to Terminal, Chromium, and File Manager. On the right is a Bluetooth menu, a Wi-Fi menu, volume control, and a digital clock.

Components

PCManFM is a file browser allowing quick access to all areas of the computer, and was redesigned in the first Raspberry Pi OS Buster release (2019-06-20).

Raspberry Pi OS originally used Epiphany as the web browser, but switched to Chromium with the launch of its redesigned desktop.

Raspberry Pi OS comes with many beginner IDEs, such as Thonny Python IDE, Mu Editor, and Greenfoot. It also ships with educational software like Scratch and Bookshelf.

Version Size

The Raspberry Pi documentation recommends at least a 4GB microSD card for Raspberry Pi OS Lite, an 8GB microSD card for Raspberry Pi OS, and a 16GB microSD card for Raspberry Pi OS Full.[19] The image files themselves are 1,875MB, 3,980MB, and 8,603MB respectively.

Python

What is Python?

Python: Dynamic programming language which supports several different programming paradigms:

- Procedural programming
- Object oriented programming
- Functional programming

Standard: Python byte code is executed in the Python interpreter (similar to Java) → platform independent code

Why Python?

Extremely versatile language Website development, data analysis, server maintenance, numerical analysis,

- Syntax is clear, easy to read and learn (almost pseudo code)
- Common language
- Intuitive object oriented programming
- Full modularity, hierarchical packages
- Comprehensive standard library for many tasks
- Big community Simply extendable via C/C++, wrapping of C/C++ libraries
- Focus: Programming speed

History

Start implementation in December 1989 by Guido van Rossum (CWI)

- 16.10.2000: Python 2.0
- Unicode support
- Garbage collector
- Development process more community oriented

- 3.12.2008: Python 3.0
- Not 100% backwards compatible 2007 & 2010 most popular programming language (TIOBE Index)
- Recommendation for scientific programming (Nature News, NPG, 2015)
- Current version: Python 3.9.2
- Python2 is out of support

Is Python fast enough?

- For user programs: Python is fast enough!
- Most parts of Python are written in C
- For compute intensive algorithms: Fortran, C, C++ might be better
- Performance-critical parts can be re-implemented in C/C++ if necessary
- First analyses, then optimize!

Conclusion

Python is a fully-fledged programming language. Any code you download from github, the Python Package Index, or anywhere else, can be malicious and would almost certainly go unnoticed by most people's firewalls.

OpenCV

OpenCV is a cross-platform library using which we can develop real-time computer vision applications. It mainly focuses on image processing, video capture and analysis including features like face detection and object detection. Let's start the chapter by defining the term "Computer Vision"

Computer Vision

Computer Vision can be defined as a discipline that explains how to reconstruct, interpret, and understand a 3D scene from its 2D images, in terms of the properties of the structure present in

the scene. It deals with modeling and replicating human vision using computer software and hardware.

Computer Vision overlaps significantly with the following fields:

- Image Processing: It focuses on image manipulation.
- Pattern Recognition: It explains various techniques to classify patterns.
- Photogrammetry: It is concerned with obtaining accurate measurements from images.

Computer Vision Vs Image Processing

Image processing deals with image-to-image transformation. The input and output of image processing are both images.

Computer vision is the construction of explicit, meaningful descriptions of physical objects from their image. The output of computer vision is a description or an interpretation of structures in 3D scene.

Applications of Computer Vision

Here we have listed down some of major domains where Computer Vision is heavily used.

Robotics Application

- Localization — Determine robot location automatically
- Navigation
- Obstacles avoidance

- Assembly (peg-in-hole, welding, painting)
- Manipulation (e.g. PUMA robot manipulator)
- Human Robot Interaction (HRI): Intelligent robotics to interact with and serve people

Medicine Application

Classification and detection (e.g. lesion or cells classification and tumor detection)

- 2D/3D segmentation
- 3D human organ reconstruction (MRI or ultrasound)
- Vision-guided robotics surgery

Industrial Automation Application

- Industrial inspection (defect detection)
- Assembly
- Barcode and package label reading
- Object sorting
- Document understanding (e.g. OCR)

Security Application

- Biometrics (iris, finger print, face recognition)
- Surveillance — Detecting certain suspicious activities or behaviors Transportation

Application

- Autonomous vehicle
- Safety, e.g., driver vigilance monitoring

Features of OpenCV Library

Using OpenCV library, you can –

- Read and write images
- Capture and save videos
- Process images (filter, transform)
- Perform feature detection
- Detect specific objects such as faces, eyes, cars, in the videos or images.
- Analyze the video, i.e., estimate the motion in it, subtract the background, and track objects in it. OpenCV was originally developed in C++. In addition to it, Python and Java bindings were provided. OpenCV runs on various Operating Systems such as windows, Linux, OSx, FreeBSD, Net BSD, Open BSD, etc.

This tutorial explains the concepts of OpenCV with examples using Java bindings.

OpenCV Library Modules

Following are the main library modules of the OpenCV library.

Core Functionality

This module covers the basic data structures such as Scalar, Point, Range, etc., that are used to build OpenCV applications. In addition to these, it also includes the multidimensional array Mat, which is used to store the images. In the Java library of OpenCV, this module is included as a package with the name org.opencv.core.

Image Processing

This module covers various image processing operations such as image filtering, geometrical image transformations, color space conversion, histograms, etc. In the Java library of OpenCV, this module is included as a package with the name org.opencv.imgproc.

