INTEGRATED DESIGN PROJECT (IDP II)

CSE-460

AUTOMATED FRESHNESS AND DEFECTION DETECTOR

SOFTWARE REQUIREMENTS SPECIFICATION DOCUMENT

Submitted by

GROUP - FOXTROT A

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1 Preface:

Defining quality in food production is, arguably, one of the most widespread and complicated issues to solve when new products are released in the market. In short, food quality can be defined as the characteristics of food that are between certain limits of acceptance in every step of manufacturing, from the raw materials to the acceptance of consumers. Usage of computer science in terms of grading raw materials in our country is still not that popular in industrial levels. Our projectaims to create a detector of freshness and defection for grading general raw fruits or vegetables for industrial use. This document contains the entire system architecture and model of the system as well as the scope and requirements of the system functionality.

2 Introduction:

2.1 Purpose:

One of the biggest problems in the food industry is that it faces food spoilage specially in case of vegetables and fruits. The bigger problem is these spoilt items are going undetected and onto the hands of the consumer. In many fruits and vegetables industries, the process of checking of quality of items is done manually,mostly by a person sitting across a conveyor belt as the items pass by. The target of this project is to establish an efficient automated process which would not onlyincrease the accuracy of spoilt food detection, but also reduce manual manpowerrequired.

2.2 Intended Audience:

This project will provide an automated food freshness detector and the main audience is intended for the food industry. It will be useful for the industries as it decreases human dependency in industrial level food grading and replace it with machine dependency for better output of quality grading

2.3 Project Scope:

Fruit freshness grading via computer vision technology exploits on the fruit texture,colour and shape for visual feature evaluation. The whole system will work on identifying the raw and stale elements and separate them from the fresh ones. Thisproject will work using some specific food and vegetables (Apple, Banana, Mango,Tomato). All system information will be maintained in a database. The system is designed to use as few people as possible and get higher production rate and product quality.

2.4 Glossary:

CNN model: Convolutional Neural Networks (CNNs) is the most popular neural network model being used for image classification problem. The big idea behind CNNs is that a local understanding of an image is good enough.

VGG model: VGG is a convolutional neural network model which achieves 92.7% top-5 test accuracy in ImageNet, which is a dataset of over 14 million images belonging to 1000 classes. VGG also outperforms baselines on many tasks and datasets outside of ImageNet.

Computer vision: Computer vision is a field of artificial intelligence that trains computers to interpret and understand the visual world. Using digital images from cameras and videos and deep learning models, machines can accurately identify and classify objects — and then react to what they “see.”

Saliency map: In computer vision, a saliency map is an image that shows each pixel's unique quality. The goal of a saliency map is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze.

OpenCV: OpenCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library. OpenCV was built toprovide a common infrastructure for computer vision applications and to accelerate the use of machine perception in the commercial products.

Jetson Nano: Jetson Nano is a small, powerful computer that lets one run multiple neural networks in parallel for applications like image classification, object detection, segmentation, and speech processing. All in an easy-to-use platform that runs in as little as 5 watts. Windows isn't officially supported on Jetson. The official operating system for the Jetson Nano is the Linux4Tegra,based on Ubuntu 18.04.

2.5 References:

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[10] Farida, Caraka RE, Cenggoro TW, Pardamean B. Batik Parang Rusak Detection UsingGeometric Invariant Moment. 2018 Indones. Assoc. Pattern Recognit. Int. Conf., IEEE; 2018,p. 71–4.doi:10.1109/INAPR.2018.8627000.

[11] Muchtar K, Rahman F, Cenggoro TW, Budiarto A, Pardamean B. An Improved Version ofTexture-based Foreground Segmentation: Block-based Adaptive Segmenter. Procedia ComputSci 2018;135:579–86. doi:10.1016/j.procs.2018.08.228.

3 Overall Description:

The process of developing abstract models of our system, with each modelpresenting a different view or perspective of that system.

