A PRELIMENERY REPORT
ON

SYSTEM FOR WASTE MANAGEMENT- SWACHH BHARAT MISSION

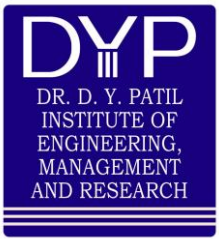
SUBMITTED TO THE SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE
IN THE PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE

OF

BACHELOR OF ENGINEERING (COMPUTER ENGINEERING)

SUBMITTED BY

STUDENT NAME	EXAM NO :
SHARDUL KULKARNI	BACO17102
SAGAR BORLE	BACO17107
ABHIKET MEHARE	BACO17122



DEPARTMENT OF COMPUTER ENGINEERING

DR. D.Y.PATIL INSTITUTE OF ENGINEERING, MANAGEMENT & RESEARCH

AKURDI, PUNE 411044
SAVITRIBAI PHULE PUNE UNIVERSITY

2020 -2021

DR. D. Y. PATIL INSTITUTE OF ENGINEERING, MANAGEMENT AND RESEARCH

CERTIFICATE

This is to certify that the project report entitles

"SYSTEM FOR WASTE MANAGEMENT- SWACHH BHARAT MISSION"

Submitted by

STUDENT NAME	EXAM NO:
SHARDUL KULKARNI	BACO17102
SAGAR BORLE	BACO17107
ABHIKET MEHARE	BACO17122

is a bonafide student of this institute and the work has been carried out by him/her under the supervision of Prof. **P. P. Shevatekar** and it is approved for the partial fulfillment of the requirement of Savitribai Phule Pune University, for the award of the degree of **Bachelor of Engineering** (Computer Engineering).

Prof. P. P. Shevatekar
Guide
Department of Computer Engineering

Prof.P.P.Shevatekar
Head,
Department of Computer Engineering

Dr. Anupama V. Patil
Principal,
Dr.D.Y.Patil Institute of Engineering,Management & Research Akurdi Pune – 41

Place : Pune
Date :

ACKNOWLEDGEMENT

We are pleased to acknowledge our indebtedness to Prof. P. P. Shevatekar our guide, for their innovative and invaluable suggestions in completing this work. We are thankful to them for their gracious encouragement and very valued constructive guidance in reviewing the results of this work. We offer profound gratitude towards Dr. A. V. Patil, Principal, DYPIEMR and Prof.P.P. Shevatekar, HOD of Computer Engineering Department for providing us all the excellent facilities required to complete this work.

We are thankful to other staff members of the Computer Engineering Department of DYPIEMR who have extended cooperation during the completion of this work.

Finally, we would like to thank all our friends who have directly or indirectly helped us during this course of work.

NAME OF THE STUDENTS

SHARDUL KULKARNI BACO17102
SAGAR BORLE BACO17107
ABHIKET MEHARE BACO17122

ABSTRACT

Waste management is all the activities and actions required to manage waste from its inception to its final disposal. This includes collection, transportation, treatment and disposal of waste together with monitoring and regulation. Waste collection methods vary widely among different countries and regions. Domestic waste collection services are often provided by local government authorities. Nowadays, cities with developing economies experience exhausted waste collection services, inadequately managed and uncontrolled dumpsites and the problems are worsening. Waste collection method in such countries is an ongoing challenge and many struggles due to weak institutions and rapid urbanization.

Using IoT, Machine Learning and Data Science we will provide a system for managing different types of waste in a proper way where even the users get benefited when they dump the organic and in-organic waste in a proper way. Even the users can sell the Iron scraps, books or paper waste through our system.

TABLE OF CONTENTS

LIST OF ABBREVATIONS

ABBREVIATION	ILLUSTRATION
IOT	Internet of Things
IR	Infrared Sensor
CNN	Convolutional Neural Network
AI	Artificial Intelligence
RFID	Radio Frequency Identification
NGO	Non Governmental Organisation
PMC	Pune Municipal Corporation
SRS	Software Requirement Specification

LIST OF FIGURES

CHAPTER 1

1. INTRODUCTION

1.1 OVERVIEW

This project is a combination of both hardware and software which helps municipality in managing waste, managing waste is of prime importance and also in public places and societies properly managed waste improves the air quality index as well as environment.

Aim of this module is to design a system with Raspberry pi which can help in the classification of waste.

If waste is not processed by municipality members then this system will help in classification of waste into Organic and Recyclable products with the help of machine learning and deep learning.

We also have Camera and IR sensor to detect the waste which is deposited by customers. For handling the unclassified waste (i. e plastic bags full of organic material) we have created a separate class.

We have created a portal where the user can track the kind of waste segregation he has done in the previous week. Depending on the highest score we can give some rewards.

1.2 MOTIVATION

Normally in any metropolitan cities or villages there is a big problem in the organization system of waste. There is no proper system that can manage and process the waste accordingly. First problem of the societies is that they can't find the proper solution to change the mindset of the people for maintaining hygiene. Sometimes recyclable products are not properly processed and thus resulting in landfills and floods. Another case is people sometimes throw the waste in the surrounding areas without any concern, so such things needs a proper solution. Some societies are just throwing away the organic or food waste generated from the households into the dustbins without making a proper use of it. They do not know the fact that processing such organic waste can help them get free bio-gas which in turn helps in getting electricity. Our main aim is to design a system and web app for helping and analyzing the organic, recyclable waste and thus providing solution for Swachh Bharat Mission started by our Honorable Prime Minister.

1.3 PROBLEM DEFINITION AND OBJECTIVES

Problem Statement:

Nowadays, cities with developing economies experience exhausted waste collection services, inadequately managed and uncontrolled dumpsites and the problems are worsening. So, to manage this problem build a system which properly manages and tracks the waste along with the benefits provided to end users

Objectives:

To develop more efficient and beneficial waste management system. To achieve the mission started by our Honorable Prime Minister- Swachh Bharat Mission.

1.4 PROJECT SCOPE & LIMITATIONS

It will help municipality to manage the waste and give the results which will help them in maintaining ecological balance. It will keep the place clean and systematic. It will organize the waste into recyclable and organic. It can be used as a personal system in societies or homes. It can be used for providing electricity by processing organic waste to bio-gas.

The limitations here are the challenges to make aware of the efficient and productive system to the society.

1.5 METHODOLOGIES OF PROBLEM SOLVING

Firstly the research papers regarding the waste management was discovered by various publication. Then the references were drawn by seeking help from the papers selected to built the different system than existing one.Various diagram were drawn to look at the flow and feasibility of the system. The hardware requirement were gathered from various sources and then the implementation of the prototype began .

The CNN model was developed and trained and would be deployed on the raspberry PI. The servers and Client was setup. After the trial and error of the hardware the CNN was deployed on the raspberry PI.

CHAPTER 2

2. LITERATURE SURVEY

2.1. Cenk Bircanoğlu, Meltem Atay, Fuat Beşer, Özgün Genç, Merve Ayyüce Kizrak, 'RecycleNet: Intelligent Waste Sorting Using Deep Neural Networks',(2018)

Description: Tried several different deep CNN architectures and applied different optimization methodologies on neural networks. To enhance the prediction performance of the models, altered the connection patterns of the skip connections inside dense blocks. Found Recyclenet as Optimized deep CNN. The networks used in this paper are slightly slower in prediction which may impact the overall system.

2.2. Gary White, Christian Cabrera, Andrei Palade, Fan Li, Siobh´an Clarke,' WasteNet: Waste Classification at the Edge for Smart Bins',(2020)'

Description: Prepared a waste classification CNN based model called WasteNet which can be deployed at low power device using transfer learning and data augmentation. There are some confused classification in this model which leads to mislabeled Classification of recyclable waste.

2.3. Muhannad Al-Jabi, Mohammad Diab, 'IoT-Enabled Citizen Attractive Waste Management System',(2017)

Description: It involves the waste management process by using IoT unit on each trash bin equipped with an RFID reader,weight sensor and ultrasonic sensor to evaluate the citizen interaction with the system and give them points according to that interaction. Moreover, the system provides a control mechanism for the waste collection trucks, such that it has a control that verifies the location for dumping and evacuation processes before it permits any process to start. Algorithms used do not consider the filling rate of each bin, the truck location and the shortest path in order the threshold for each bin as well to optimize the bin dumping process.

2.4. Dimitris Ziouzios, Dimitris Tsiktsiris, Nikolaos Baras and Minas Dasygenis, 'A Distributed Architecture for Smart Recycling Using Machine Learning', (2020)

Description: Paper has cloud based classification algorithm for automated machines in recycling factories using machine learning using which outputs 96.57 accuracy on MobileNet model improved by data augmentation and hyper-parameter tuning. Did not evaluate performance of system on federated learning techniques.

2.5. Fayez Alqahtani,Zafer Al-Makhadmeh, Amr Tolba, Wael Said3, 'Internet of things-based urban waste management system for smart cities using a Cuckoo Search Algorithm',(2020)

Description: This paper analyzed a CLSTRNN-based approach to urban smart waste management.TrashNet dataset properties was extracted through the use of robust speeded-up descriptors.From the derived value, the features were trained and stored with their respective class labels in the database using tanh activation function Thus, the introduced system improved the overall waste management system on the basis of bin priority with minimum processing time (15 min), max accuracy (98.4%), and minimum error (0.16).Appling Metaheuristic feature selection along with the feature training process should have improved the performance.

2.6. Chutimet Srinilta, Sivakorn Kanharattanachai, 'Municipal Solid Waste Segregation with CNN',(2019)

Description: This paper explored performance of CNN-based waste-type classifiers (VGG-16, ResNet-50, MobileNet V2 and DenseNet-121) in classifying waste types of 9,200 municipal solid waste images.Derived classifiers outperformed others.ResNet-50 classifiers performed equally well in classifying waste items and waste types.The training dataset is very small which suggest that model may not be reliable.

2.7. Zhuang Kang, Jie Yang, Guilan Li and Zeyi Zhang, 'An Automatic Garbage Classification System Based on Deep Learning',(2020)

Description: This paper proposes an improved algorithm based on ResNet-34 and three tailor-made modifications, including the multi feature fusion, the feature reuse of residual

unit, and optimization of activation function. An automatic garbage classification system is integrated with the proposed algorithm and necessary hardware, and the system is effective with the classification accuracy as high as 0.99 and stable with the classification cycle as quick as 0.95 seconds on average.The classification of small target is not well and can be improved in future and the classification criteria can be further extended, such as kitchen waste.

2.8. Sachin Hulyalkar, Rajas Deshpande, Karan Makode, and Siddhant Kajale, 'Implementation of Smartbin Using Convolutional Neural Networks',(2018)

Description: This paper is divided primarily into 3 modules: -The classifier module.The Raspberry Pi module.The website module.The classifier module is a CNN based prediction module which is fed with an images captured by the raspberry pi module for prediction of 4 classes of waste.The website module provides the graphical monthly statistical report about the percentage of waste segregated by each bin.Image segmentation can be used to separate multiple waste materials in the same image.Occlusion Detection can be done in order to find the hidden objects Sensors can be used in the trash cans in order to keep a check on the waste levels.

2.9. Krishna C. Rao, Binu Parthan and Kamalesh Doshi, 'Power from municipal solid waste at Pune Municipal Corporation',(2016)

Description: It demonstrates power generation from organic fraction of MSW in Pune Municipal Corporation(PMC) through generation of biogas and also the MAILHEM-PMC BIOGAS PLANT BUSINESS MODEL CANVAS.PMC biogas to electricity value chain provides the insights regarding the eco friendly electricity generation and its consumption by PMC.Lack of public awareness and active commitment and participation of citizens in local collection schemes.

2.10. Nurul Awanis Muhamad Faudzi, and Zarul Fitri Zaaba, 'Interactive and Usable Waste Management System: A concept by My Intelligent Bin (MIB)',(2018)

Description: The paper describes My Intelligent Bin (MIB),a new waste management system application that give benefits to both citizen and waste management company as the application can show garbage collection schedule, check garbage status collected or not, report problems and give feedback directly to the waste management company. For waste management company they able to generate report based on the report and used it as their reference to improve their service. QR Code scanning is used as a method for the garbage collection process so that waste management company able to track the waste management process in real time.It can only work with the usage of Internet and it only suitable for small residential area (i.e. registered with the company).Also load balancing of user pooling might affect the app.

