RFID Based Surveillance System for School Bus

A PROJECT REPORT
Submitted by

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to

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COLLEGE OF ENGINEERING & MANAGEMENT PUNNAPRA
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DECLARATION

I undersigned hereby declare that the project report \ "RFID Based Surveillance System for School Bus " , submitted for partial fulfillment of the requirements for the award of degree of Bachelor of Technology of the APJ Abdul Kalam Technological University, Kerala is a bonafide work done by me under supervision of Mrs. Aggie Varghese. This submission represents my ideas in my own words and where ideas or words of others have been included, I have adequately and accurately cited and referenced the original sources. I also declare that I have adhered to ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in my submission. I understand that any violation of the above will be a cause for disciplinary action by the institute and/or the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously formed the basis for the award of any degree, diploma or similar title of any other University.

Alappuzha

06-07-2022 Harikrishnan KB

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

COLLEGE OF ENGINEERING AND MANAGEMENT PUNNAPRA

CERTIFICATE

This is to certify that the seminar report entitled "**RFID Based Surveillance System for School Bus**" submitted by **HARIKRISHNAN KB (KTU ID : PRP19CS029)** to the APJ Abdul Kalam Technological University in partial fulfillment of the requirements for the award of the Degree of Bachelor of Technology in Computer Science and Engineering is a bonafide record of the project work carried out by her under our guidance and supervision. This report in any form has not been submitted to any other University or Institute for any purpose.

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HARIKRISHNAN KB

ABSTRACT

RFID Based Surveillance system is a best way to keep our children safe in school bus. As technology is growing rapidly we are also moving to a technical world where safety can be provided technologically. The main goal is to ensure that the children board the school bus correctly and that they have no other issues on the bus. On the bus, The video of the student is delivered through an app installed on the parent's phone so that the parents can monitor their children live and ensure their safety. When a student gets on a bus from their bus stop and scans the RFID on his ID card, parents can see them through the app installed on their phone. It ends when the student arrives at the correct location and scans the RFID again. Such a system will help student to travel safe.

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ABBREVIATIONS

RFID	Radio Frequency Identification
Rpi	Raspberry Pi
JSON	Javascript Object Notation

Chapter 1

INTRODUCTION

1.1 Radio Frequency Identification(RFID)

RFID (radio frequency identification) is a form of wireless communication that incorporates the use of electromagnetic or electrostatic coupling in the radio frequency portion of the electromagnetic spectrum to uniquely identify an object.

Every RFID system consists of three components: a scanning antenna, a transceiver and a transponder. When the scanning antenna and transceiver are combined, they are referred to as an RFID reader or interrogator. There are two types of RFID readers – fixed readers and mobile readers. The RFID reader is a network-connected device that can be portable or permanently attached. It uses radio waves to transmit signals that activate the tag. Once activated, the tag sends a wave back to the antenna, where it is translated into data.

The transponder is in the RFID tag itself. The read range for RFID tags varies based on factors including the type of tag, type of reader, RFID frequency and interference in the surrounding environment or from other RFID tags and readers. Tags that have a stronger power source also have a longer read range.

RFID tags are made up of an integrated circuit (IC), an antenna and a substrate. The part of an RFID tag that encodes identifying information is called the RFID inlay.
There are two main types of RFID tags:

- Active RFID : An active RFID tag has its own power source, often a battery.
- Passive RFID : A passive RFID tag receives its power from the reading antenna, whose electromagnetic wave induces a current in the RFID tag's antenna.

1.2 RFID Based Surveillance System

A school bus system is one of the most important transportation methods for students all over the world. But the potential safety risks associated with them often go overlooked.

A school bus security system should be able to;

- Monitor the vehicle and ensure students remain safe to and from school.
- Capture the bus's interior for comprehensive monitoring.
- RFID integration to track the entry of students.

1.3 Problem Statement

Waste can be separated between plastic and non-plastic via smart bins. Three machine learning models are utilised in this instance to classify the garbage.