3.1 System Environment:

3.1.1 Context Diagram

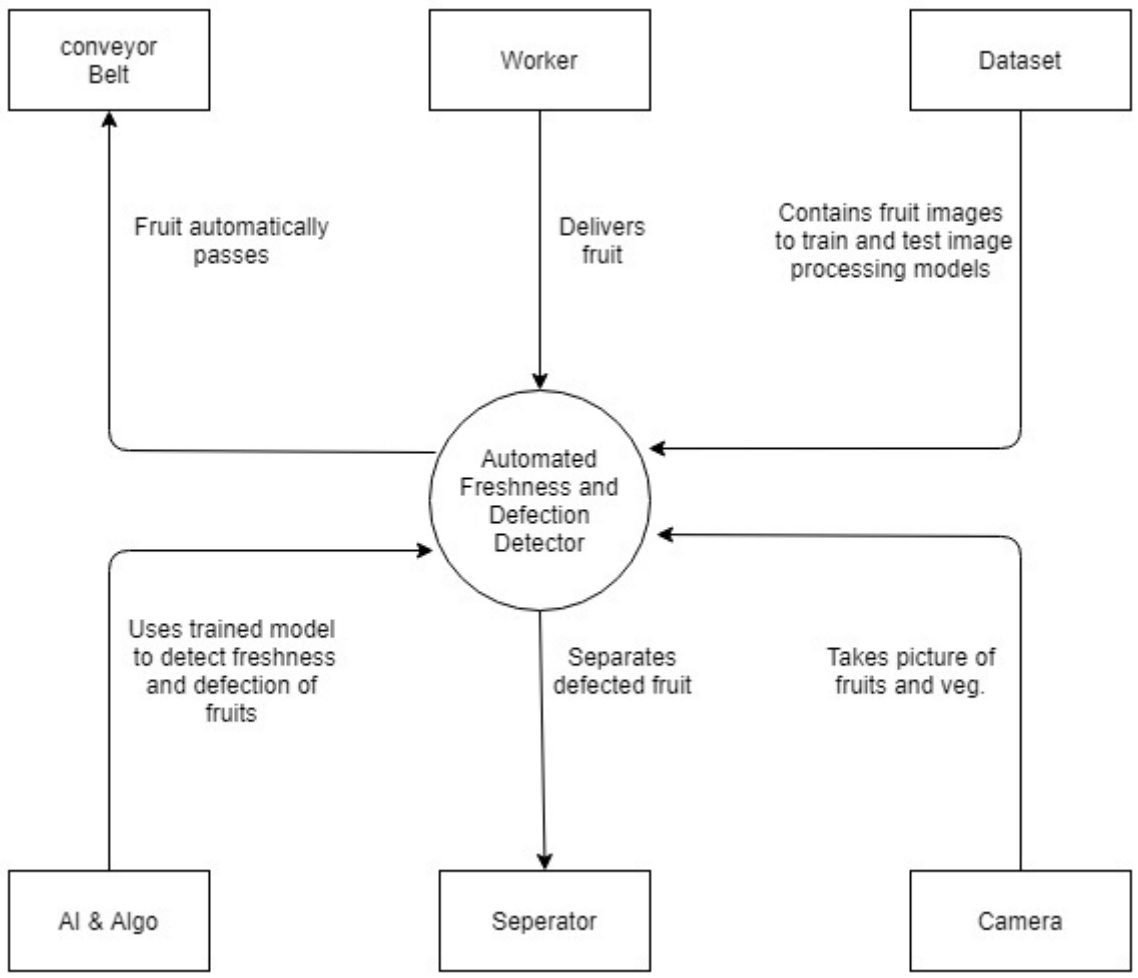


Fig: Context Diagram of Automated Freshness and Defection Detector

3.1.2 Activity Diagram

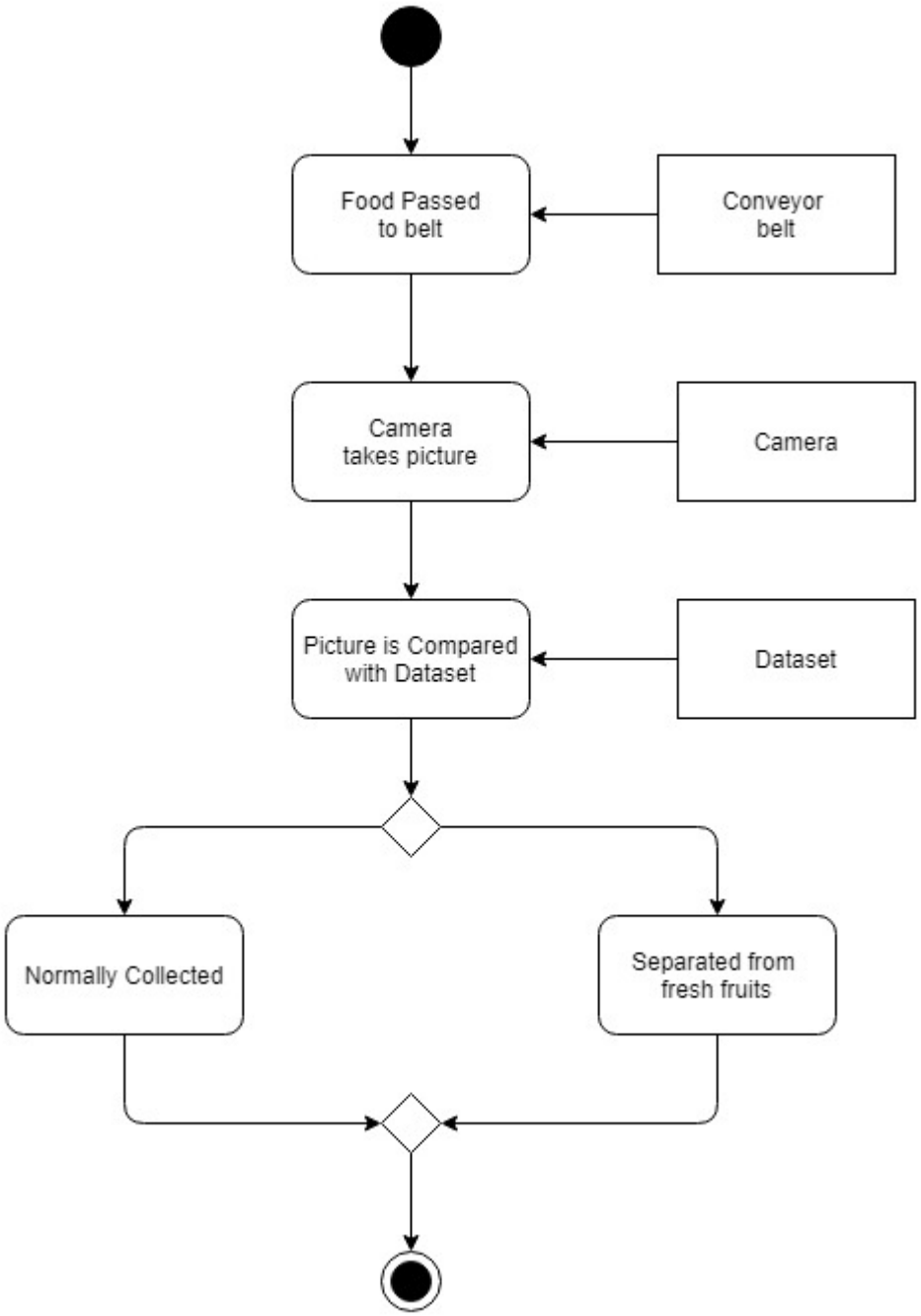


Fig: Activity Diagram of total system

3.1.3 Sequence Diagram

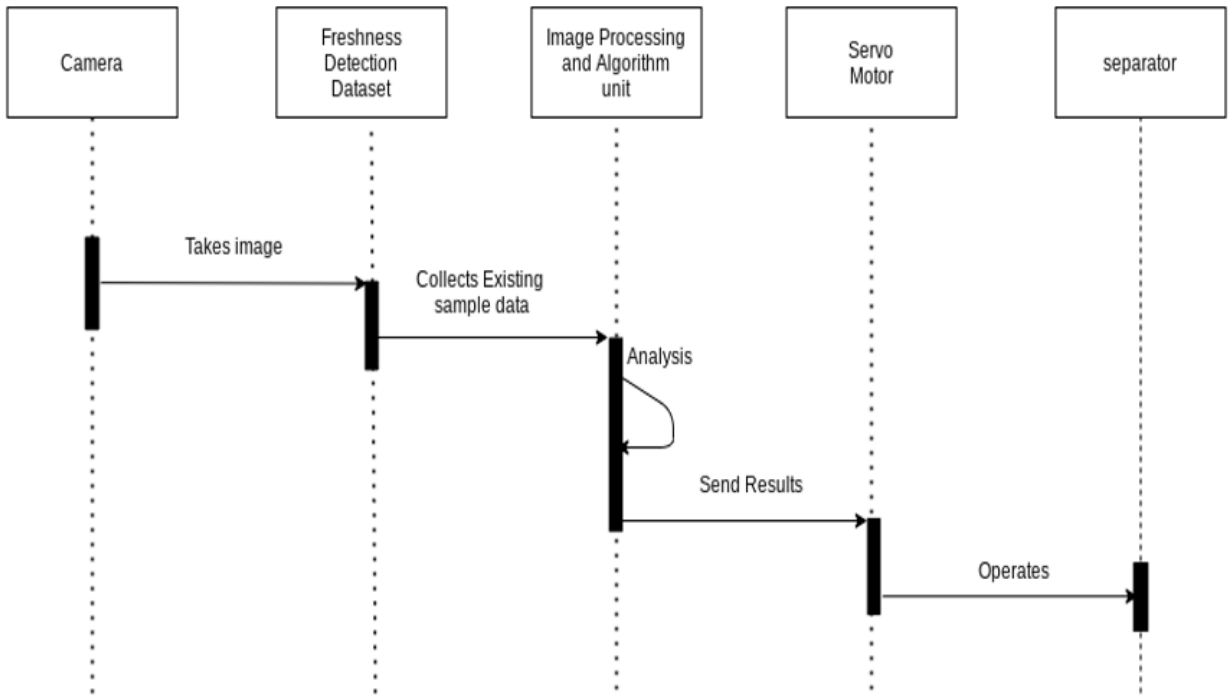


Fig: Sequence diagram of detecting detect mechanism

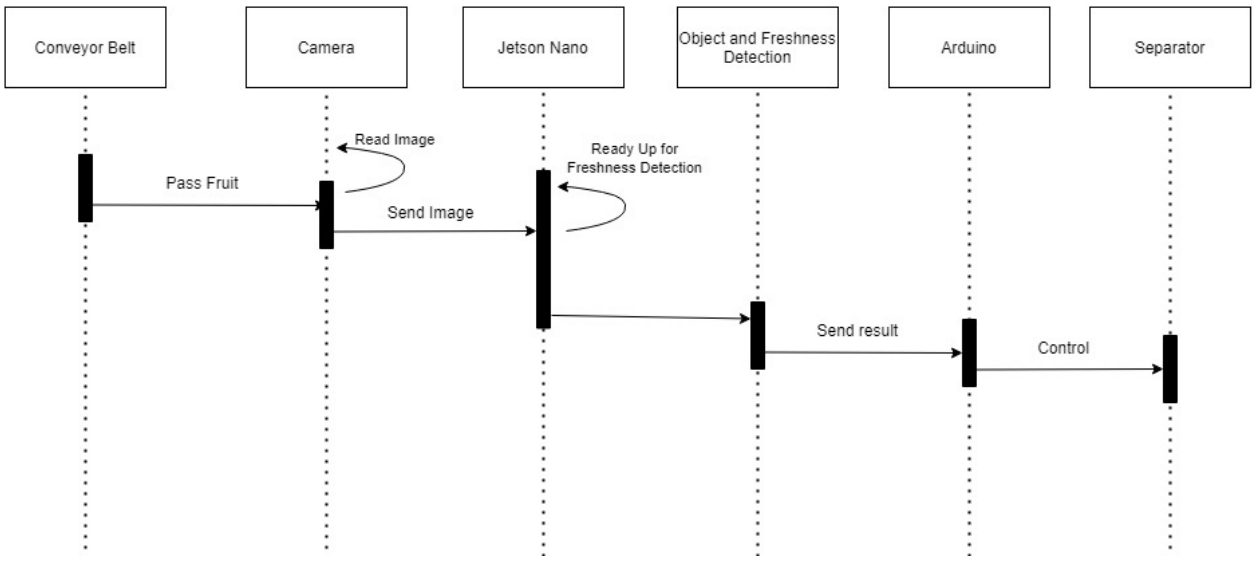


Fig: Sequence diagram of total system

3.2 User Requirements:

3.2.1 Functional Requirements:

3.2.1.1 The system should be able to identify stale and defected raw materials.
3.2.1.1.1 An automated food detection system will be used to identify defectedor rotten fruits by itself using image recognition and computer vision models.
3.2.1.1.2 Two cameras will beused to take readings for object detection and freshness detection.

3.2.1.2 The system should be able to separate the stale and raw materialsfrom the fresh ones.
3.2.1.2.1 A conveyer belt will be used to deliver the fruits and vegetables in a single column which will be headed directly for the freshness detection process.