CHAPTER 3

SOFTWARE REQUIREMENT SPECIFICATIONS

A software requirement specification (SRS) is a comprehensive description of the intended purpose and environment for software under development. The SRS fully describes what the software will do and how it will be expected to perform. The SRS provides an overview of the entire SRS with purpose, scope, acronyms, abbreviations, and references. The aim of the document is to gather and analyse and give an in-depth insight of the complete description.

3.1 ASSUMPTIONS AND DEPENDENCIES

The assumptions are: All the datasets that are being used to train the models are accurate and no discrepancy is present and all the articles that are being fed to the system for analysis are in the particular format of header and body, with sources clearly mentioned.

The dependencies are: We require a pi camera for continuous sensing of data and classifying it accordingly.

3.2 FUNCTIONAL REQUIREMENTS

3.2.1 **Raspberry pi:** It is the heart of the system. It is also used to give signals to both system and camera as and when required. It transfers the information to and fro from the database as required. It also supplies power(20v) to servo motor.

3.2.2 **Servo motor:** It acts has controlling unit for movements of module i.e. it gives direction to the lid of the bins for opening and closing.

3.2.3 **Camera:** Device for recording visual images in the form of photographs, film, or video signals.

3.2.4 **IR Sensor:** IR sensors is a type of Infrared sensors used to detect any object that comes its way. It is used to detect the waste that is being dumped in.

3.3 EXTERNAL INTERFACE REQUIREMENTS

3.3.1 Hardware Interfaces

Raspberry pi: Raspberry Pi 3 Model B. Raspberry Pi® is an ARM based credit card sized SBC (Single Board Computer) created by Raspberry Pi Foundation. Raspberry Pi runs Debian based GNU/Linux operating system Raspbian and ports of many other OSes exist for this SBC.

FIGURE 3.1: Raspberry Pi.

Camera: A camera is an optical instrument to capture still images or to record moving images, which are stored in a physical medium such as in a digital system or on photographic film. A camera consists of a lens which focuses light from the scene, and a camera body which holds the image capture mechanism. The still image camera is the main instrument in the art of photography and captured images may be reproduced later as a part of the process of photography, digital imaging, photographic printing. The similar artistic fields in the moving image camera domain are film, videography, and cinematography. The word camera comes from camera obscura, which means "dark chamber" and is the Latin name of the original device for projecting an image of external reality onto a flat surface.

Figure 3.2: Camera.

Servo motor: A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. Servomotors are not a specific class of motor, although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system. Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing.

Figure 3.3: Servo Motor.

IR Sensor: IR detectors are little microchips with a photocell that are tuned to listen to infrared light. They are almost always used for remote control detection - every TV and DVD player has one of these in the front to listen for the IR signal from the clicker. Inside the remote control is a matching IR LED, which emits IR pulses to tell the TV to turn on, off or change channels. IR light is not visible to the human eye, which means it takes a little more work to test a setup.

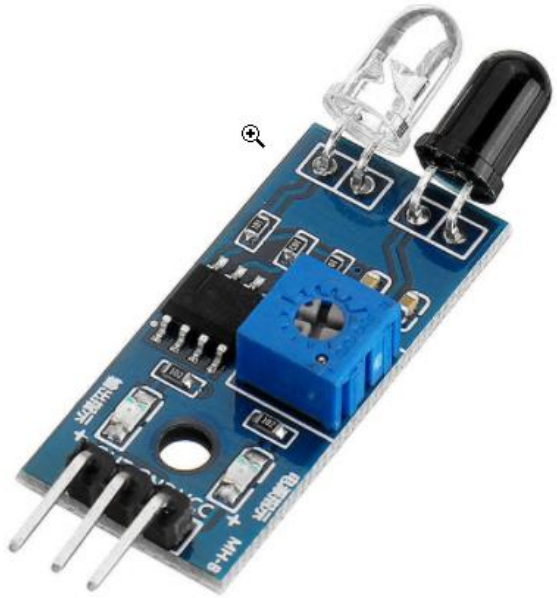


Figure 3.4: IR sensor.

3.3.2 Software Interfaces

Python 3.6:

Python is an easy to learn, powerful programming language. It has efficient high-level data structures and a simple but effective approach to object-oriented programming. Python's elegant syntax and dynamic typing, together with its interpreted nature, make it an ideal language for scripting and rapid application development in many areas on most platforms.

The Python interpreter and the extensive standard library are freely available in source or binary form for all major platforms from the Python Web site, https://www.python.org/, and may be freely distributed. The same site also contains distributions of and pointers to many free third-party Python modules, programs and tools, and additional documentation.

The Python interpreter is easily extended with new functions and data types implemented in C or C++ (or other languages callable from C). Python is also suitable as an extension language for customizable applications.

Raspbian OS:

Raspbian is a Debian-based computer operating system for Raspberry Pi. There are several versions of Raspbian including Raspbian Buster and Raspbian Stretch. Since 2015 it has been

officially provided by the Raspberry Pi Foundation as the primary operating system for the family of Raspberry Pi single-board computers. Raspbian was created by Mike Thompson and Peter Green as an independent project. The initial build was completed in June 2012. The operating system is still under active development. Raspbian is highly optimized for the Raspberry Pi line's low-performance ARM CPUs.

Tensor flow 2.0:

TensorFlow the massively popular open-source platform to develop and integrate large scale AI and Deep Learning Models has recently been updated to its newer form TensorFlow 2.0. This brings a massive boost in features in the originally feature-rich ML ecosystem created by the TensorFlow community. What is Open-Source and how is it made TensorFlow so successful? Open-Source means the something that the people (mainly developers) can modify, share, integrate because all the original design features are open to all. This makes it very easy for a particular software, product to expand easily, effectively and in a very little time. This feature allowed the original creator of TensorFlow i.e. Google to easily port this into every platform available in the market that includes Web, Mobile, Internet of Things, Embedded Systems, Edge Computing and included support of various other languages such JavaScript, Node.js, F#, C++, C#, React.js, Go, Julia, Rust, Android, Swift, Kotlin and many other.

Firebase:

Firebase is a toolset to “build, improve, and grow your app”, and the tools it gives you cover a large portion of the services that developers would normally have to build themselves, but don’t really want to build, because they’d rather be focusing on the app experience itself. This includes things like analytics, authentication, databases, configuration, file storage, push messaging, and the list goes on. The services are hosted in the cloud, and scale with little to no effort on the part of the developer.

Pandas:

Pandas is an open source, BSD-licensed library providing high-performance, easy-to-use data structures and data analysis tools for the Python programming language. Pandas is a Num FOCUS sponsored project. This will help ensure the success of development of pandas as a world-class open-source project, and makes it possible to donate to the project. Pandas is a Python package providing fast, flexible, and expressive data structures designed to make working with structured (tabular, multidimensional, potentially heterogeneous) and time series data both easy and intuitive. It aims to be the fundamental high-level building block for doing practical, real world data analysis in Python. Additionally, it has the broader goal of becoming

the most powerful and flexible open source data analysis / manipulation tool available in any language. It is already well on its way toward this goal.

NumPy:

NumPy is the fundamental package for scientific computing with Python. It contains among other things: a powerful N-dimensional array object sophisticated (broadcasting) functions tools for integrating C/C++ and Fortran code useful linear algebra, Fourier transform, and random number capabilities. Besides its obvious scientific uses, NumPy can also be used as an efficient multi-dimensional container of generic data. Arbitrary data-types can be defined. This allows NumPy to seamlessly and speedily integrate with a wide variety of databases. NumPy is licensed under the BSD license, enabling reuse with few restrictions.

Matplotlib:

Matplotlib is a collection of command style functions that make matplotlib work like MATLAB. Each pyplot function makes some change to a figure: e.g., creates a figure, creates a plotting area in a figure, plots some lines in a plotting area, decorates the plot with labels, etc. In matplotlib.pyplot various states are preserved across function calls, so that it keeps track of things like the current figure and plotting area, and the plotting functions are directed to the current axes (please note that “axes” here and in most places in the documentation refers to the axes part of a figure and not the strict mathematical term for more than one axis).

Scikit:

scikit-learn is an open-source Python library that implements a range of machine learning, pre-processing, cross-validation and visualization algorithms using a unified interface.

Important features of scikit-learn:

1. Simple and efficient tools for data mining and data analysis.
2. It features various classification, regression and clustering algorithms including support vector machines, random forests, gradient boosting, k-means, etc.
3. Accessible to everybody and reusable in various contexts.
4. Built on the top of NumPy, SciPy, and matplotlib. Open source, commercially usable BSD license.

Anaconda Distribution:

The open-source Anaconda Distribution is the easiest way to perform Python/R data science and machine learning on Linux, Windows, and Mac OS X. With over 15 million users worldwide, it is the industry standard for developing, testing, and training on a single machine, enabling individual data scientists to:

1. Quickly download 1,500+ Python/R data science packages
2. Manage libraries, dependencies, and environments with Conda.
3. Develop and train machine learning and deep learning models with scikit-learn, TensorFlow, and Theano
4. Analyse data with scalability and performance with Dask, NumPy, pandas, and Numba
5. Visualize results with Matplotlib, Bokeh, Datashader, and Holoviews/

Google Colab:

Colaboratory is a free Jupyter notebook environment that requires no setup and runs entirely in the cloud. With Colaboratory you can write and execute code, save and share your analyses, and access powerful computing resources, all for free from your browser.

For anyone who doesn't already know, Google has done the coolest thing ever by providing a free cloud service based on Jupyter Notebooks that supports free GPU. ... Colab provides GPU and it's totally free. Seriously! There are, of course, limits.

Hive:

The Apache Hive data warehouse software facilitates reading, writing, and managing large datasets residing in distributed storage using SQL. Structure can be projected onto data already in storage. A command line tool and JDBC driver are provided to connect users to Hive.

Apache Hive helps with querying and managing large datasets real fast. It is an ETL tool for Hadoop ecosystem. In this tutorial, you will learn important topics of Hive like HQL queries, data extractions, partitions, buckets and so on.

Hive is developed on top of Hadoop. It is a data warehouse framework for querying and analysis of data that is stored in HDFS. Hive is an open source-software that lets programmers analyse large data sets on Hadoop. The size of data sets being collected and analysed in the industry for business intelligence is growing and, in a way, it is making traditional data warehousing solutions more expensive.

Spark:

Apache Spark achieves high performance for both batch and streaming data, using a state-of-the-art DAG scheduler, a query optimizer, and a physical execution engine. Spark is a distributed platform for executing complex multi-stage applications, like machine learning algorithms, and interactive ad hoc queries. Spark provides an efficient abstraction for in-memory cluster computing called Resilient Distributed Dataset.

Pytorch:

PyTorch is an open source machine learning library based on the Torch library, used for applications such as computer vision and natural language processing. Torch Script provides a seamless transition between eager mode and graph mode to accelerate the path to production. Scalable distributed training and performance optimization in research and production is enabled by the torch. Distributed backend. A rich ecosystem of tools and libraries extends PyTorch and supports development in computer vision, NLP and more.

3.3.3 Communication Interfaces

The stakeholders will communicate through the application interface.

Figure 3.5: Representing Communication Interface

3.4 NONFUNCTIONAL REQUIREMENTS

3.4.1 Performance Requirements

1) Response Time:

The length of time taken for a person or system to react to a given stimulus or event. Response time is the total amount of time it takes to respond to a request for service. That service can be anything from a memory fetch, to a disk IO, to a complex database query, or loading a full web page. Ignoring transmission time for a moment, the response time is the sum of the service time and wait time. 0.1 Second for clicks. It shows that the system is reacting instantaneously, meaning that no special feedback is necessary. 1.0 Second for loading and displaying the results or outputs required

2) Workload:

The amount of work or of working time expected or assigned students with a heavy workload. The amount of work performed or capable of being performed (as by a mechanical device) usually within a specific period.