- Convolution Neural Network (CNN)
- Random Forest
- Gaussian Naive Bayes

By determining the values for precision, accuracy, recall, and f1-score, the three models are assessed. Therefore, locating the ideal waste classification model is simple.

Chapter 2

LITERATURE SURVEY

RFID Based attendance system : In this paper RFID Based attendance system has been developed where, RFID tranceiver that communicates with a passive tag when the tag enters the generated RF field it is able to draw enough power from the field to access its internal memory and transmit its stored information. When the transponder tag draws power in its way the resultant interaction of the RF fields causes the voltage at the tranciever anteena to drop in value. Their effect is utilized by the tag to communicates its information to the reader

Video streaming to random cloud using Raspberry Pi and FFMPEG based USB Camera : Rapid technological growth made surveillance as most promising application domain. With great extent of smart city most of the things are controlled by internet. Security is one of the applications that everyone needs to be controlled remotely. This paper presents cloud based surveillance system for live video streaming that can be surveillance from anywhere and anytime. This system provides the live streaming by using cloud; Raspberry Pi 2 module and FFMPEG based USB Camera. .

CoAP based IoT data transfer from a Raspberry Pi to Cloud : Things board is an open source software tool, which is used to collect, monitor and visualise streams of data received in real-time by sensor devices. The platform can be hosted in the cloud and provides Message Queuing Telemetry Transport (MQTT), The Constrained Application Protocol (CoAP) and Hyper Text Transfer Protocol (HTTP) protocols support. A CoAP-based IoT architecture is proposed using a Raspberry Pi (RPi) and sensors acting as IoT endpoints and it will poll sensors and using CoAP send the latest data formatted as JavaScript Object Notation (JSON) to the ThingsBoard cloud endpoint at regular intervals.

Table 2.1: Comparison between Related Works

Sl No	Name of Paper	Paper type	Year	Description
1	RFID Based Attendance System	IEEE paper	2020	Reading attendance of each student using inbuilt RFID tag provided with ID card.
2	Radio frequency communication using Iot	IEEE paper	2021	System for Library Materials Management using Android based UHF mobile reader (Android mobile reader) as its entry to increase the efficiency of library materials management.
3	CoAP based IoT data transfer from a Raspberry Pi to Cloud	IEEE	2020	Development of an Internet of Things (IoT) monitoring system using ThingsBoard IoT platform. .
4	Live Video Streaming using Raspberry Pi in IOT Devices	IEEE	2021	The algorithm is implemented on Raspberry Pi, which provide the live streaming that can be viewed from any web browser.
5	Design of Adaptive Coding Approach to Support Video Streaming for Camera Surveillance Systems.	IEEE	2020	It demonstrate the proposed system can adjust the quality of video streaming automatically when network bandwidth drops suddenly.
6	Real-Time Streaming Application for IoT Using Raspberry Pi and Handheld Devices	IEEE	2021	Divided high quality video into image files with the jpg format, into packets and then transmitted them to multiple handheld devices simultaneously.

Table 2.2: Comparison between Related Works

7	Video streaming to random cloud using Raspberry Pi and FFMPEG based USB Camera	IEEE	2021	This paper presents cloud based surveillance system for live video streaming that can be surveillance from anywhere and anytime. This system provides the live streaming by using cloud; Raspberry Pi 2 module and FFMPEG based USB Camera.
8	Video rendering software development in Java Native Interface(Android)	IEEE Journal	2021	Introducing JNI (Java Native Interface), an android app for video meeting and surveillance system.
9	Smart Tracking System for School Buses	International Research Journal of Engineering and Technology	2017	Smart tracking system for School buses, which is an android based application designed and implemented to provide remote tracking and SMS mode of alert mechanism.
10	RFID Based School Bus Monitoring & Security System	Journal of Emerging Technologies and Innovative Research	2021	The system has a developed androidbased database-driven application that facilities its management and provides useful information about the children to authorized personal.