3.2.1.2.2 A servo motor will be used with the alignment of conveyer belt to take out any fruits and vegetables from the belt which doesn't meet the desired freshness value.

3.2.1.2.3 Machine Learning will be used for increasing the capability of image recognition and defect detection system.

3.2.1.3 System should have enriched and versatile database of apple, banana, orange.
3.2.1.3.1 Database will be used to store reference images that will be compared with input image.
3.2.1.3.2 A large database of these selected fruits and vegetables by user demand will already available in the system before the deployment.

3.2.2 Use-Case Diagram of Database Maintenance

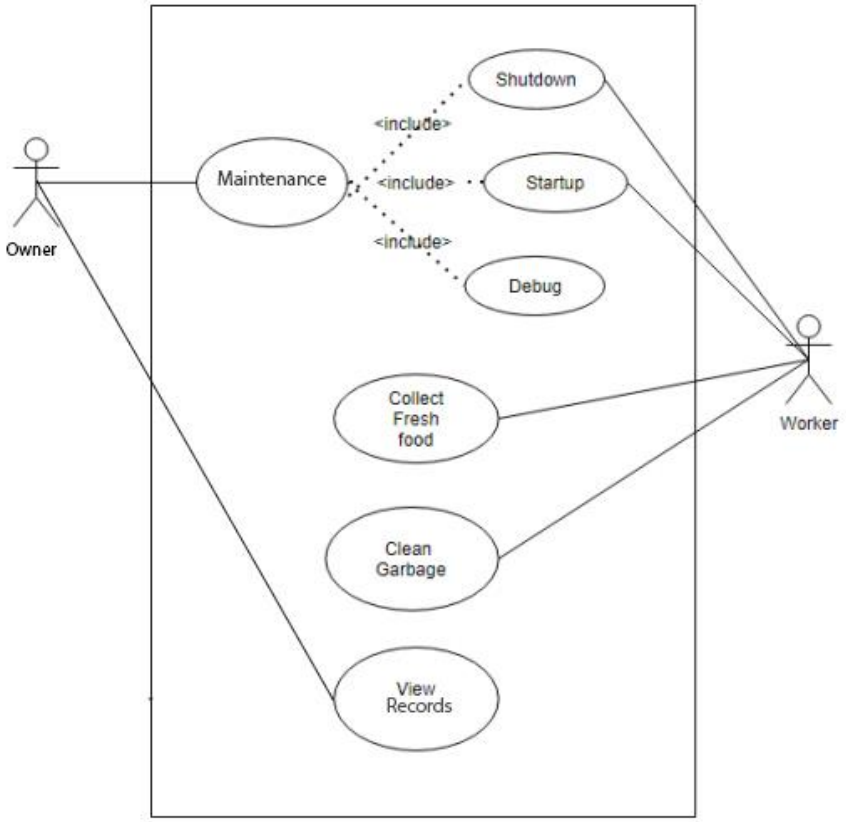


Fig: Use-case diagram of database maintenance

Actors	Owner, Worker.
Description	Owner will view records of fruits of any particular day. Shutdown and startup of the system will be done by worker and worker will also collect fresh food and clean garbage.
Data	Records data.
Stimulus	Startup and shutdown command, and command to view records.
Response	Startup and Shutdown of system at getting command.
Comments	The worker must have the appropriate security permission to access the system.