3.4.2 Reliability Requirements

The application should provide a reliable environment to both the users. i.e. Admin, and customer. The functionalities and working of the application should be easy and there should not be errors.

3.4.3 Security Requirements

1. The database used is decentralized and distributed in nature. So, altering the data through database breach is not possible.
2. The security system features from having a login for all the users to access the application's full features. The login details will be used in the system also minimizing the chances of the application getting intruded.
3. Password strength is predetermined thus making it hard for an intruder to penetrate the block of security (for admin). During a long delay in the login page above the threshold decided, the page gets a timeout in order to make the system secured.

3.4.4 Efficiency Requirements

The application environment should be user friendly and accessible in an efficient manner. All the functionalities should be efficient with respect to end users.

3.5 SYSTEM REQUIREMENTS

3.5.1 Database Requirements

NoSQL in google firebase storage is used as the database.

3.5.2 Software Requirements(Platform Choice)

This module will use machine learning with the help of tensor flow and pyTorch. This module will also consist of a web portal using flask and No-SQL. The designed module will consist Raspbian as the OS.

3.5.3 Hardware Requirements

1. IR Sensor
2. Raspberry pi and node MCU
3. Camera
4. Servo motor

3.6 ANALYSIS MODELS: SDLC MODEL TO BE APPLIED

3.6.1 Introduction:

Prototyping is defined as the process of developing a working replication of a product or system that has to be engineered. The Prototyping Model is one of the most popularly used Software Development Life Cycle Models (SDLC models). This model is used when the customers do not know the exact project requirements beforehand. In this model, a prototype of the end product is first developed, tested and refined as per customer feedback repeatedly till a final acceptable prototype is achieved which forms the basis for developing the final product.

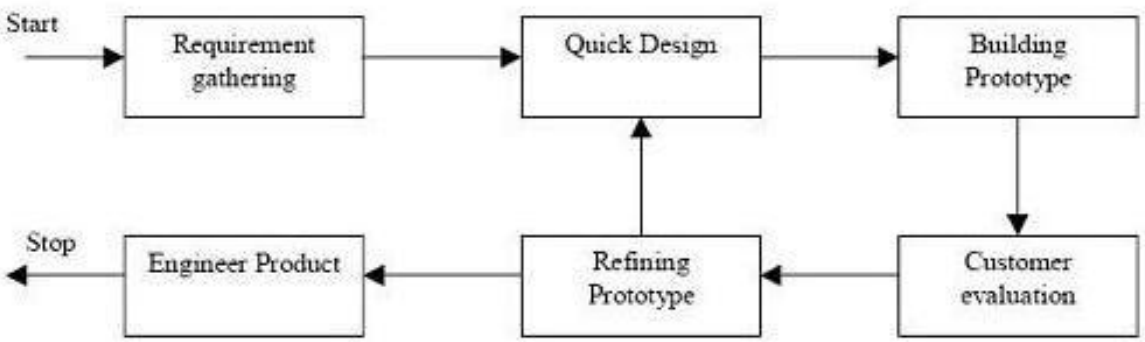


Figure 3.6: Prototyping Model

3.6.2 SDLC Phases

Prototyping Model has following six SDLC phases as follow: -

I. **Requirements gathering and analysis:** A prototyping model starts with requirement analysis. In this phase, the requirements of the system are defined in detail. During the process, the users of the system are interviewed to know what is their expectation from the system.

II. **Quick design:** The second phase is a preliminary design or a quick design. In this stage, a simple design of the system is created. However, it is not a complete design. It gives a brief idea of the system to the user. The quick design helps in developing the prototype.

III. **Build a Prototype:** In this phase, an actual prototype is designed based on the information gathered from quick design. It is a small working model of the required system.

IV. **Initial user evaluation:** In this stage, the proposed system is presented to the client for an initial evaluation. It helps to find out the strength and weakness of the working model. Comment and suggestion are collected from the customer and provided to the developer**.**

V. **Refining prototype:** If the user is not happy with the current prototype, you need to refine the prototype according to the user's feedback and suggestions. This phase will not over until all the requirements specified by the user are met. Once the user is satisfied with the developed prototype, a final system is developed based on the approved final prototype.

VI. **Implement Product and Maintain:** Once the final system is developed based on the final prototype, it is thoroughly tested and deployed to production. The system undergoes routine maintenance for minimizing downtime and prevent large-scale failures.

3.6.3 Advantages of the SDLC

Advantages of the Prototyping Model: -

- Users are actively involved in development. Therefore, errors can be detected in the initial stage of the software development process.
- Missing functionality can be identified, which helps to reduce the risk of failure as Prototyping is also considered as a risk reduction activity.
- Helps team member to communicate effectively
- Customer satisfaction exists because the customer can feel the product at a very early stage.
- There will be hardly any chance of software rejection.
- Quicker user feedback helps you to achieve better software development solutions.
- Allows the client to compare if the software code matches the software specification.
- It helps you to find out the missing functionality in the system.
- It also identifies the complex or difficult functions.
- Encourages innovation and flexible designing.
- It is a straightforward model, so it is easy to understand.
- No need for specialized experts to build the model
- The prototype serves as a basis for deriving a system specification.

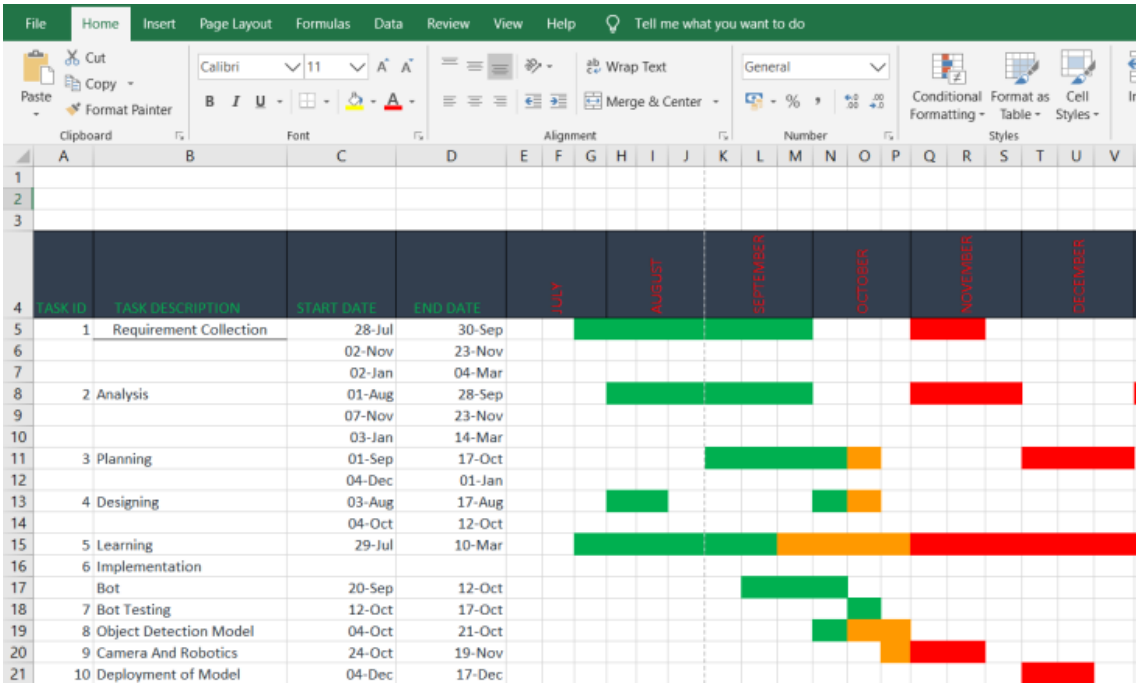
- The prototype helps to gain a better understanding of the customer's needs.
- Prototypes can be changed and even discarded.
- A prototype also serves as the basis for operational specifications.
- Prototypes may offer early training for future users of the software

3.6.4 Disadvantages of the SDLC

Disadvantages of the Prototyping Model: -

- Prototyping is a slow and time taking process.
- The cost of developing a prototype is a total waste as the prototype is ultimately thrown away.
- Prototyping may encourage excessive change requests.
- Sometimes customers may not be willing to participate in the iteration cycle for the longer time duration.
- There may be far too many variations in software requirements when each time the prototype is evaluated by the customer.
- Poor documentation because the requirements of the customers are changing.
- It is very difficult for software developers to accommodate all the changes demanded by the clients.
- After seeing an early prototype model, the customers may think that the actual product will be delivered to him soon.
- The client may lose interest in the final product when he or she is not happy with the initial prototype.
- Developers who want to build prototypes quickly may end up building sub-standard development solutions.

3.7 SYSTEM IMPLEMENTATION PLAN



TASK ID	TASK DESCRIPTION	START DATE	END DATE
1	Requirement Collection	28-Jul	30-Sep
		02-Nov	23-Nov
		02-Jan	04-Mar
2	Analysis	01-Aug	28-Sep
		07-Nov	23-Nov
		03-Jan	14-Mar
3	Planning	01-Sep	17-Oct
		04-Dec	01-Jan
4	Designing	03-Aug	17-Aug
		04-Oct	12-Oct
5	Learning	29-Jul	10-Mar
6	Implementation		
	Bot	20-Sep	12-Oct
7	Bot Testing	12-Oct	17-Oct
8	Object Detection Model	04-Oct	21-Oct
9	Camera And Robotics	24-Oct	19-Nov
10	Deployment of Model	04-Dec	17-Dec

Figure 3.7: System Implementation Plan.

CHAPTER 4

4 SYSTEM DESIGN

This project is a combination of both hardware and software which helps municipality in managing waste, managing waste is of prime importance and also in public places and societies properly managed waste improves the air quality index as well as environment. The hardware components consist of Camera, Raspberry pi and node MCU, IR sensors and Servo motor. Software components consist of UI for customer, Object detection model.

4.1 SYSTEM ARCHITECTURE

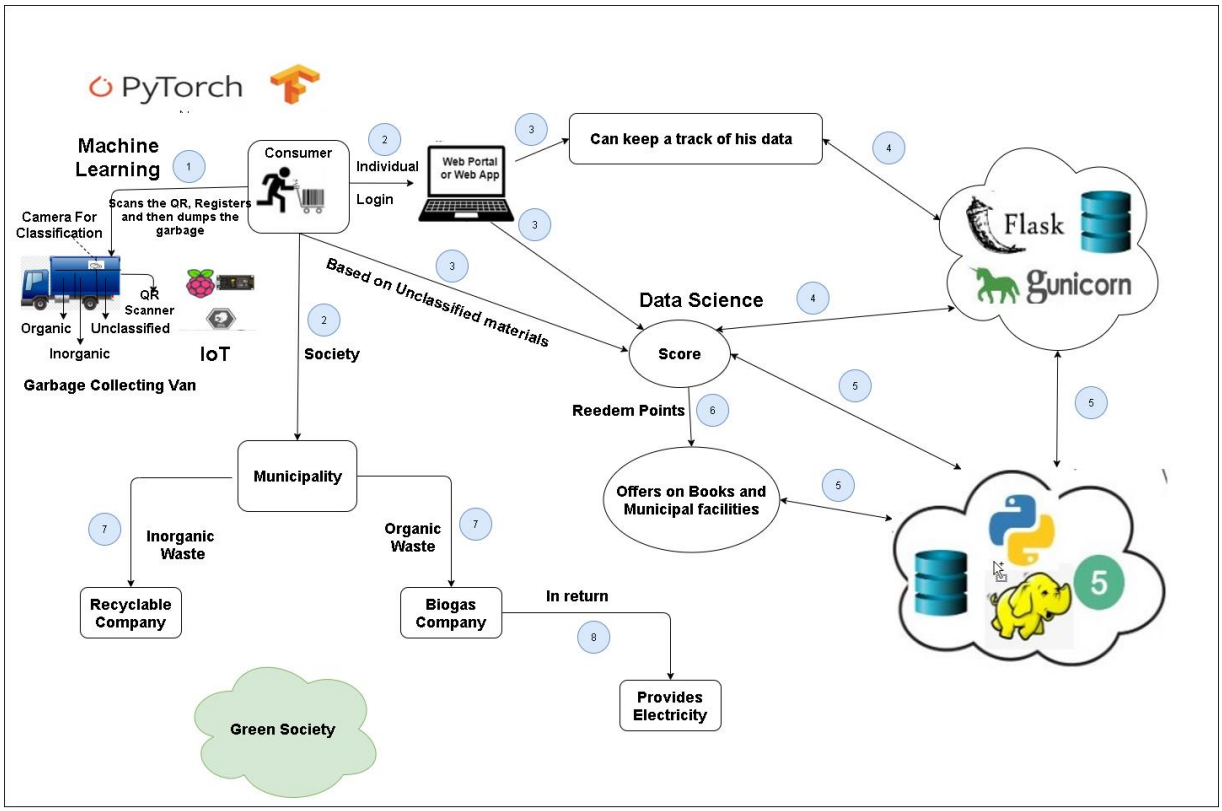


Figure 4.1: System Architecture.