Chapter 3

METHODOLOGY

3.1 Introduction

This chapter discusses the methodology that was used in gathering the data and implementing a RFID Based Surveillance System. Here the researcher aimed at identi fying the objectives to be carried out and the methods and tools to be used to present and analyze data to develop the RFID Based Surveillance System.

3.2 Data Collection Techniques

3.2.1 Interviews

An interview is a process of conducting intensive individual interviews with a small number of respondents to explore their perspectives on a particular idea, program or situation. Face to face method of discussion was used to gather information from people who work in the company / organization and get the knowledge to design a responsive system.

3.2.2 Observation

This technique was used to gather accurate information about how the system actually operates, particularly about processes. This involves the researcher to systematically watch and record the behaviors and characteristics of operations and processes in the company. Although the method is time consuming, it has a number of advantages, which include: It gives more detailed and context related information, It permits the collection of information on facts not mentioned in the

interview, It permits tests of the reliability of the responses to the questionnaires, observe operations of a program as they are actually occurring and can adapt to events as they occur.

3.2.3 Design

In systems design the design functions and operations are described in detail, including business rules, process diagrams and other documentation. The output of this stage was describe the new system as a collection of modules or subsystems. The design stage takes as its initial input the requirements identified in the approved requirements document. For each requirement, a set of one or more design elements will be produced as a result of interviews, workshops, and/or prototype efforts.

3.3 Study Findings

According to the data collection methods the following was thought to be done to improve on the gaps found in the current system.

3.3.1 Weakness of the Current System

It was through the information got about the current system that the researcher was able to identify its weaknesses. This helped in understanding what was to be done in order to develop a new system.
The following weaknesses were found in the current system:

- In the current system parents don't have access to view the footage of the bus.
- There is no system for identifying students. So, Outsiders can also be travel through the bus without any problem.
- The current system is very costly and not efficient.
- Parents don't have the permission to download the bus footages.

3.3.2 Presentation and Analysis of the findings

From the analysis made, there is need for an online RFID Based Surveillance System to enusure safety to students with more features and functionalities. The

current system is unreliable, inefficient and costly. Three categories of stakeholders were interviewed and these included;

3.4 Designing or modeling the system

System design tools to create systems that meet the needs of parants.The tools are used in system designing and modeling are flow charts, use case diagrams. A system flow chart is a way of displaying how data flows in a system and how decisions are made to control events.

3.4.1 RFID

Radio Frequency Identification (RFID) is a technology that uses radio waves to passively identify a tagged object. It is used in several commercial and industrial applications, from tracking items along a supply chain to keeping track of items checked out of a library.Radio Frequency Identification is used in conjunction with a microchip, a powered antenna, and a scanner. Although commercial uses for it were first developed in the 1970s, it has become more universally accessible in recent years. With advancements to the technology used to read and store information, it is now more affordable to purchase and adapt. There are two main types of RFID tags:

- Active RFID. An active RFID tag has its own power source, often a battery.
- Passive RFID. A passive RFID tag receives its power from the reading antenna, whose electromagnetic wave induces a current in the RFID tag's antenna.

3.4.2 Raspberry Pi

Raspberry Pi is a small single board computer. By connecting peripherals like Keyboard, mouse, display to the Raspberry Pi, it will act as a mini personal computer.

Raspberry Pi is popularly used for real time Image/Video Processing, IoT based applications and Robotics applications.

Raspberry Pi is slower than laptop or desktop but is still a computer which can provide all the expected features or abilities, at a low power consumption.

Raspberry Pi Foundation officially provides Debian based Raspbian OS. Also, they provide NOOBS OS for Raspberry Pi. We can install several Third-Party versions of OS like Ubuntu, Archlinux, RISC OS, Windows 10 IOT Core, etc.