3.2.3 Use-Case Diagram of Freshness Detection System

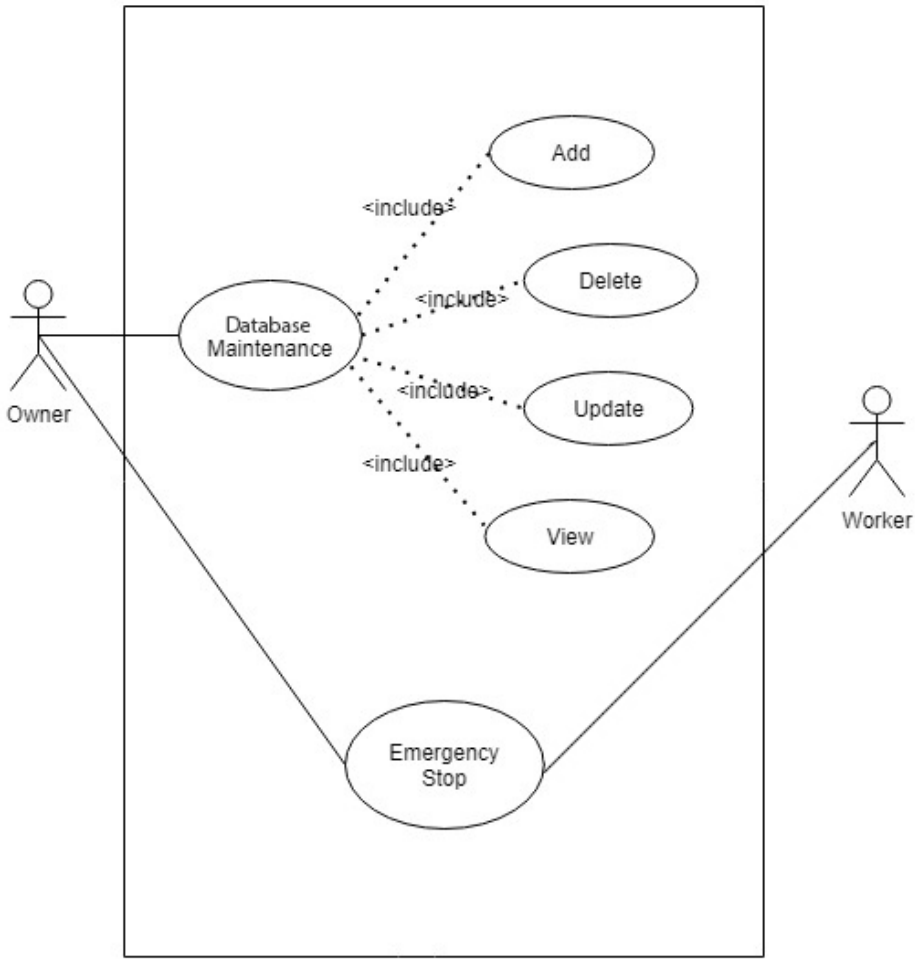


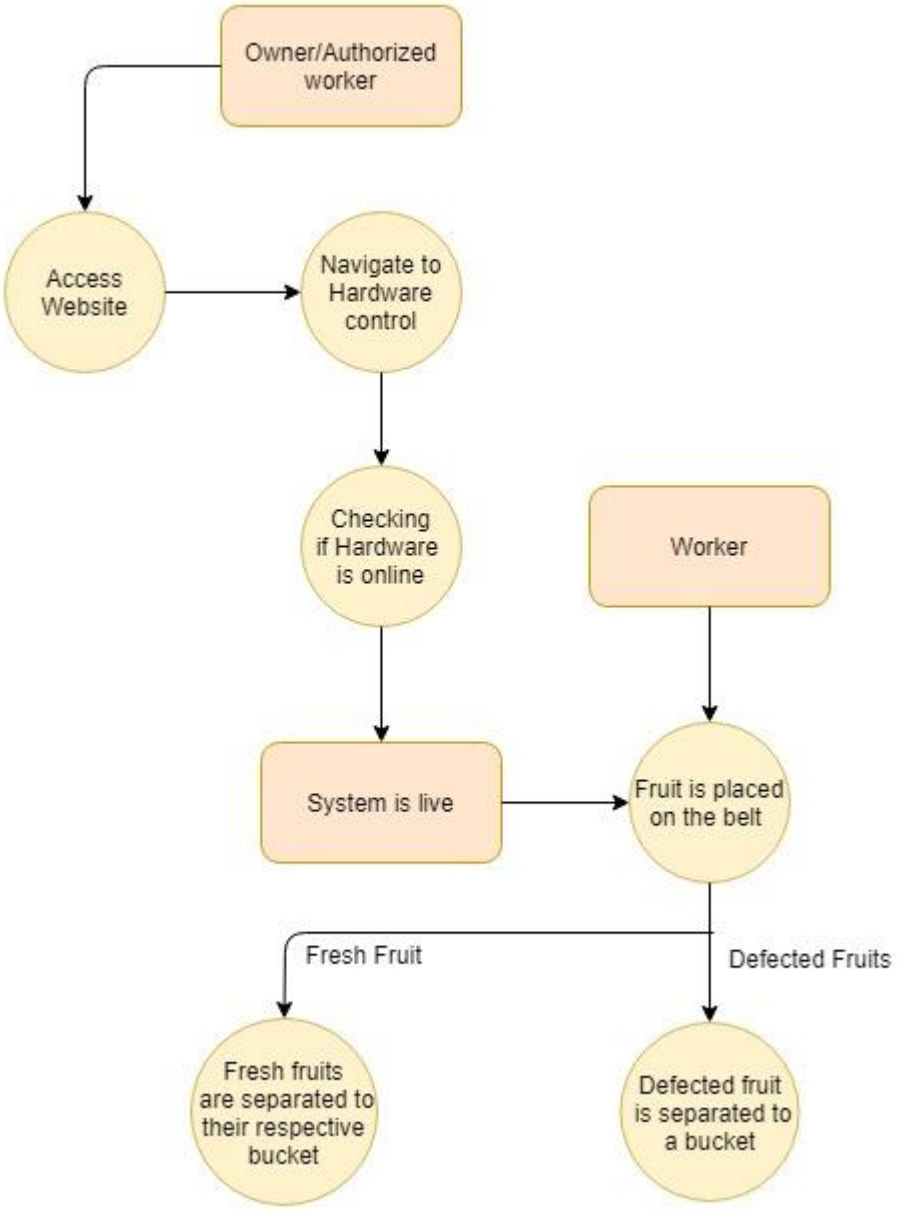
Fig: Use case diagram of freshness detection system

Actors	Owner and Worker
Description	Owner will maintain the database and in case of emergency he will be able to stop the system. Worker will also be able to stop thesystem in emergency situation.
Data	Collection of food images.
Stimulus	By user command emergency stop will occur. And using query owner can add, delete, update or view database.
Response	Database will response to query and system will stop at emergency stop command.
Comments	The worker must have the appropriate security permission to access the system.

3.2.4 Data Flow Diagram

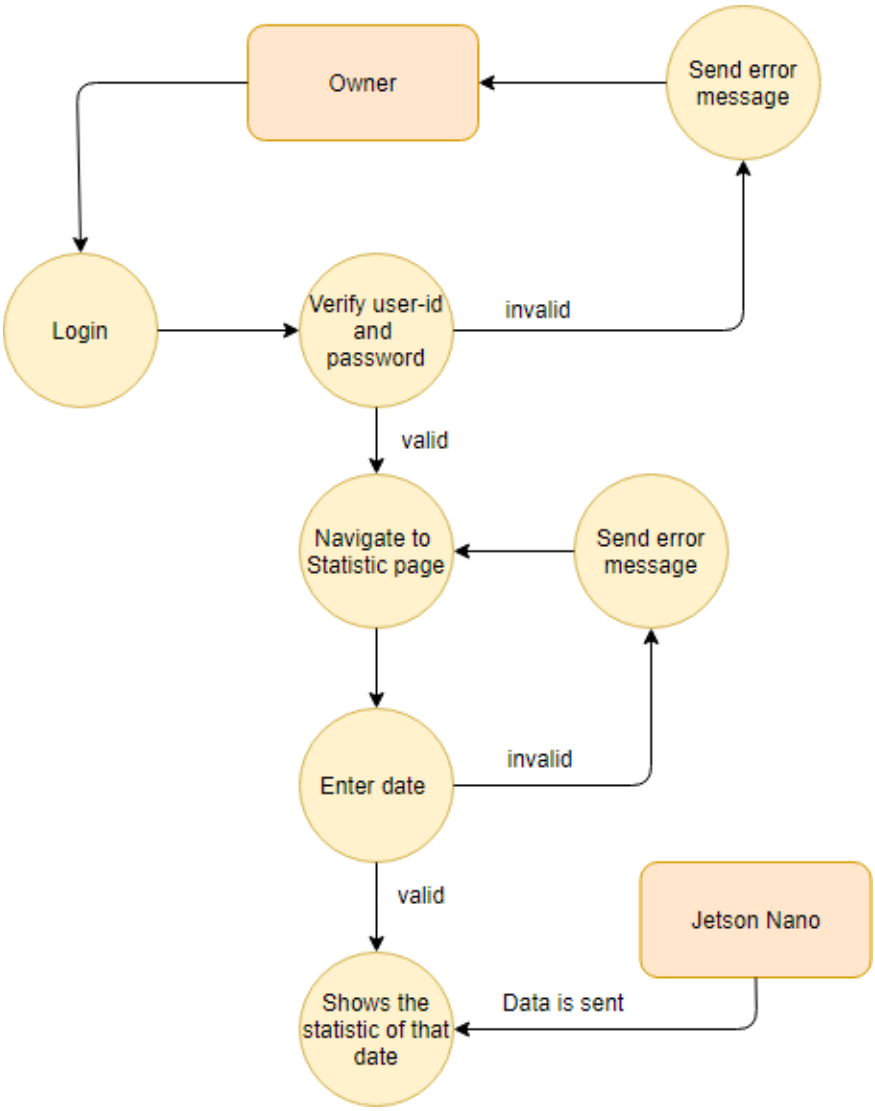
Scenario 1

Owner/Authorized worker accesses the website. Navigate to hardware control section. Enables conveyor belt, camera, and servo motor. Then workers started toplace fruit in the belt for separation process.



Scenario 2

Owner logins to the website. Go to the statistic page. Enter the date of which he wants to view the total amount of fresh/defected food. The query shows the result of all the fresh/defected food of that day.



3.2.5 User Charateristics

Owner: Owner have the access to the user interface. The user interface needs owner to login for having the access of the records page which contains the records of fresh fruits & defected fruits of any particular day.

Worker: Worker will need to put the raw materials on the conveyer belt which ensures a fully automated system with minimal human worker inspection. They have the access to the user interface. The user interface does not need worker to login. They can access every page except the records page which contains the records of fresh fruits & defected fruits of any particular day.