4.2 DATA FLOW DIAGRAMS

A data-flow diagram (DFD) is a way of representing a flow of a data of a process or a system (usually an information system). The DFD also provides information about the outputs and inputs of each entity and the process itself. A data-flow diagram has no control flow, there are no decision rules and no loops. Specific operations based on the data can be represented by a flowchart.

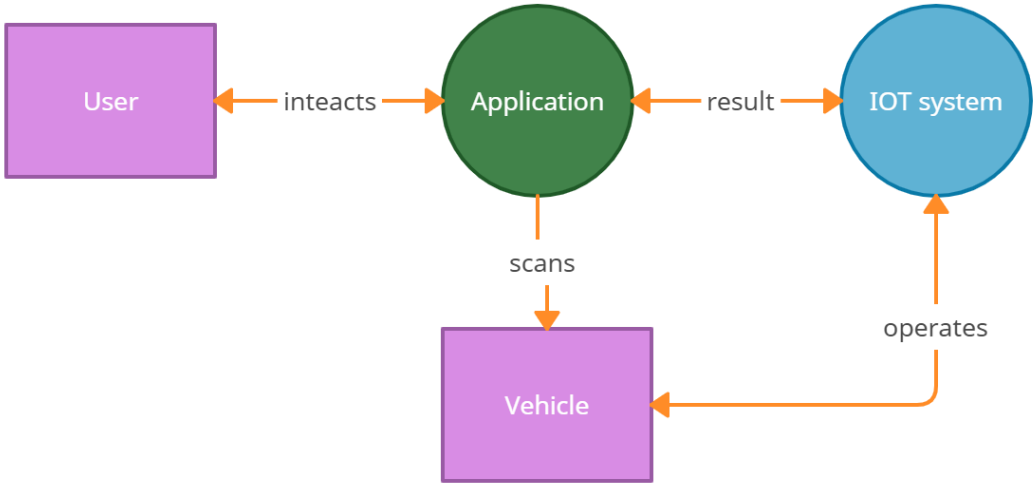


Figure 4.2: Data Flow Diagram(DFD) Level 0

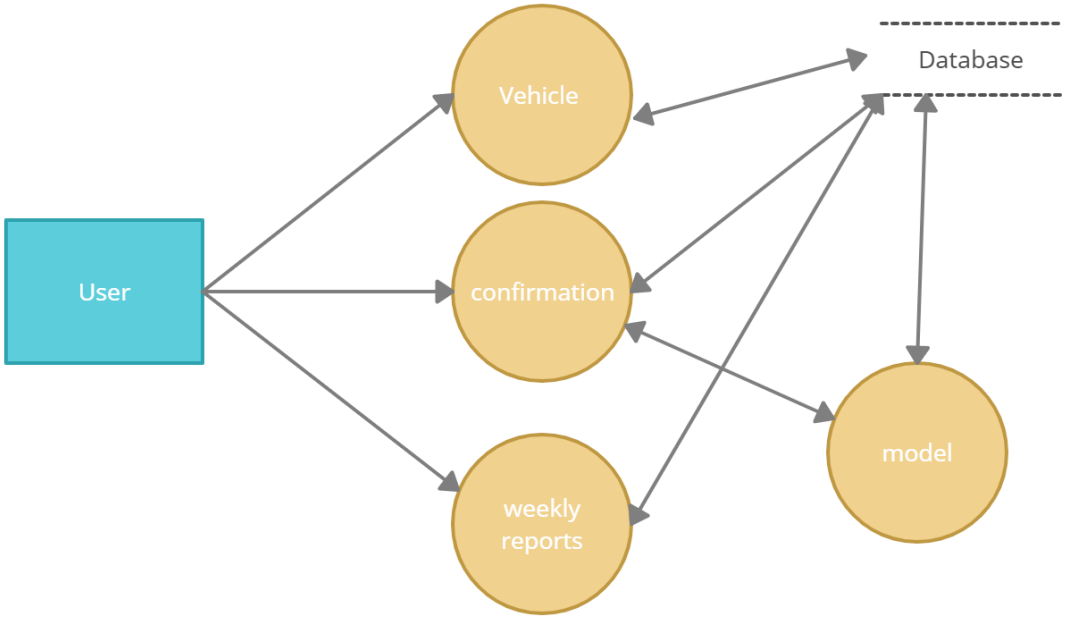


Figure 4.3: Data Flow Diagram(DFD) Level 1

4.3 ENTITY RELATIONSHIP DIAGRAMS

An Entity–relationship model (ER model) describes the structure of a database with the help of a diagram, which is known as Entity Relationship Diagram (ER Diagram). An ER model is a design or blueprint of a database that can later be implemented as a database. The main components of E-R model are: entity set and relationship set.

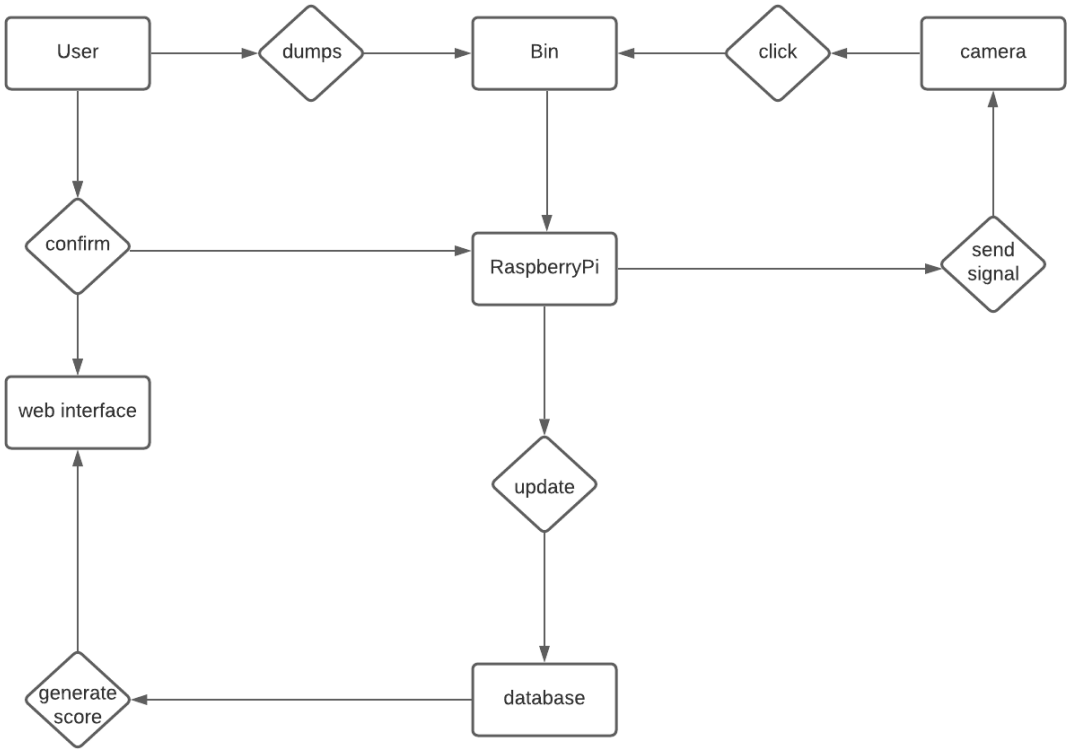


Figure 4.4: Entity Relation(ER) Diagram

4.4 UML DIAGRAMS

A use case diagram is a simple representation of a user's interaction with the system that shows the relationship between the user and the different use cases in which the user is involved. A use case diagram can identify the different types of users of a system and the different use cases. These different types of users are called as actors.

1.4.1. Usecase

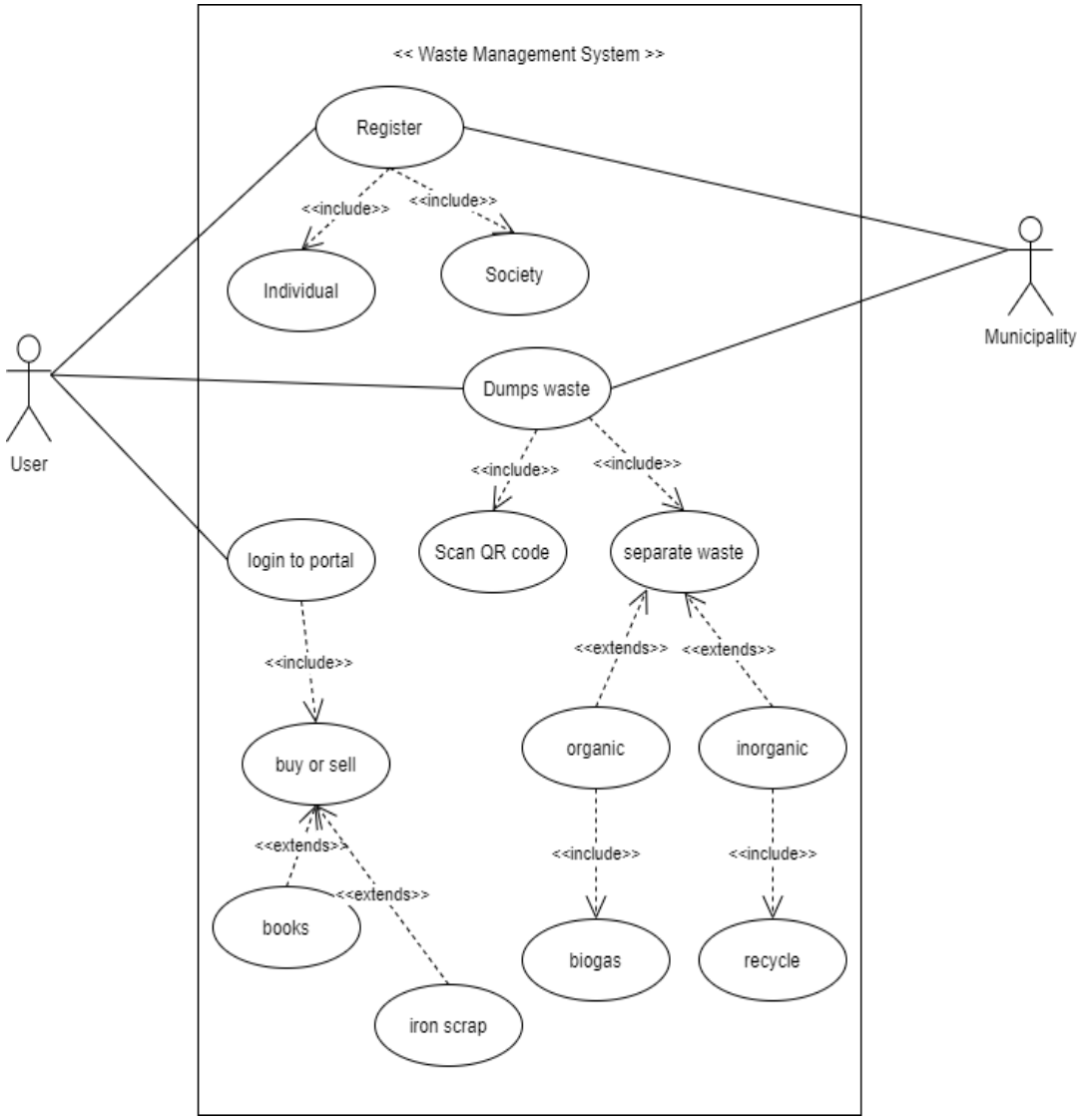


Figure 4.5: Usecase Diagram

1.4.2. Class

A class diagram in the Unified Modeling Language (UML) is a type of static structure diagram that describes the structure of a system by showing the system's:

- classes,
- their attributes,
- operations (or methods),
- and the relationships among objects.