3.4.3 Kotlin

Kotlin is an open-source, statically-typed programming language that supports both object-oriented and functional programming. Kotlin provides similar syntax and concepts from other languages, including C#, Java, and Scala, among many others. Kotlin does not aim to be unique-instead, it draws inspiration from decades of language development. It exists in variants that target the JVM (Kotlin/JVM), JavaScript (Kotlin/JS), and native code (Kotlin/Native).Certain Android APIs, like Android KTX, are Kotlin-specific, but most are written in Java and can be called from either Java or Kotlin. Kotlin's interoperability with Java is core to its growth. It means that you can call into Java code from Kotlin and vice-versa, leveraging all of your existing Java libraries. Kotlin's popularity results in a nicer development experience on Android, but development of the Android framework continues with both Kotlin and Java in mind.

3.4.4 Python

Python is an interpreted, object-oriented, high-level programming language with dynamic semantics developed by Guido van Rossum. It was originally released in 1991. Designed to be easy as well as fun, the name "Python" is a nod to the British comedy group Monty Python. Python has a reputation as a beginner-friendly language, replacing Java as the most widely used introductory language because it handles much of the complexity for the user, allowing beginners to focus on fully grasping programming concepts rather than minute details.

Python is used for server-side web development, software development, mathematics, and system scripting, and is popular for Rapid Application Development and as a scripting or glue language to tie existing components because of its high-level, built-in data structures, dynamic typing, and dynamic binding. Program maintenance costs are reduced with Python due to the easily learned syntax and emphasis on readability. Additionally, Python's support of modules and packages facilitates modular programs and reuse of code. Python is an open source community language, so numerous independent programmers are continually building libraries and functionality for it.