3.2.6 Non-Funtional Requirements

3.2.6.1 The system should need the least amount of human inspection during the automated process.

3.2.6.1.1 Freshness will be measured using image recognition and CNN models withthe help of images of various stages (under-ripe, ripe, over-ripe) of a single fruit/vegetable stored in the database.

3.2.6.1.2 The raw materials will be automatically transferred via a conveyer belt forthe freshness detection process and also be separated automatically with the helpof a servo motor.

3.2.6.1.3 The only human contact the system will need to put the raw materials onthe conveyer belt and take them off from it which ensures a fully automated system with minimal human worker inspection.

3.2.6.2 The system should be user friendly.

3.2.6.2.1 A user will be able to put the vegetables & fruits on the conveyer belt easily.

3.2.6.2.2 The system will be built on jetson nano which will enable users to makechanges to the available options of the system.

4 Specific Requirements

4.1 External Interfaces

4.1.1 User Interface

Homepage:

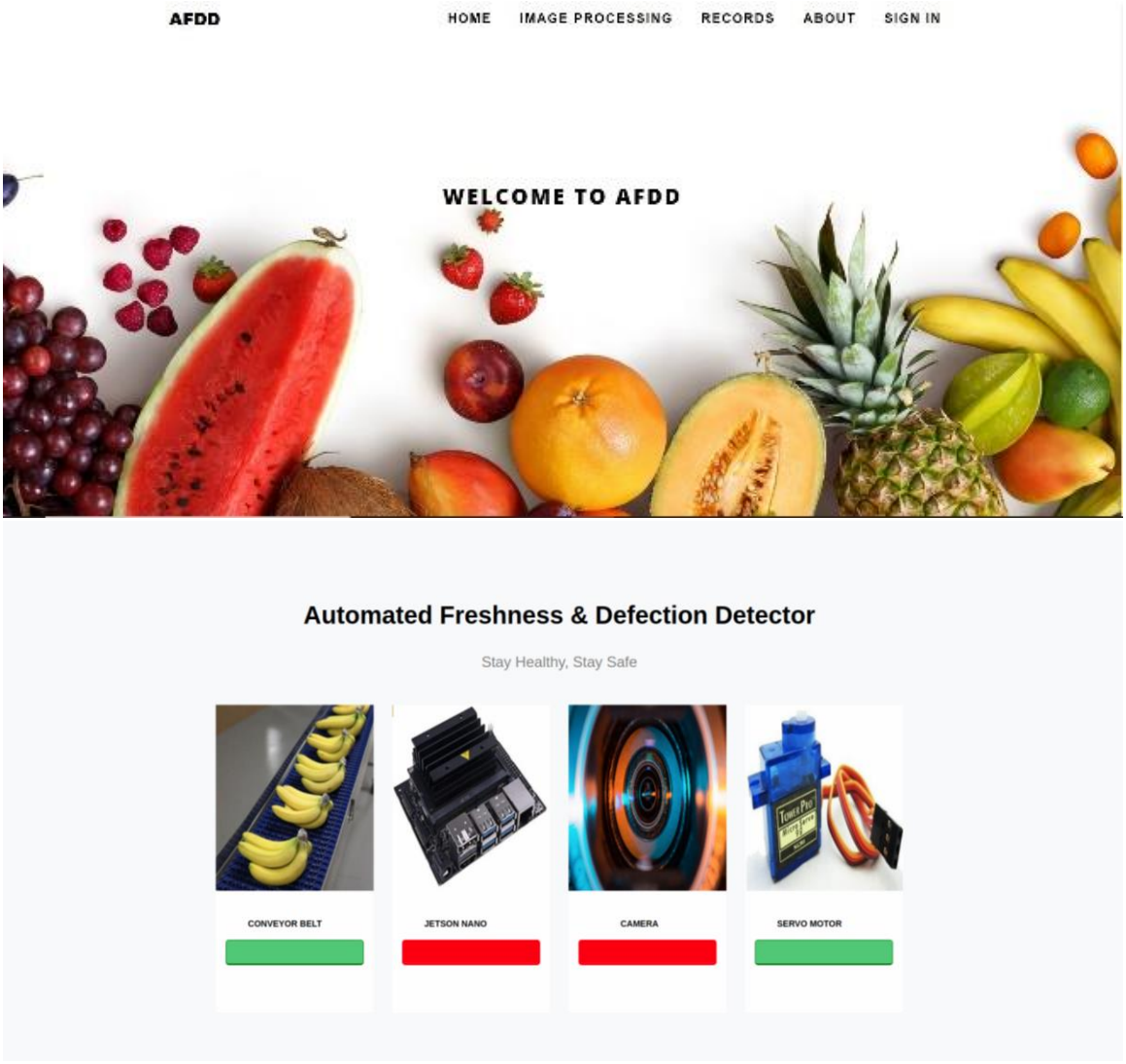
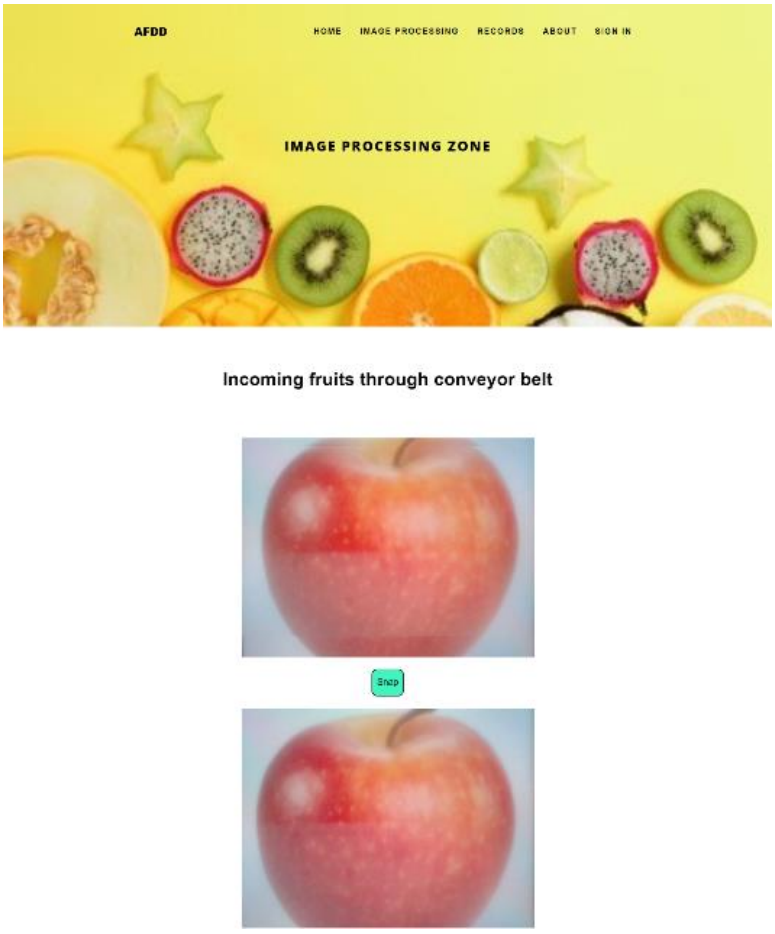
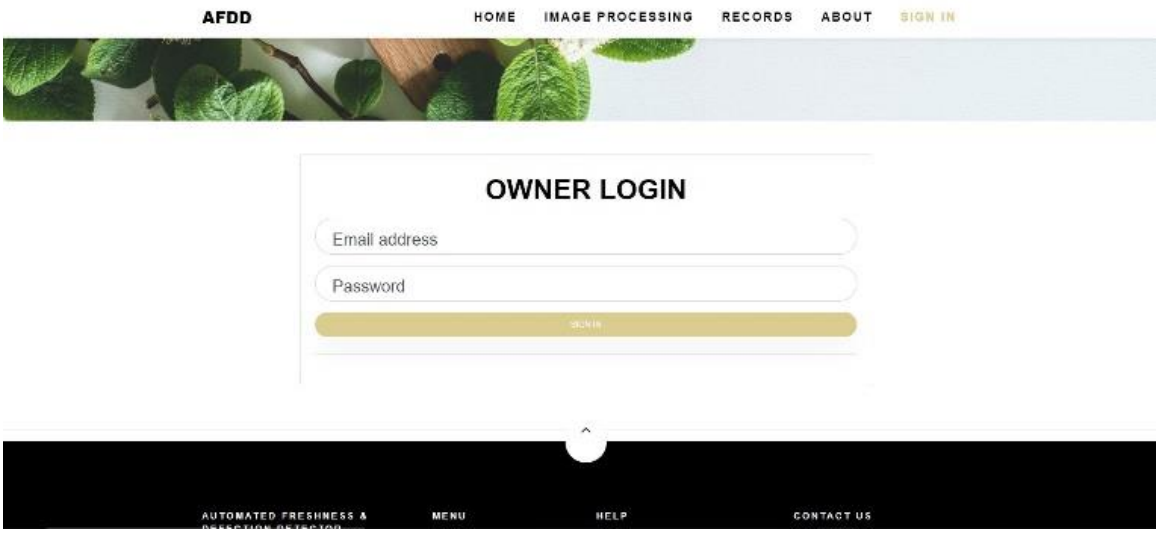