Our project has five classes User,Application,QR code,Database and CNN model which have some variables such as username,password,vehicle no.,etc and methods such as generateScore,traiinmodel,etc.

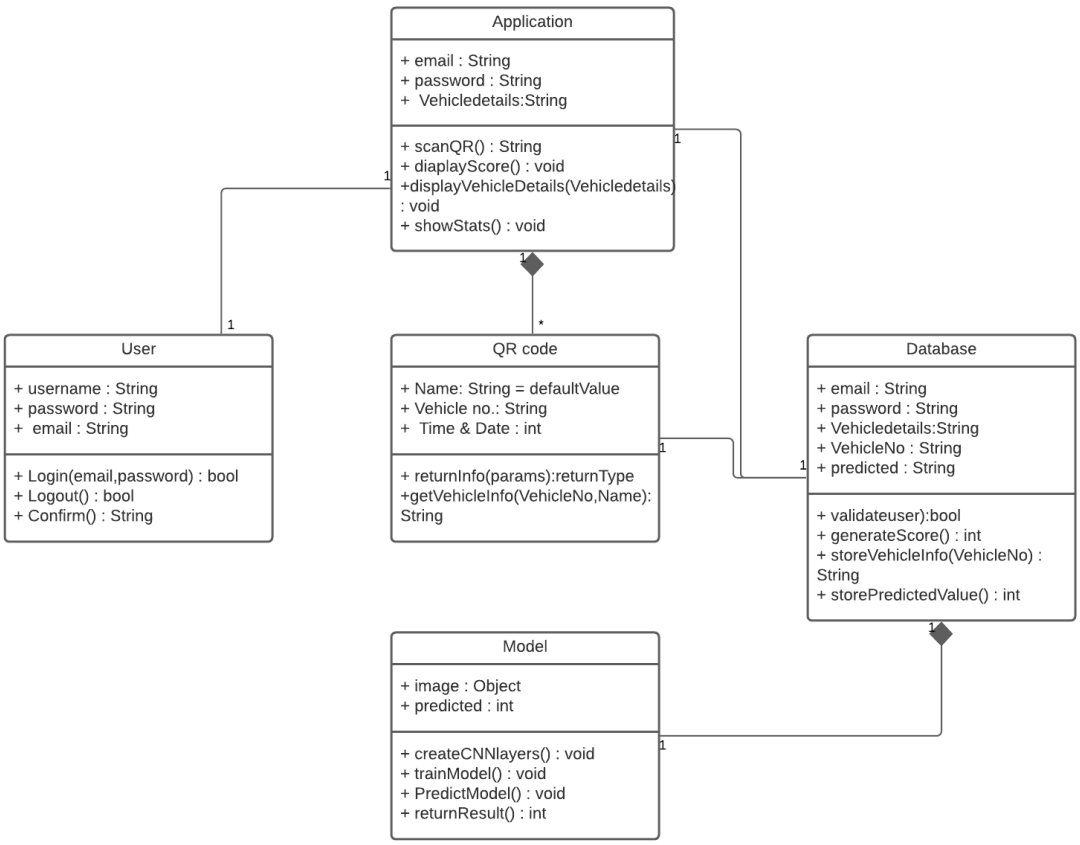


Figure 4.6: Class Diagram

1.4.3. Sequence

A sequence diagram is a type of interaction diagram because it describes how—and in what order a group of objects works together. Sequence diagrams are sometimes known as event diagrams or event scenarios.

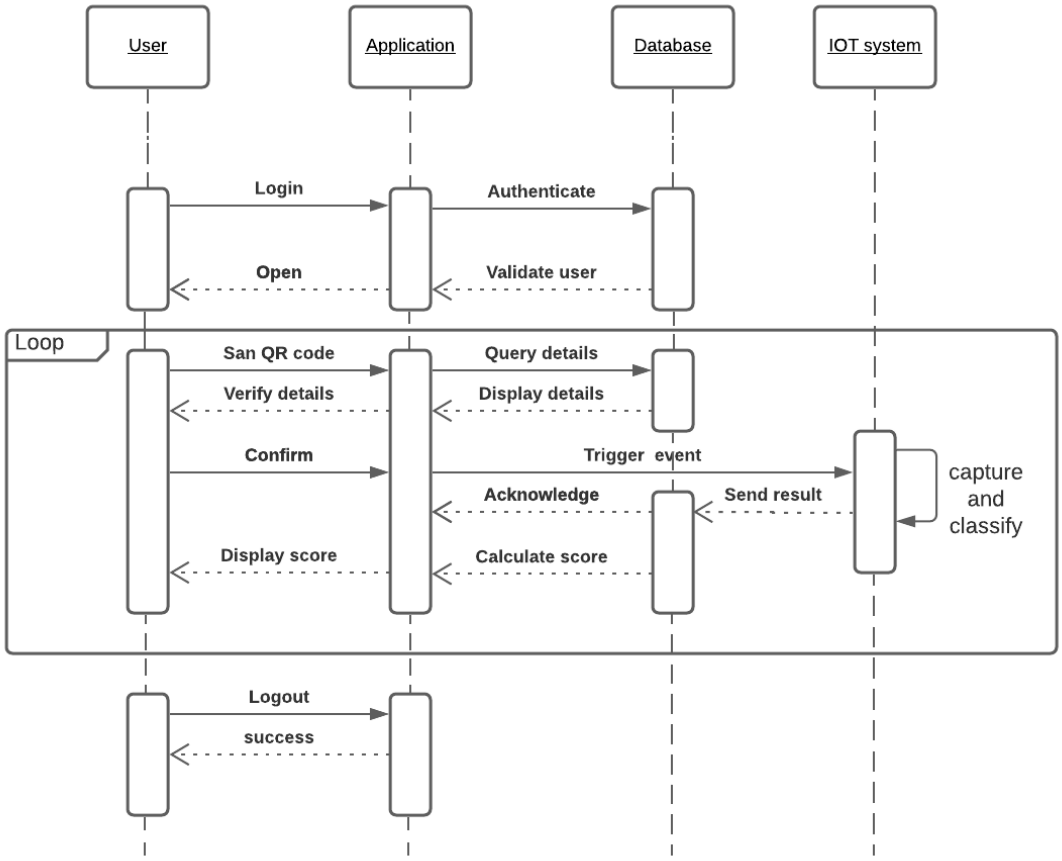


Figure 4.7: Sequence Diagram

CHAPTER 5

PROJECT PLAN

5.1. PROJECT ESTIMATE

5.1.1. Recoiled Estimates

5.1.2. Project Resources

5.2. RISK MANAGEMENT

5.2.1. Risk Identification

5.2.1.1. It is the process of determining potential threats which can later harm the performance of the project. One method of identifying risks is to create a risk item checklist. The checklist can be used for risk identification and focuses on some subset of known and predictable risks in the following generic subcategories:

5.2.1.2. Product size: Risks associated with the overall size of the software to be built or modified.

5.2.1.3. Business Impact: Risks associated with constraints imposed by management or the market place.

5.2.1.4. Customer characteristics: Risks associated with the sophistication of the customer and the developer's ability to communicate with customer in a timely manner.

5.2.1.5. Process definition: Risks associated with the degree to which the software process has been defined and is followed by the development organization.

5.2.1.6. Development Environment: Risks associated with the ability and quality of the tools to be used to build the product.

5.2.1.7. Technology to be built: Risks associated with the complexity of the system to be built.

5.2.1.8. Used System: System on which we are going to implanted are damaged due to some reasons.

5.2.2. Risk Analysis:

5.2.2.1. Risk management is concerned with identifying risks and drawing up plans to minimize their effect on a project.

5.2.2.2. A risk must also have a probability. It must be a chance to happen or it is not a risk.

5.2.2.3. The risks for project can be analyzed within the constraint of time and quality.

5.2.3. Overview of Risk Mitigation, Monitoring and Management

5.2.3.1. If the overall system used in the building and implementation of the project is out dated, then it may cause problems which may disturb the entire flow of the project. For this case, the system used should be up to date.

5.2.3.2. For the better and easy undertaking of the customer. The web application must be designed in such a way that implicates sophistication and ease of understanding and usage.

5.3. **PROJECT SCHEDULE**

5.3.1. Project Task Set

5.3.1.1. Task 1: Selection of topic

5.3.1.2. Task 2: Literature Survey

5.3.1.3. Task 3: Applications and Objectives

5.3.1.4. Task 4: Platform/Technology Selection

5.3.1.5. Task 5: Internal Presentation - 1

5.3.1.6. Task 6: Changes suggested by guide

5.3.1.7. Task 7: Requirement Gathering

5.3.1.8. Task 8: Software Requirements Specification

5.3.1.9. Task 9: UML Diagrams

5.3.1.10. Task 10: Problem Definition using NP Hard/ NP Complete

5.3.1.11. Task 11: System Architecture

5.3.1.12. Task 12: Checking Feasibility

5.3.1.13. Task 13: Internal Presentation – 2

5.3.1.14. Task 14: Changes suggested by guide

5.3.1.15. Task 15: Hardware Gathering

5.3.1.16. Task 16: Prototype Preparation

5.3.1.17. Task 17: Report Preparation

5.3.1.18. Task 18: Overview of Project Model

5.3.1.19. Task 19: Test Planning

5.3.1.20. Task 20: Testing

5.3.1.21. Task 21: Research of Journals For Final Report

5.3.2. Task Network

Project tasks and their dependencies are noted in this diagrammatic form.

Fig. 5.1: Task Network

5.3.3. Timeline chart

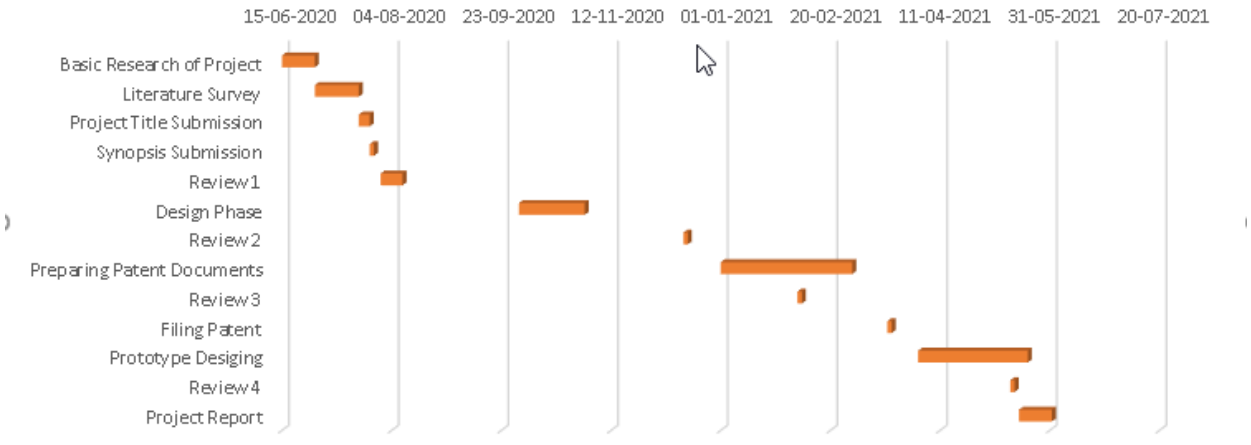


Fig. 5.2 : Timeline Chart

5.4. **TEAM ORGANIZATION**

5.4.1. Team Structure

Sr. No.	Member	Responsibilities
1	Shardul Kulkarni	Requirement analysis, Developer and Design
2	Sagar Borle	Requirement Gathering and Developer
3	Abhiket Mehare	Testing and Developer

5.4.2. Management reporting and communication.

5.4.2.1. We reported the progress of our project to our internal guide twice a week. We show our weekly status to our guide and incorporate the necessary changes. We communicate among ourselves in case we want suggestions while executing our tasks.