3.5 Requirement Analysis (using a use case diagram)

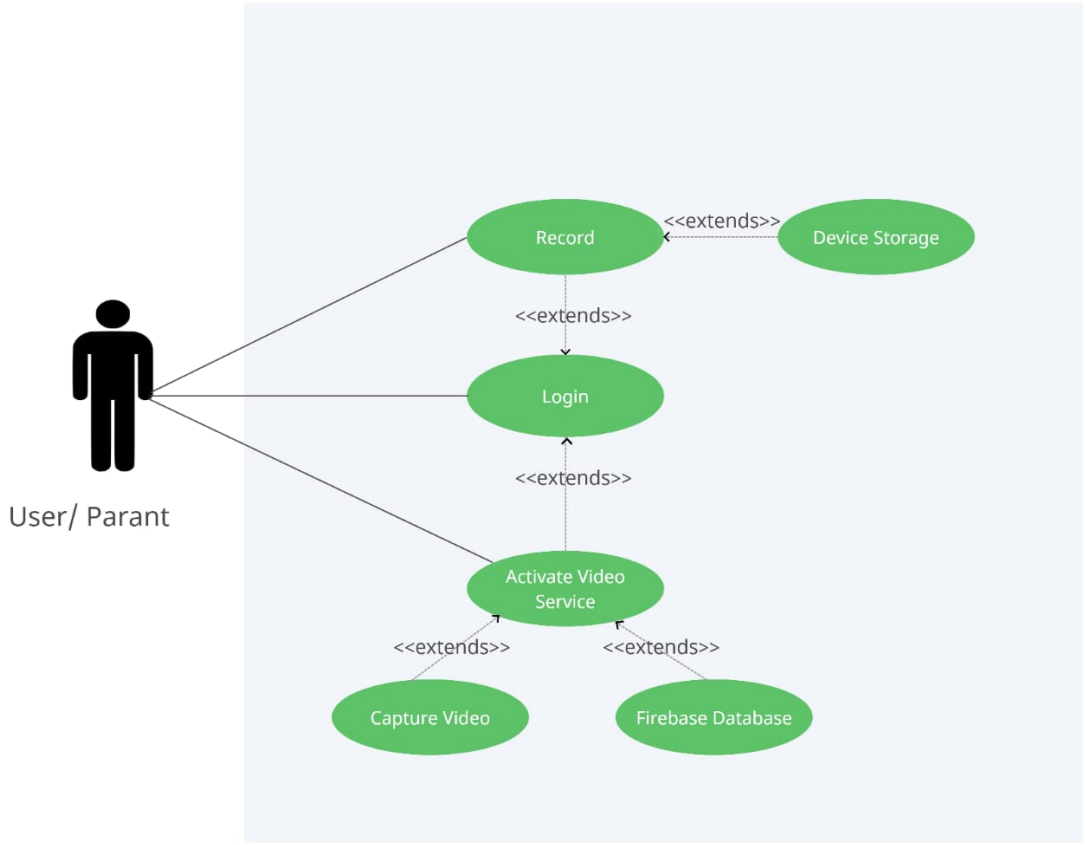


Figure 3.1: Use case diagram

3.5.1 Functional Requirements

We need to add Functional requrements here.

3.5.2 Non-Functional Requirements

Non-functional requirements address aspects of the system other than the specific functions it performs. These aspects include system performance, costs, and such general system characteristics as reliability, security, and portability. The non-functional requirements also address aspects of the system development process and operational personnel.

It includes the following:

- The system was user friendly and consistent.

- The system provided attractive graphical interface for the user.
- The system allowed user access to installed environment.
- The system targeted customer base.

3.5.3 System Requirements

To be used efficiently, the RFID Based Surveillance System will need certain hardware components and software resources to be present on a computer.
These requirements are regarded as minimum for the sake of running the system:

Hardware Requirements

- Raspberry Pi 3B - 1.2GHz, Memory - 1GB RAM, 40-pin extended GPIO.
- RFID MF RC522 - 13.56MHz, Data Transfer Rate: Maximum 10Mbit/s

Software Requirements

- Server - Python Localhost Server, DBMS - Firebase Realtime Database.
- Client - Android OS (Minimum api 29)

3.6 System Design

The new RFID Based Surveillance System has been designed in line with the user and system requirements that were identified during the data collection and analysis stage. The system will be used by the Parents and th School authority.

3.6.1 Network and System Architecture

Chapter 4

RESULTS AND DISCUSSIONS

4.1 Calculation of Confusion Matrix

In classification issues, classification models are used to forecast the target class data sample. The likelihood that each occurrence belongs to one class or another is predicted by the categorization model. The confusion matrix is a matrix representation of TP, TN, FP, and FN. These are the three models' confusion matrices.

TP is 380, FP is 46, FN is 4, and TN is 461 in the CNN confusion matrix. In this case, the plastic is forecasted to be 461 and the non-plastic is 380 as expected.

In the Random Forest confusion matrix, the TP is 403, FP is 23, FN is 0, and TN is 465. In this instance, it is anticipated that the plastic will be 465 and the non-plastic will be 403.