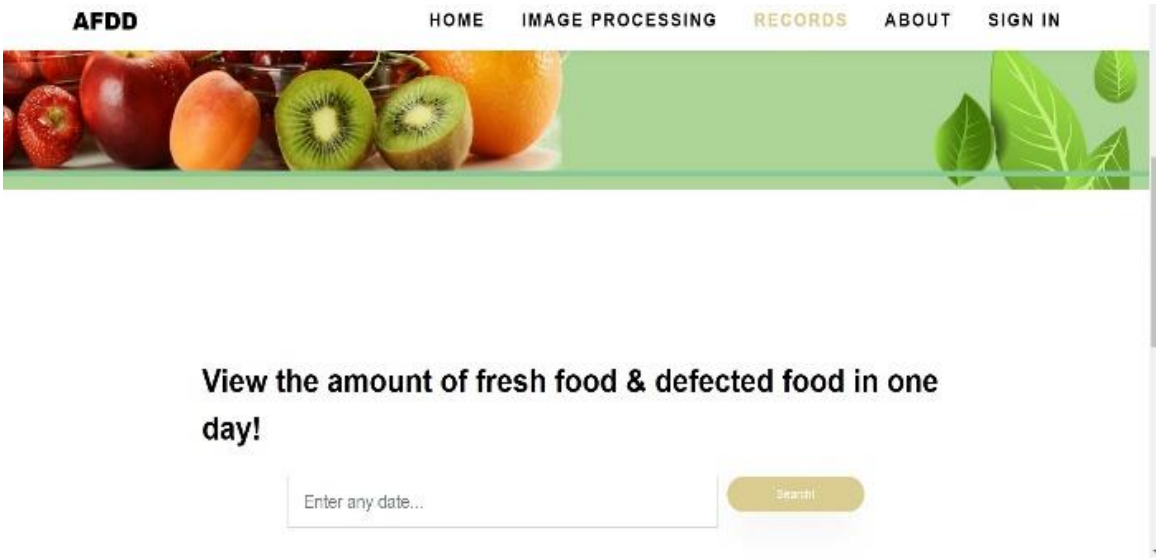
Image Processing Page:



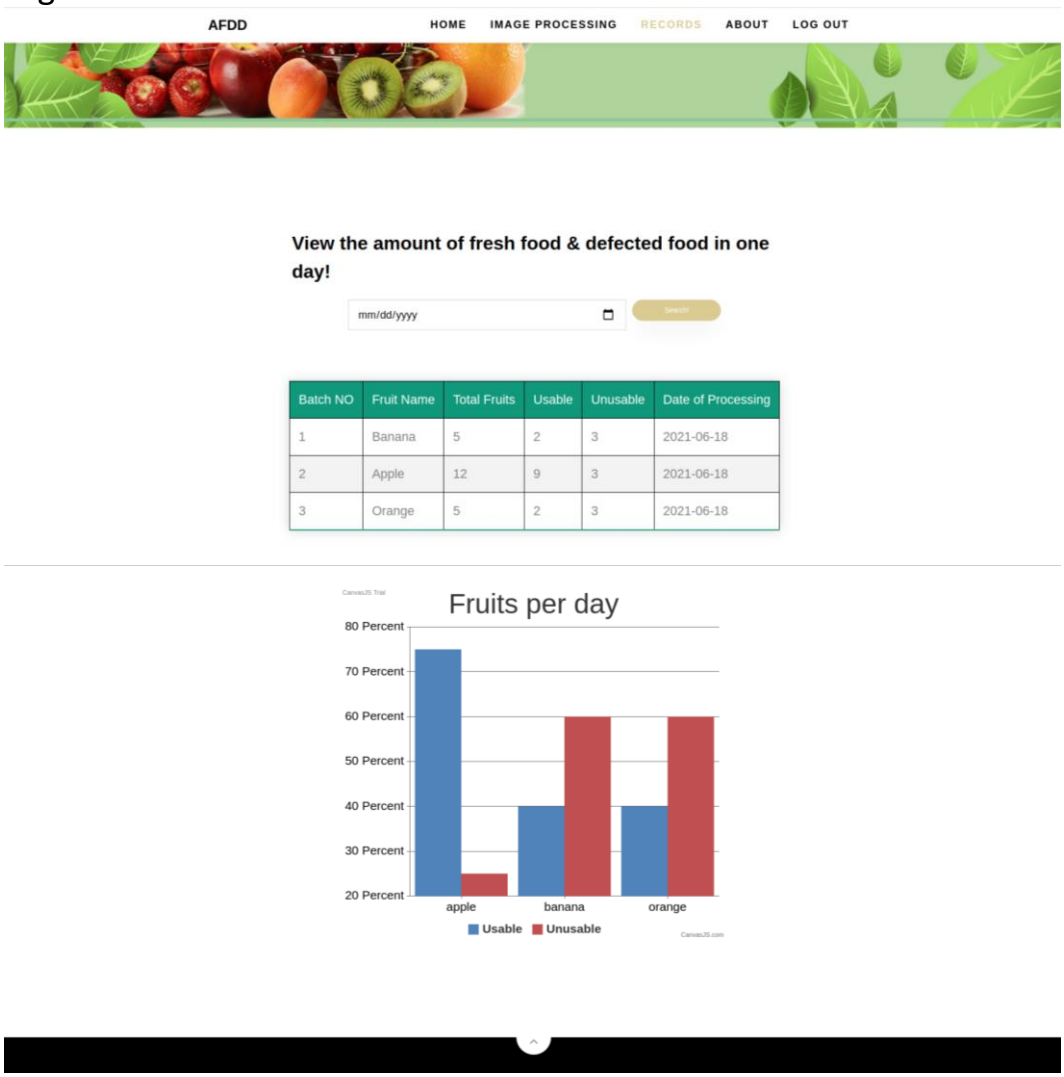
Login Page:



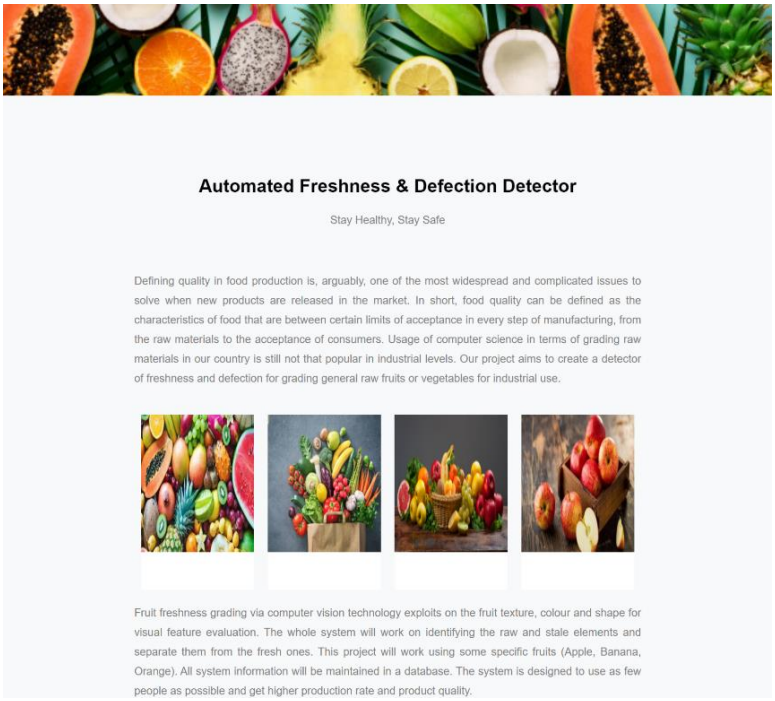
Records Page:



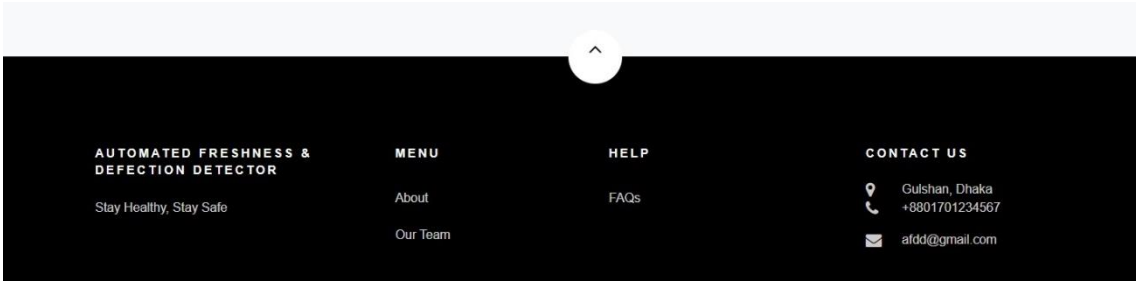
After entering the date:



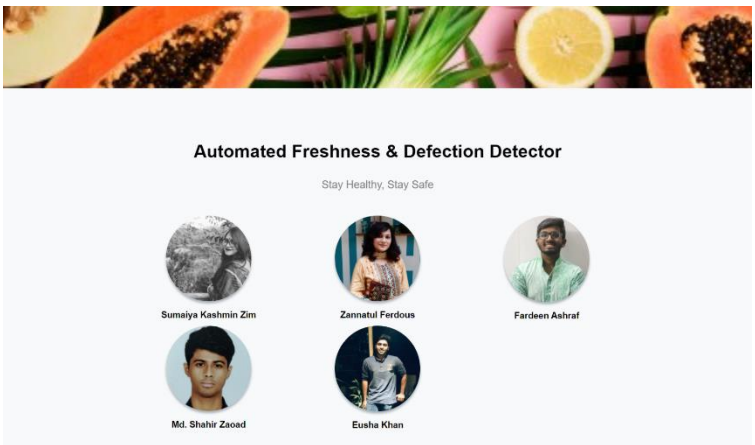
About Page:



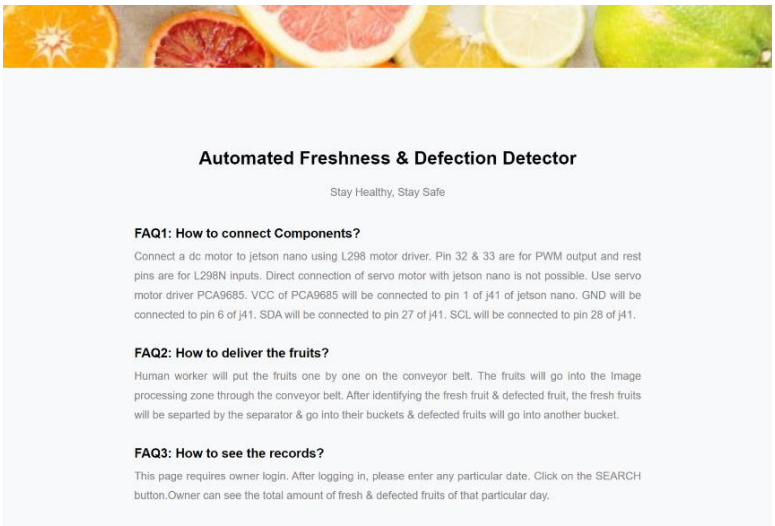
Footer:



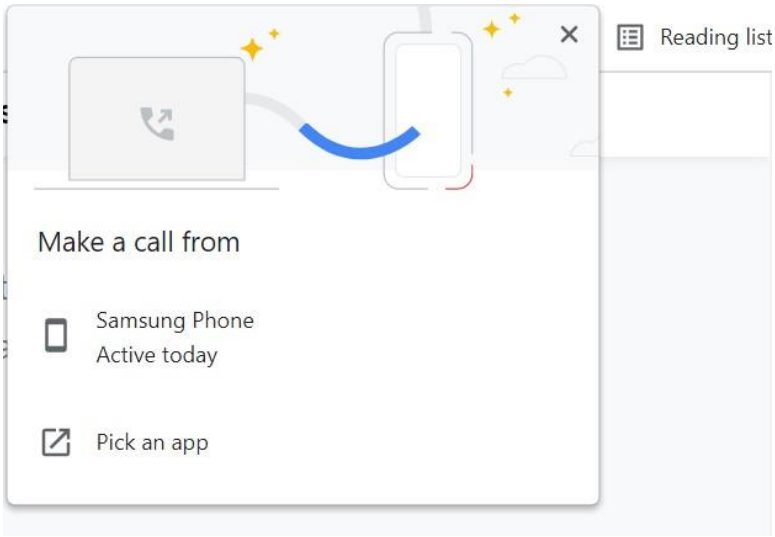
From Footer Our Team Page:



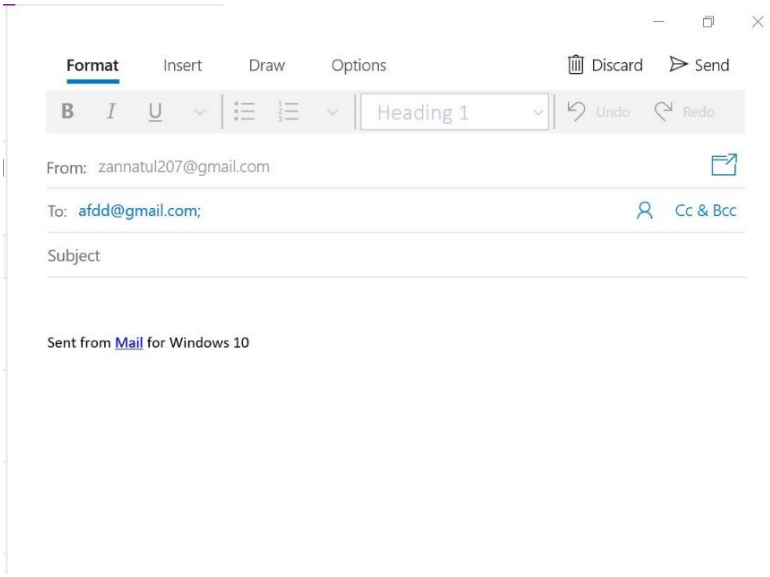
From Footer FAQs Page:



From Footer generating phone number in users' keypad:



From Footer generating email id in the receiver section:



4.1.2 Hardware Interface

System Architecture:

The system architecture is basically consisting of three part- Hardware, software backend and software frontend (UI). The hardware is a conveyor belt system where camera will be incorporated to detect fruits. Backend of software is basically consisting of database to store fruits images and result of detection and image processing algorithm. And lastly UI will be an interface among hardware and software.