CHAPTER 6

PROJECT IMPLEMENTATION

6.1 OVERVIEW OF PROJECT MODULES

6.1.1 User: To scan the QR code on the vehicle :

6.1.1.1 Registration

6.1.1.2 DustBin Lid Opens

6.1.2 Server: The server will connect the client and predict the score of the classification and generate the points to be allotted to user.

6.1.3. Client: Client have the CNN model and captures images and classify the images.

1.1 TOOLS AND TECHNOLOGIES USED

1.1.1 Tensorflow

1.1.2 Flask

1.1.3 HTML

1.1.4 CSS

1.2 ALGORITHM DETAILS

1.2.1 In this project we are going to use Convolutional Neural Network for the classification of the model .

1.2.2 The images are gathered and the model is created .

1.2.3 Then the accuracy is calculated after prediction.

CHAPTER 7

SOFTWARE TESTING

7.1. TYPE OF TESTING

7.1.1. Unit testing:

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .it is done after the completion of an individual unit before integration. This is a structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

7.1.2. System Test:

System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration-oriented system integration test. System testing is based on process descriptions and flows, emphasizing pre-driven process links and integration points.

7.1.3 Manual testing:

Manual testing is a software testing process in which test cases are executed manually without using any automated tool. All test cases executed by the tester manually according to the end user's perspective. It ensures whether the application is working, as mentioned in the requirement document or not.

7.2. TEST CASES AND TEST RESULTS

7.2.1. In our project ,First our camera ,IR sensors and servomotor was tested on the raspberry PI using some script.

7.2.2. Then afterwards the client and server was tested by deploying CNN model over the raspberry PI and synchronizing the sensors ..

7.2.3. Then the system was tested using live image feed on the raspberry PI.

CHAPTER 8

RESULTS

8.1. OUTCOMES

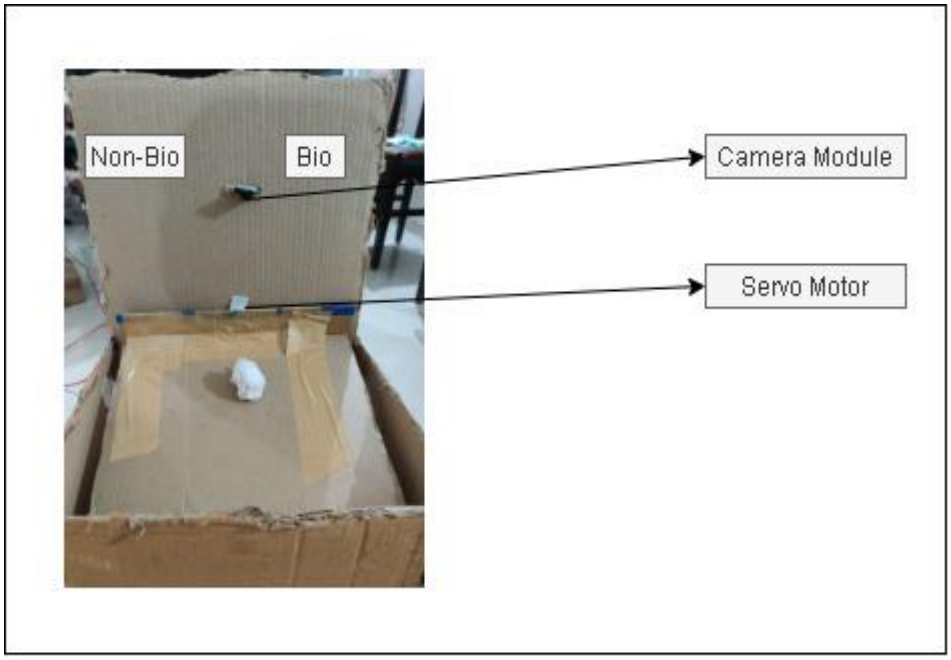


Fig. 8.1. Front-view of the prototype

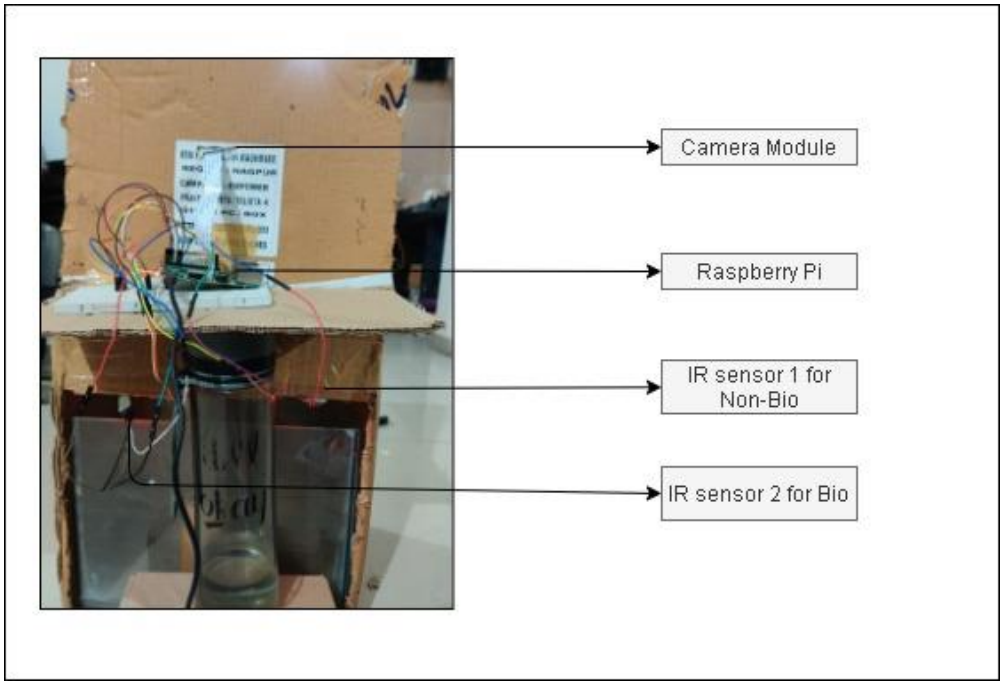


Fig. 8.2. Back-view of the prototype

8.2. **SCREENSHOTS**

Fig. 8.3. Starting the server.

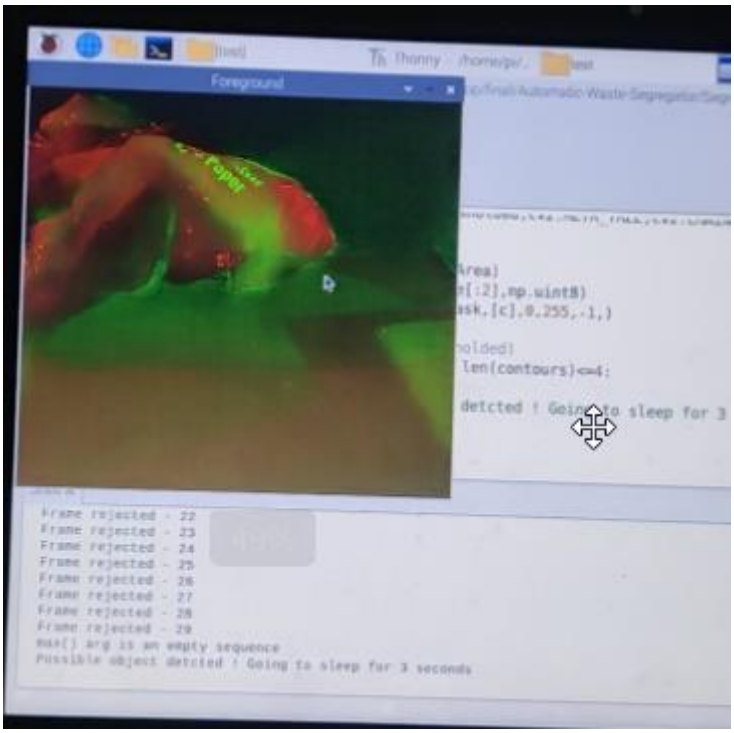


Fig. 8.4. Object is detected (Response from Client Side).

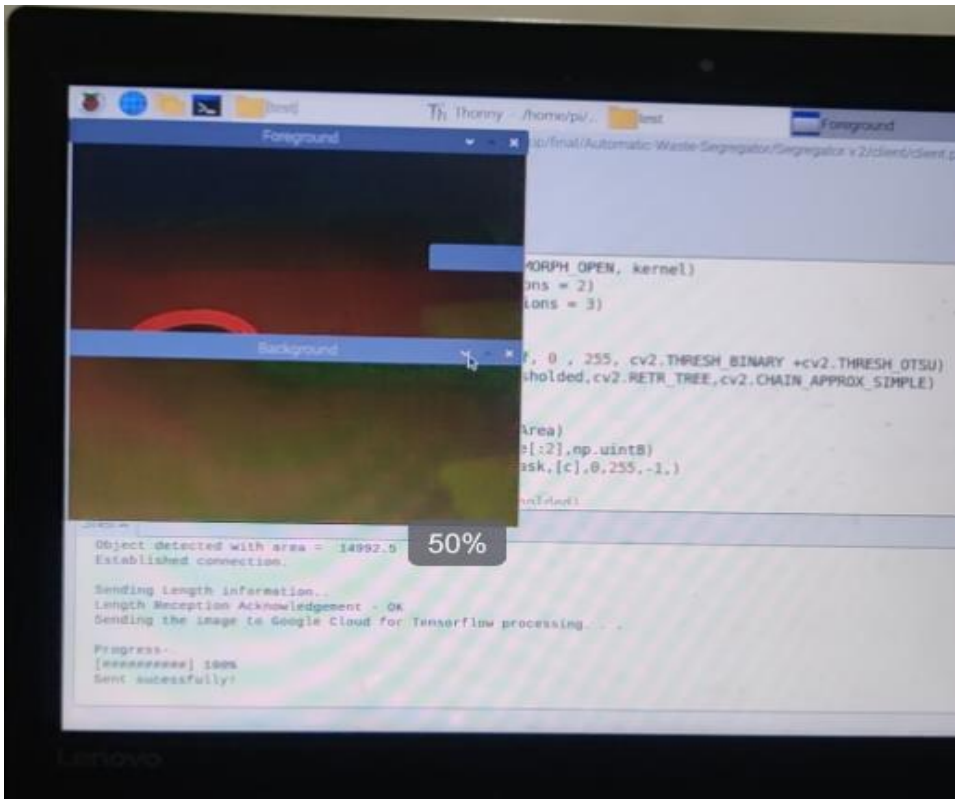


Fig. 8.5. Client-side(Capturing the photo and sending it to Server side for classification).

Fig. 8.6. Classifying the image into Bio-Degradable form depending on the image.