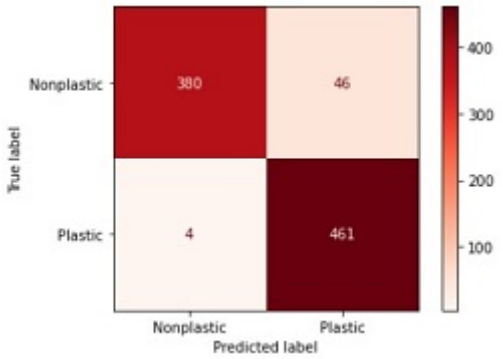


Figure 4.1: Confusion Matrix of CNN

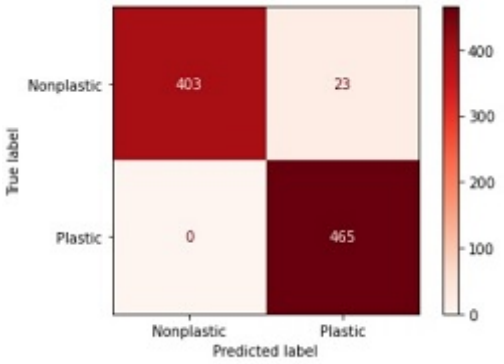


Figure 4.2: Confusion Matrix of Random Forest

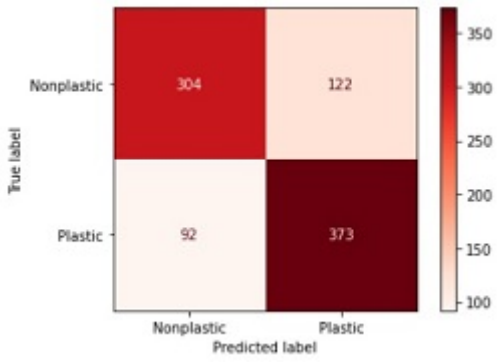


Figure 4.3: Confusion Matrix of Gaussian Naive Bayes

4.1.1 Calculation of Parameters

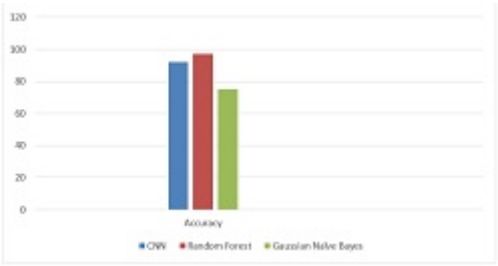
To study the three models, calculate the values of the following parameters.

1. Accuracy

The proportion of true positives and true negatives to all positive and negative observations is used to calculate the accuracy of a machine learning model. In other words, accuracy measures how often we can assume that our machine will correctly forecast the outcome based on all of the predicted iterations. The accuracy score derived from the confusion matrix above is displayed in the table below.

Model	TP	TN	FP	FN	Accuracy= $\frac{TP+TN}{TP+TN+FP+FN}$
CNN	380	461	46	4	0.943
RANDOM FOREST	403	465	23	0	0.974
NAÏVE BAYES	304	373	122	92	0.759

From the calculations, Random Forests achieved the highest accuracy score, i.e. 97%. The accuracy score is then plotted as follows

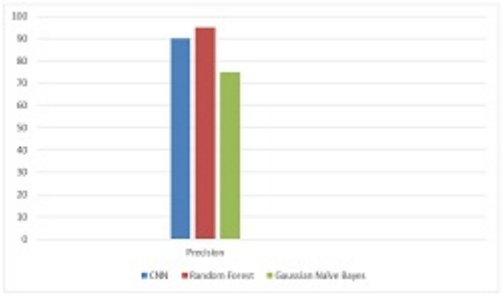


2. Precision

The percentage of positively predicted labels that are really correct is represented by the model's accuracy score. Positive predictive value and precision are both synonyms. False positives and false negatives are balanced using precision and recall. Class distribution affects precision. The following table represents the precision score from the above mentioned confusion matrix:

Model	TP	TN	FP	FN	Precision= $\frac{TP}{TP+FP}$
CNN	380	461	46	4	0.909
RANDOM FOREST	403	465	23	0	0.952
NAÏVE BAYES	304	373	122	92	0.753

After calculation, the precision score of Random Forests is higher than CNN & Gaussian Naive Bayes. The precision score is then plotted as follows

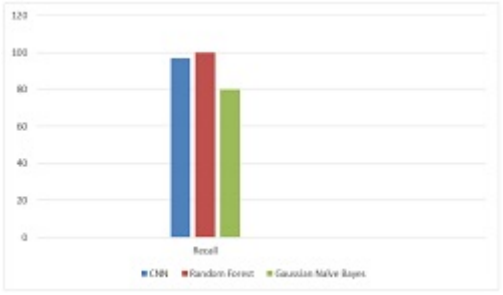


3. Recall

The model's recall score shows how well it can distinguish false positives from real positives. This is in contrast to precision, which assesses the proportion of a model's positive predictions that come to pass. The following table represents the recall score from the confusion matrix mentioned above:

Model	TP	TN	FP	FN	Recall = $\frac{TP}{TP+FN}$
CNN	380	461	46	4	0.989
RANDOM FOREST	403	465	23	0	1
NAÏVE BAYES	304	373	122	92	0.767