Video

This module covers the video analysis concepts such as motion estimation, background subtraction, and object tracking. In the Java library of OpenCV, this module is included as a package with the name `org.opencv.video`.

Video I/O

This module explains the video capturing and video codecs using OpenCV library. In the Java library of OpenCV, this module is included as a package with the name `org.opencv.videoio`.

calib3d

This module includes algorithms regarding basic multiple-view geometry algorithms, single and stereo camera calibration, object pose estimation, stereo correspondence and elements of 3D reconstruction. In the Java library of OpenCV, this module is included as a package with the name `org.opencv.calib3d`.

features2d

This module includes the concepts of feature detection and description. In the Java library of OpenCV, this module is included as a package with the name `org.opencv.features2d`.

Objdetect

This module includes the detection of objects and instances of the predefined classes such as faces, eyes, mugs, people, cars, etc. In the Java library of OpenCV, this module is included as a package with the name `org.opencv.objdetect`.

Highgui

This is an easy-to-use interface with simple UI capabilities. In the Java library of OpenCV, the features of this module is included in two different packages namely, `org.opencv.imgcodecs` and `org.opencv.videoio`.

OpenCV — Storing Images

To capture an image, we use devices like cameras and scanners. These devices record numerical values of the image (Ex: pixel values). OpenCV is a library which processes the digital images, therefore we need to store these images for processing. The `Mat` class of OpenCV library is used to store the values of an image. It represents an n-dimensional array and is used to store image data of grayscale or color images, voxel volumes, vector fields, point clouds, tensors, histograms, etc. This class comprises of two data parts: the header and a pointer

- Header: Contains information like size, method used for storing, and the address of the matrix (constant in size).
- Pointer: Stores the pixel values of the image (Keeps on varying).

The Mat Class

The OpenCV Java library provides this class with the same name (`Mat`) within the package `org.opencv.core`.

Constructors

The `Mat` class of OpenCV Java library has various constructors, using which you can construct the `Mat` object.

1. This is the default constructor with no parameters in most cases. We use this to constructor to create an empty matrix and pass this to other OpenCV methods.

2. `Mat(int rows, int cols, int type)` This constructor accepts three parameters of integer type representing the number of rows and columns in a 2D array and the type of the array (that is to be used to store data).

3. `Mat(int rows, int cols, int type, Scalar s)` Including the parameters of the previous one, this constructor additionally accepts an object of the class `Scalar` as parameter.

4. `Mat(Size size, int type)` 3. OpenCV — Storing Images

CHAPTER 6

RESULTS AND CONCLUSION

6.1 RESULT:

Past the pic

6.2 CONCLUSIONS:

In this analysis, we got described an epitome system to scan written communication and hand-held objects for serving to the blind people. To extract text regions from advanced backgrounds, we have got projected a totally distinctive text localization formula supported models of stroke orientation, and edge distributions. The corresponding feature maps estimate the worldwide structural feature of text at every element. Block patterns project the projected feature maps of an image patch into a feature vector. A adjacent character grouping is performed to calculate candidates of text patches prepared for text classification. Associate Ada boost

learning model is used to localize text in camera-based footage. OCR is utilized to perform word recognition on the localized text regions and work into audio output for blind users. Throughout this analysis, the camera acts as input for the paper. As a result of the Raspberry Pi board is high-powered the camera starts streaming. The streaming data square measure attending to be displayed on the screen victimization interface application. Once the item for text reading is placed earlier than the camera then the capture button is clicked to supply image to the board. Mistreatment Tesseract library the image square measure attending to be converted into data, and conjointly the data detected from the image square measure attending to be shown on the standing bar. The obtained data square measure attending to be pronounced through.

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The reminder of this paper is organized as follows:

Section 2 summarizes the recent related work in the proposed context.

Section 3 presents the proposed framework.

After that, a preliminary study is given in Section 4 Section 5 denoting the dataset collection. Hereafter, we introduce the evaluation metrics in Section 6, while the numerical result is discussed in Section 7. Finally, we conclude this paper in Section 8.

COVID-19 Detection Methods

Deep Learning Tools and CXR Image-Based COVID-19 Detection:

Radiography is a technique used to quantify the functional and structural consequences of chest diseases, to provide high-resolution images on disease progression. Several works have been carried out in this context. Echioui et al., proposed a new AI-based method for COVID-19 recognition, through analyzing radiographic images of a patient's lungs. The aim of this scheme is to provide clinical decision support for healthcare workers and also for researchers. Hence, performance results, as well as the accuracy value of about 91.34%, and the other metrics in terms of recall, precision, and F1-score, proves the efficiency of the method. In the same context, Ozturk et al., introduced a new automatic COVID-19 detection model using CXR images denoted by the "DarkCovidNet." It is used to provide correct diagnosis for both a binary classification (COVID-19 VS no findings) and a multiclass classification (COVID-19 VS pneumonia VS no findings). For binary classes, the classification accuracy produced by this model is about 98.08%, but, for multiclass cases, the accuracy is 87.02%. To validate their initial screening, radiologists can use the model to assist them. This model can be employed also via cloud to screen patients immediately. As a solution to the shortage of radiologists, this method can be used in remote places especially in countries affected by COVID-19. The most important advantage of this method is that such models can be used to diagnose supplementary chest-related diseases such as tuberculosis and pneumonia.