Fig. 8.7. Rotating the servo motor flap towards left side for Bio-degradable object

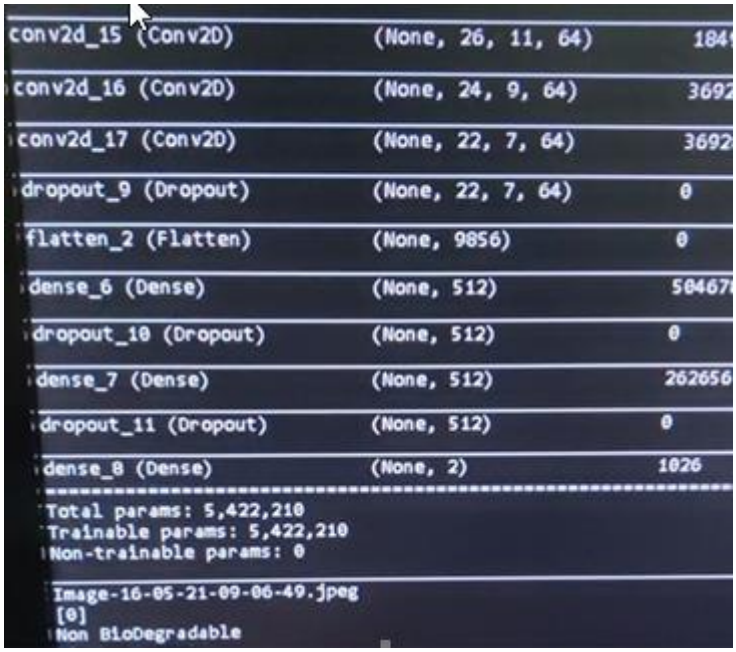


Fig. 8.8. Classifying the image into Non-BioDegradable form depending on the image.

Fig. 8.9. Rotating the servo motor flap towards right side for Non-Biodegradable object

Fig. 8.10. Response from IR-sensor 2 (Biodegradable bin is full)

CHAPTER 9

CONCLUSIONS

9.1 Conclusion

This concludes that the project undertaken is for helping the people by reducing their task of segregating waste manually. Even this system will be very helpful for analyzing the amount and kind of waste generated from a particular area.

9.2 Future Work

We can even integrate book selling system and iron scrap selling system in this model. Users can not only sell the books but also, they can buy the books and a book recommendation system will be provided for users

9.3 Applications

- Can be implemented in every city around the world to manage the waste.
- Even this system can be implemented in our homes.
- Societies can integrate this system and can turn into Green Society.

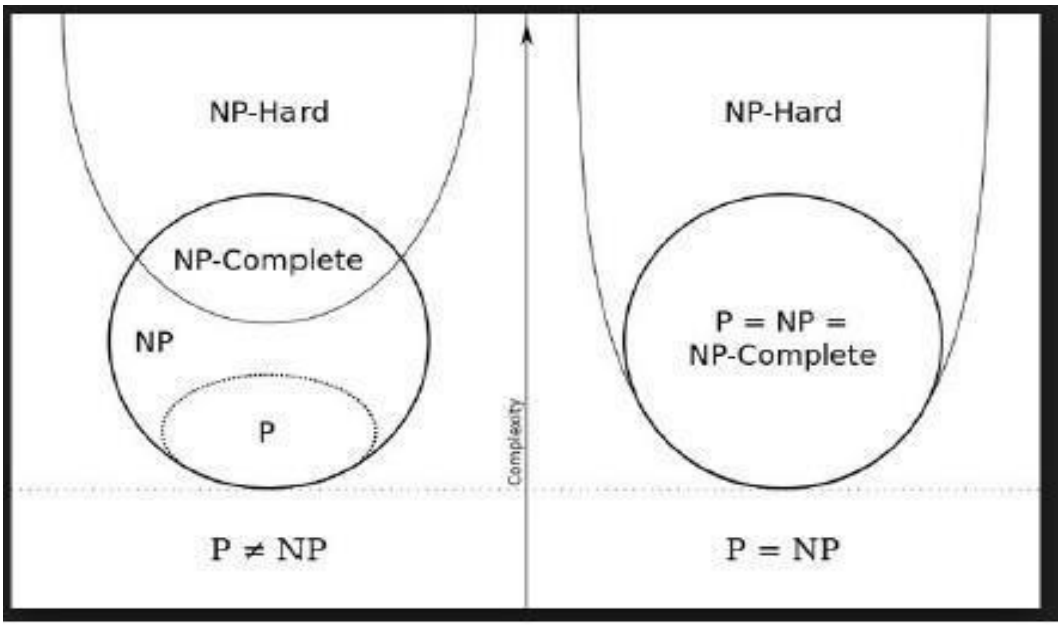
APPENDIX A:

P-Complete

- For any constant E greater than 0 there is a P-complete problem for which an E approximate solution can be found in linear time

- There exist P-Complete problems for which linear time approximate solutions that get closer and closer to the optimal (with increasing problem size) can be found.

- There exist P-Complete problems for which the approximation problems are also P-Complete. Formally, a decision problem is P-complete (complete for the complexity class P) if it is in P and that every problem in P can be reduced to it by using an appropriate reduction. The specific type of reduction used varies and may affect the exact set of problems. If we use NC reductions, that is, reductions which can operate in poly-logarithmic time on a parallel computer with a polynomial number of processors, then all P- complete problems lie outside NC and so cannot be effectively parallelized, under the unproven assumption that NC != P. If we use the weaker log- space reduction, this remains true, but additionally we learn that all P-complete problems lie outside L under the weaker unproven assumption that L != P. In this latter case the set P-complete may be smaller.



Comparison of classes

Figure 4.10: Comparison of classes

IoT based Waste Management system comes in class P. This is because problem can be solved in polynomial time. The polynomial time is nothing but the time expressed in terms of polynomial. It is not known whether NC = P. In other words, it is not known whether there are any tractable problems that are inherently sequential. Just as it is widely suspected that P does not equal NP, so it is widely suspected that NC does not equal P. Similarly, the class L contains all problems that can be solved by a sequential computer in logarithmic space. Such machines run in polynomial time because they can have a polynomial number of configurations. It is suspected that L!= P; that is, that some problems that can be solved in polynomial time also require more than logarithmic space.

Similarly, to the use of NP-complete problems to analyze the P=NP question, the P-complete problems, viewed as the probably not parallelizable or probably inherently sequential problems, serves in a similar manner to study the NC = P question. Finding an efficient way to parallelize the solution to some P-complete problem would show that NC = P. It can also be thought of as the problems requiring super logarithmic space; a log-space solution to a P-complete problem (using the definition based on log-space reductions) would imply L = P. The logic behind this is analogous to the logic that a polynomial-time solution to an NP-complete problem would prove P = NP: if we have a NC reduction from any problem in P to a problem A, and an NC solution for A, then NC = P. Similarly, if we have a log-space reduction from any problem in P to a problem A, and a log-space solution for A, then L = P.

Conclusion

Hence, we have studied the feasibility of the project problem statement using NP-Hard NP-complete. The problem statement of this project is P-Complete.

APPENDIX B:

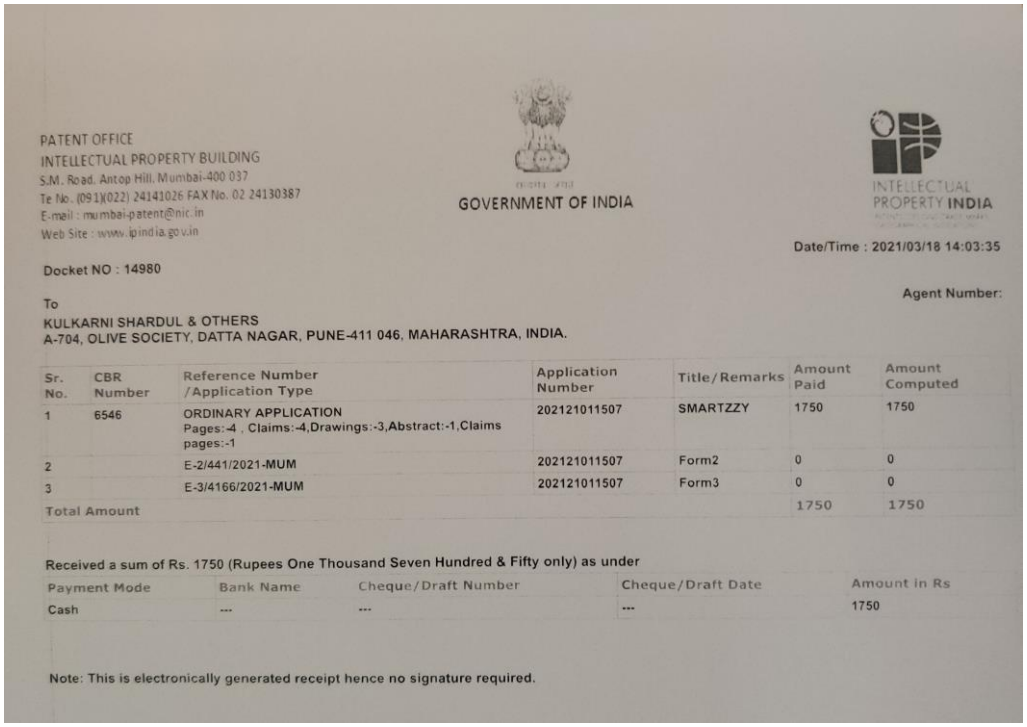
Details of the Patent Publishing:

a) **Patent Title:** "SMARTZZY"

b) **Name of the Patent Office where patent submitted:** IPR, Mumbai

c) **Patent accepted/rejected:** Accepted

d) **Review comments by reviewer:** Under Screening



PATENT OFFICE
INTELLECTUAL PROPERTY BUILDING
S.M. Road, Antop Hill, Mumbai-400 037
Te No. (091)(022) 24141026 FAX No. 02 24130387
E-mail : mumbai-patent@nic.in
Web Site : www.ipindia.gov.in

GOVERNMENT OF INDIA

INTELLECTUAL PROPERTY INDIA

Date/Time : 2021/03/18 14:03:35

Docket NO : 14980

Agent Number:

To
KULKARNI SHARDUL & OTHERS
A-704, OLIVE SOCIETY, DATTA NAGAR, PUNE-411 046, MAHARASHTRA, INDIA.

Sr. No.	CBR Number	Reference Number /Application Type	Application Number	Title/Remarks	Amount Paid	Amount Computed
1	6546	ORDINARY APPLICATION Pages:-4 , Claims:-4,Drawings:-3,Abstract:-1,Claims pages:-1	202121011507	SMARTZZY	1750	1750
2		E-2/441/2021-MUM	202121011507	Form2	0	0
3		E-3/4166/2021-MUM	202121011507	Form3	0	0
Total Amount					1750	1750

Received a sum of Rs. 1750 (Rupees One Thousand Seven Hundred & Fifty only) as under

Payment Mode	Bank Name	Cheque/Draft Number	Cheque/Draft Date	Amount in Rs
Cash	---	---	---	1750

Note: This is electronically generated receipt hence no signature required.