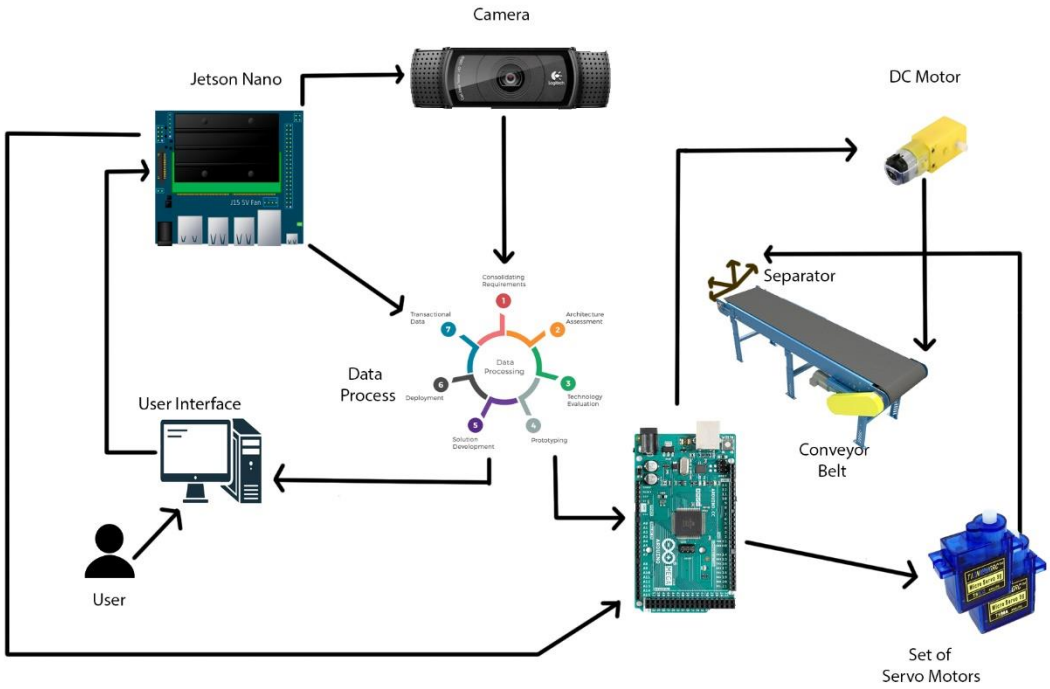


Fig: System Architecture of the system

Owner/worker can start the system by navigating the web application. After starting the conveyor belt system workers will start to provide food to the conveyor belt. Then upon detection camera will send data to micro- controller (jetson nano) and it will calculate whether the food is fresh or stale. It it detects that the fruit is not fresh it will separate it to a bucket. Upon detection fresh food the system will the separate the food based on their classification, such as we are working on three fruits (apple, banana and orange). So if the system detects that aparticular fruit is fresh then it will put it on a specific bucket of its type. And this process will continue until there is no food or the system is turned off. Apart from that owner can view the daily states of fruits from web application.

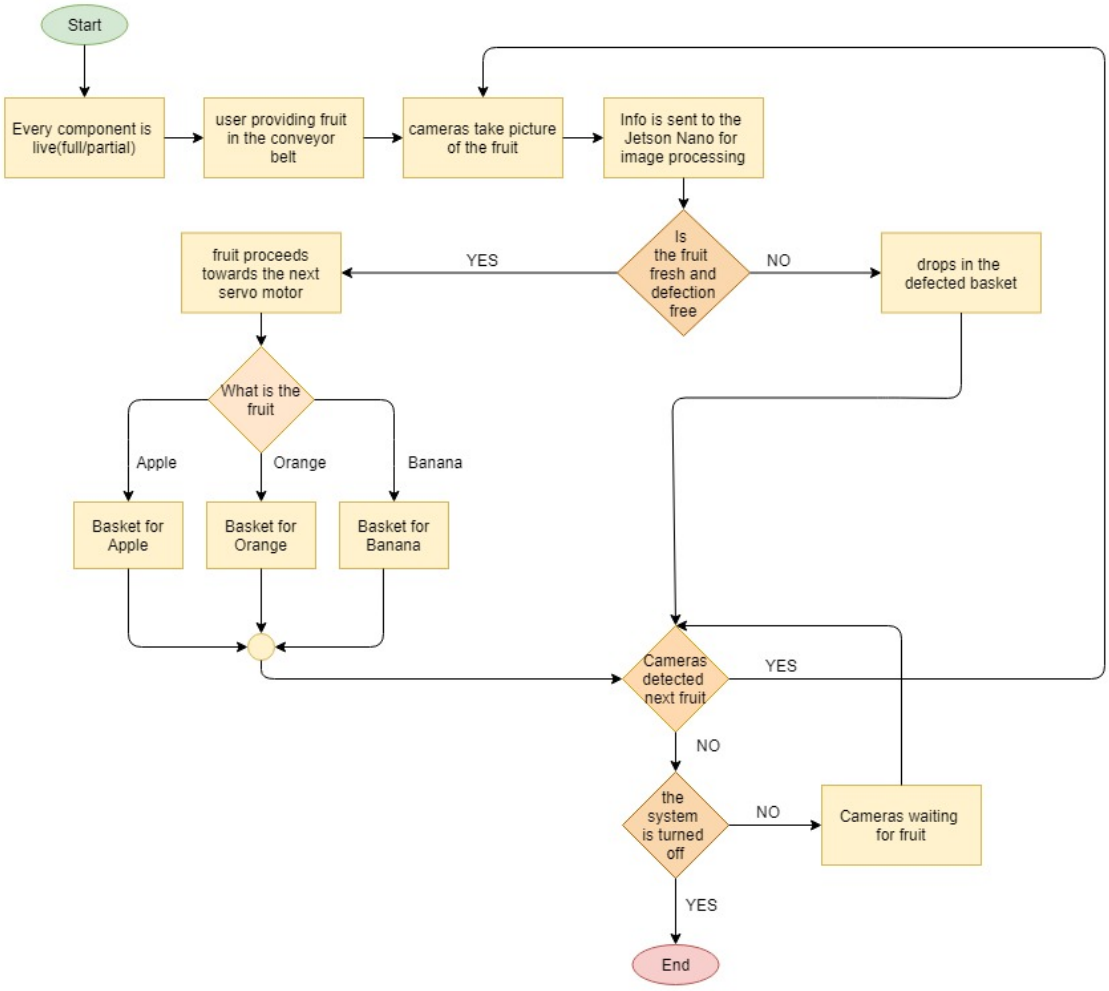


Fig: Workflow Diagram of the system

4.1.3 Software Interface

The main purpose of front-end development is to make the whole system easily accessible and usable for all the industrial personnel. The UI of our system is built on web-based platform. In this case, we have used HTML, CSS, Javascript in front-end php in the back-end to connect the web with database Python OpenCV for image processing. The database is created in localhost using MySQL. HTML and CSS are used for developing the skeleton of the website and for designing Bootstrap is used. JavaScript is used for implementing the functionalities of the website, building a connection with the MySql, and store and retrieve data from MySQL Continuous feedback from end-users are taken to develop the system and made it the most user-friendly UI. The developed website is universal and easy to use for any industry to adopt for saving a lot of time and work for them. For image processing

convolutional neural network (a class of deep neural network, most commonly applied to analyze visual imagery) is used. Using this we have been successful to detect a fruits freshness.

4.2 Constraints

4.2.1 Project Constraints

The following are identified as project constraints:

4.2.1.1 Fruit freshness detection dataset is only limited to apple, banana and orange presently. Due to pandemic on field data collection has not been possible and available online dataset is used

4.2.1.2 Lockdown restrictions further delayed the procurement of Jetson Nano.

4.2.2 Critical Project Barriers

The following are identified as critical project barriers:

4.2.2.1 Unavailability of Jetson Nano