The table shows that Random Forest achieved the highest recall score. The recall score is then plotted as follows

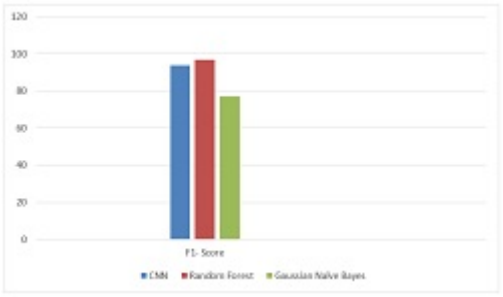


4. F1- Score

The precision and recall scores are functions of the model score, which is represented by the F1 model score. F-score is a substitute for the accuracy metrics in the following table since it measures the accuracy performance of machine learning models by equally weighting precision and recall:

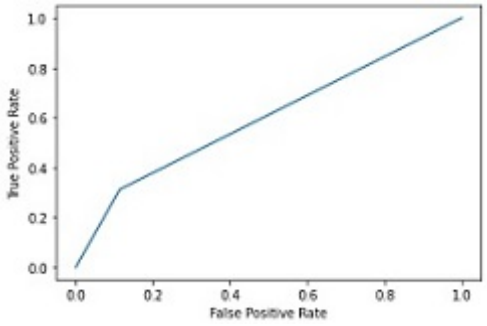
Model	Precision	Recall	F1- Score = $\frac{2*PRECISION*RECALL}{PRECISION+RECALL}$
CNN	0.909	0.989	0.947
RANDOM FOREST	0.952	1	0.975
NAÏVE BAYES	0.753	0.767	0.759

The highest F1 score belongs to Random Forest. Next, the F1 score is plotted as shown.

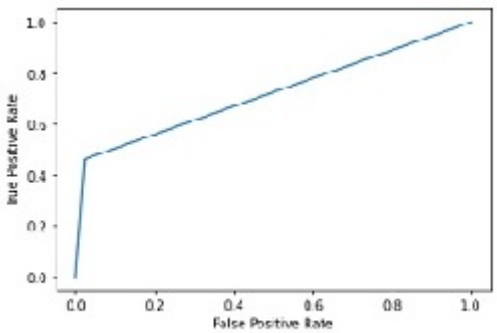


5. ROC

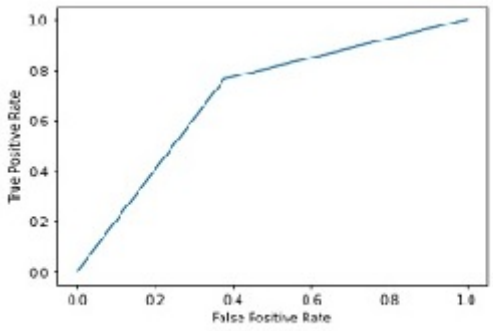
It also got simple to compare various three predictors on a certain data set. The area under the curve, or ROC, is all that matters; the greater the number, the better. The appropriate threshold for differentiating positive and negative samples is determined using ROC curves, which are used to assess how successfully your classifier can do so. ROC curves summarise the trade-off between the true positive rate and false positive rate for a predictive model using different probability thresholds. It is possible to choose the ideal operating point using the ROC curve. The three models' ROCs are as follows.



ROC of CNN



ROC of Random Forest



ROC of Gaussian Naive Bayes

Chapter 5

CONCLUSION

The findings demonstrate that the Random Forest Classifier can accurately, precisely, recall, and F1 score categorise garbage photos into plastic and non-plastic categories. Despite not reaching the same level of parameters, the other two models exhibit respectably strong accuracy, precision, recall, F1-score, and ROC. Successful development of a smart bin prototype that can automate decomposition and manage lid movement has been made.

In the future, a human detection sensor could be used in place of an ultrasonic sensor to identify people.

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