Fig. Patent Application

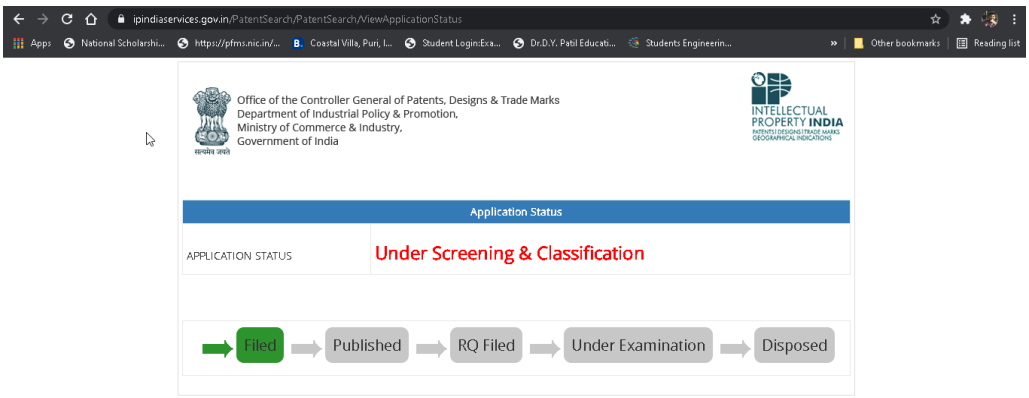
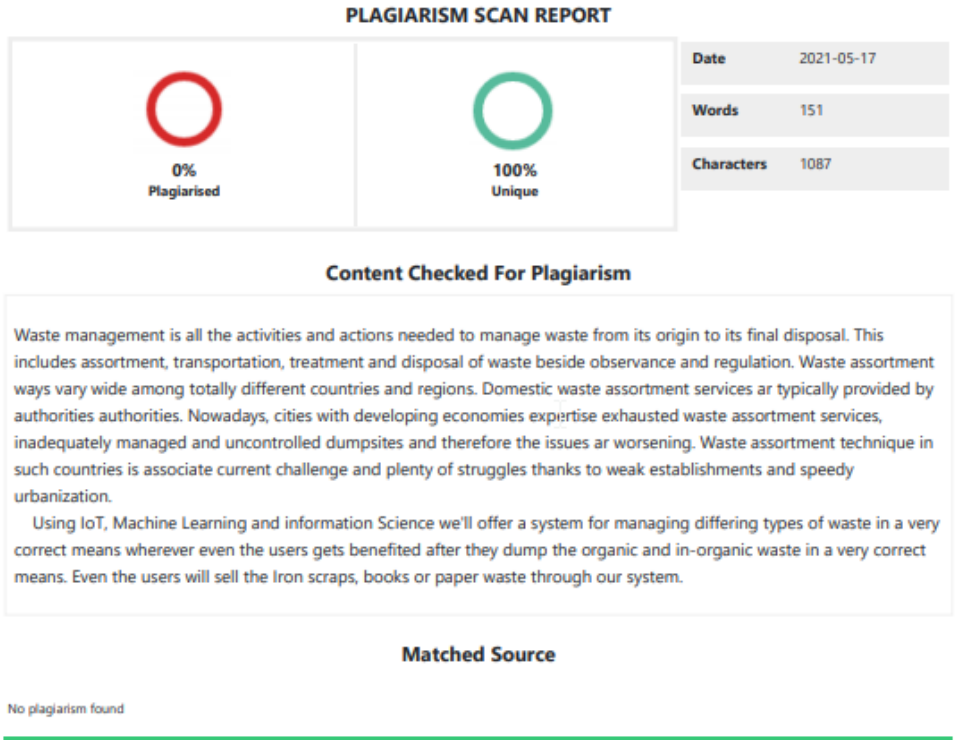


Fig. Patent Application Status

APPENDIX C:

PLAGIARISM REPORT

1. ABSTRACT



PLAGIARISM SCAN REPORT

0% Plagiarised

100% Unique

Date	2021-05-17
Words	151
Characters	1087

Content Checked For Plagiarism

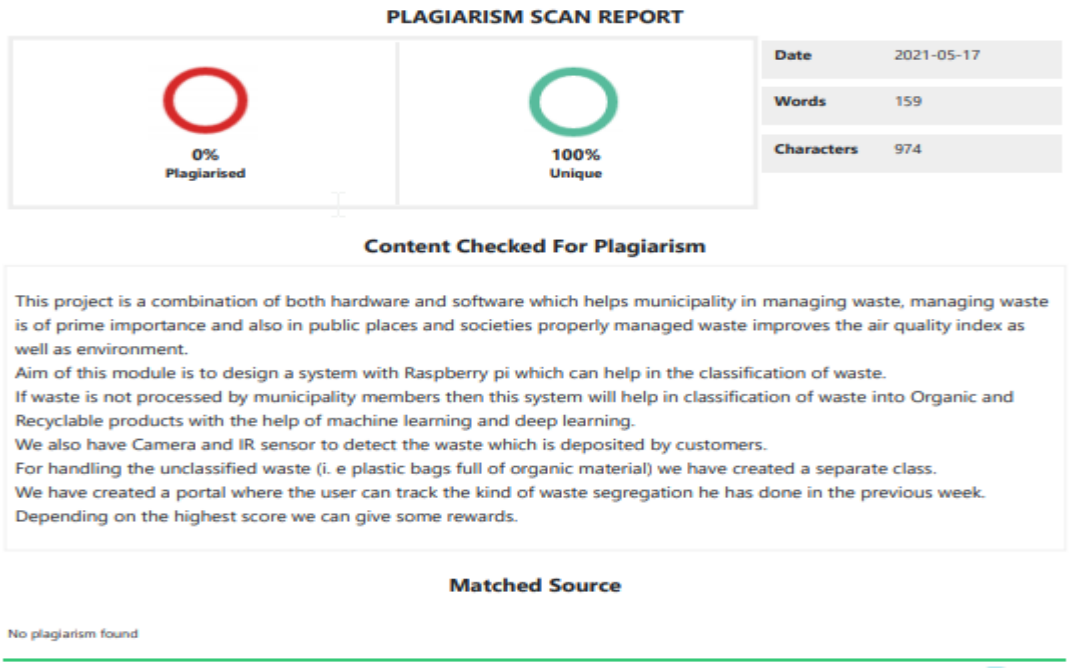
Waste management is all the activities and actions needed to manage waste from its origin to its final disposal. This includes assortment, transportation, treatment and disposal of waste beside observance and regulation. Waste assortment ways vary wide among totally different countries and regions. Domestic waste assortment services ar typically provided by authorities authorities. Nowadays, cities with developing economies expertise exhausted waste assortment services, inadequately managed and uncontrolled dumpsites and therefore the issues ar worsening. Waste assortment technique in such countries is associate current challenge and plenty of struggles thanks to weak establishments and speedy urbanization.

Using IoT, Machine Learning and information Science we'll offer a system for managing differing types of waste in a very correct means wherever even the users gets benefited after they dump the organic and in-organic waste in a very correct means. Even the users will sell the Iron scraps, books or paper waste through our system.

Matched Source

No plagiarism found

2. INTRODUCTION



PLAGIARISM SCAN REPORT

0% Plagiarised

100% Unique

Date	2021-05-17
Words	159
Characters	974

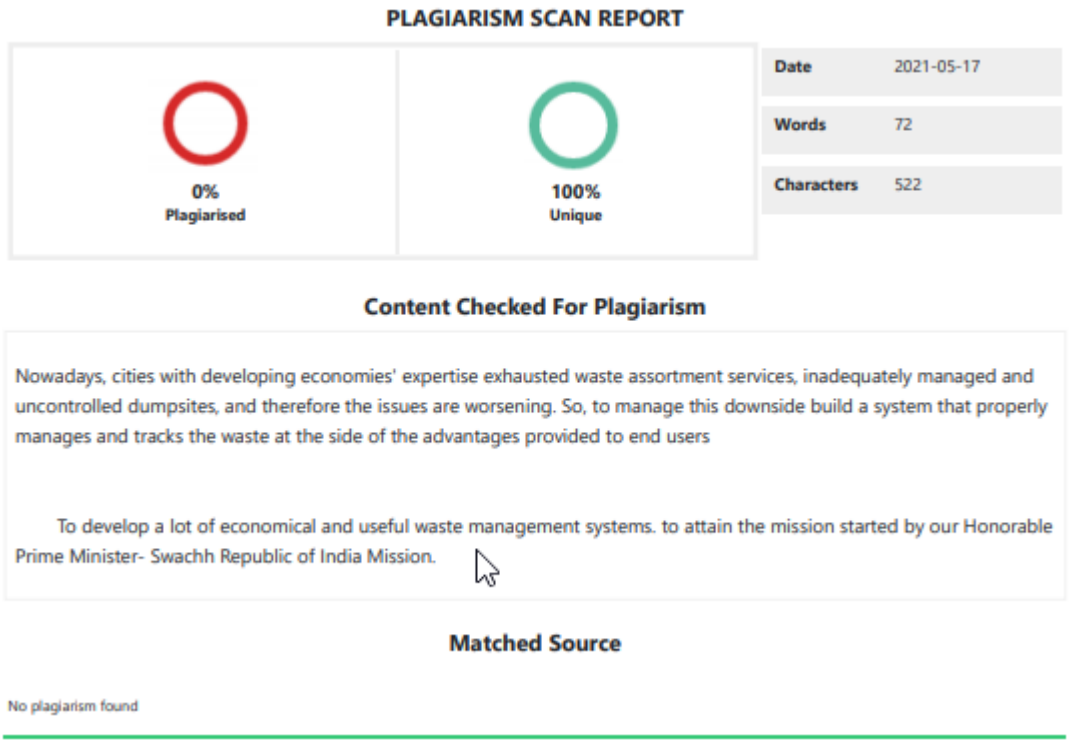
Content Checked For Plagiarism

This project is a combination of both hardware and software which helps municipality in managing waste, managing waste is of prime importance and also in public places and societies properly managed waste improves the air quality index as well as environment.
Aim of this module is to design a system with Raspberry pi which can help in the classification of waste.
If waste is not processed by municipality members then this system will help in classification of waste into Organic and Recyclable products with the help of machine learning and deep learning.
We also have Camera and IR sensor to detect the waste which is deposited by customers.
For handling the unclassified waste (i. e plastic bags full of organic material) we have created a separate class.
We have created a portal where the user can track the kind of waste segregation he has done in the previous week.
Depending on the highest score we can give some rewards.

Matched Source

No plagiarism found

3. PROBLEM STATEMENT



PLAGIARISM SCAN REPORT

0% Plagiarised

100% Unique

Date	2021-05-17
Words	72
Characters	522

Content Checked For Plagiarism

Nowadays, cities with developing economies' expertise exhausted waste assortment services, inadequately managed and uncontrolled dumpsites, and therefore the issues are worsening. So, to manage this downside build a system that properly manages and tracks the waste at the side of the advantages provided to end users

To develop a lot of economical and useful waste management systems. to attain the mission started by our Honorable Prime Minister- Swachh Republic of India Mission.

Matched Source

No plagiarism found

4. Conclusion

PLAGIARISM SCAN REPORT

0% Plagiarised

100% Unique

Date	2021-05-17
Words	39
Characters	271

Content Checked For Plagiarism

This concludes that the project undertaken is for helping the people by reducing their task of segregating waste manually. Even this system will be very helpful for analyzing the amount and kind of waste generated from a particular area.

Matched Source

No plagiarism found

References:

1. Gary White, Christian Cabrera, Andrei Palade, Fan Li, Siobh´an Clarke
   School of Computer Science and Statistics,Trinity College Dublin, Dublin, Ireland
   WasteNet: Waste Classification at the Edge for Smart Bins Wed, 10 Jun 2020
2. Muhannad Al-Jabi and Mohammad Diab, IoT-Enabled Citizen Attractive Waste Management System, IT-DREPS Conference, Amman, Jordan Dec 6-8, 2017
3. Fayez Alqahtani, Zafer Al-Makhadmeh, Amr Tolba and Wael Said, Internet of things-based urban waste management system for smart cities using a Cuckoo Search Algorithm, 6 May 2020 Springer Science+Business Media, LLC, part of Springer Nature 2020
4. Cenk Bircanoglu, Meltem Atay, Fuat Beser , O¨zgu¨n Genc and Merve Ayy¨uce Kızrak , RecycleNet: Intelligent Waste Sorting Using Deep Neural Networks, 2018
5. Jose M. Gutierrez, Michael Jensen, Morten Henius and Tahir Riaz, Smart Waste Collection System Based on Location Intelligence, Procedia Computer Science 61 (2015)
6. Krishna C. Rao, Binu Parthan and Kamalesh Doshi , Power from municipal solid waste at Pune Municipal Corporation (Pune, Maharashtra, India) , 2017
7. Dimitris Ziouzios, Dimitris Tsiktsiris, Nikolaos Baras and Minas Dasygenis, 'A Distributed Architecture for Smart Recycling Using Machine Learning', (2020)
8. Chutimet Srinilta, Sivakorn Kanharattanachai, 'Municipal Solid Waste Segregation with CNN',(2019)
9. Zhuang Kang, Jie Yang, Guilan Li and Zeyi Zhang, 'An Automatic Garbage Classification System Based on Deep Learning',(2020)
10. Sachin Hulyalkar, Rajas Deshpande, Karan Makode, and Siddhant Kajale, 'Implementation of Smartbin Using Convolutional Neural Networks',(2018)
11. https://www.pyimagesearch.com/2017/12/18/keras-deep-learning-raspberry-pi/
12. https://www.pmc.gov.in/en/move-smart-garbage-collection-system