REAL-TIME OBJECT DETECTION

Capstone project proposal
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B.E. Fourth Year - CSE

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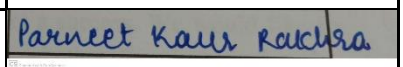
ABSTRACT

The main topic of this study is the real-time bolt and nut recognition system for usage in various industries, particularly the automobile industry. This project aims to create an image processing algorithm that produces normalized cropped images that are appropriate inputs for a neural network learning process. A real-time visual recognition system is used for testing. The stepper motor distinguishes the outcome of the bolt and nut in separate locations. The outcome demonstrates that the system can reliably and accurately detect moving objects on the belt conveyor.

DECLARATION

We hereby certify that the Real-Time Object Detection project's design principles and working prototype model are an authentic representation of the work we performed in the Computer Science and Engineering Department at TIET, Patiala, under the supervision of Dr. Samya Muhuri during the seventh semester (2022).

Date:

Roll No.	Name	Signature
101917044	Parneet Kaur Rakhra	
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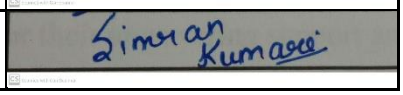
102097003	Simran Kumari	

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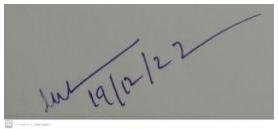

Faculty Mentor:
Dr. Samya Muhuri
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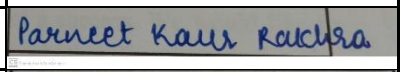
ACKNOWLEDGMENT

We would like to thank Dr. Samya Muhuri, who served as our mentor. He has been a tremendous asset to our project and a valuable source of technical expertise. He is an incredibly inspiring mentor to have.

We also wish to express our gratitude to Prof. Shalini Batra, Head of the Department of Computer Science and Engineering, to the entire faculty and staff of the Department of Computer Science and Engineering, as well as to all of our friends who gave of their precious time and assisted us in any way, they could to make this project a success. We would like to express our gratitude to everyone who helped with this initiative, whether directly or indirectly.

Finally, we would like to express our gratitude to our families for their unwavering support and affection. We are grateful for their perseverance and sacrifice since they always wanted the best for us.

Date:

Roll No.	Name	Signature
101917044	Parneet Kaur Rakhra	
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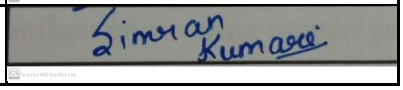
10209700	Simran Kumari	

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1. INTRODUCTION

1.1 Project Overview

Bolts and nuts work together, and neither is necessary. Making sturdy machinery is not possible. Each variety of nut and bolt serves a distinct function and is more appropriate. The major objective of this project is to develop a system that will make it simple for the user to determine the type and size of the bolt or nut they will be using. Our solution can improve the nut or bolt size that will be employed, as well as the timeliness of reporting, fieldwork efficiency, and travel requirements. This will increase the auditee's productivity and give them valuable knowledge about the bolt.

1.1.1 Technical Terminology

Arduino Nano - Arduino is an open-source electronics platform based on easy-to-use hardware and software. This is used by Robotic hand to segregate the nuts and bolts.

CNN - It stands for Convolutional Neural Network. It is a machine learning model used for detecting the nuts and bolts.

1.1.2 Problem Statement

To design a system which is capable of detecting the nuts and bolts on the conveyor belt and segregating the nuts and bolts into different sections.

1.1.3 Goal

The goal is to design a system that is capable of detecting the nuts and bolts present on the conveyor belt using a camera and the robotic hand attached will segregate the nuts and bolts into different sections. The detection of nuts and bolts will be done using CNN model of machine learning.

1.1.4 Solution

The prototype that has been built here is a conveyor belt with a webcam and a robotic hand attached. Nuts and bolts are kept on the moving conveyor belt which will reach the proximity of the camera and the camera detects whether it is nut or bolt. After the detection is done, the nut and bolt reach the proximity of the robotic hand which picks up the nut and bolt and segregates them in respective sections.

1.2 Need Analysis

Hardware items, such as small items such as nuts and bolts, may not seem important, but they are important, especially for those who need to repair or build things. The nuts and bolts represent the foundation of all buildings. This means that in a way, nuts and bolts are part of our lives. There are different types of nuts and bolts available today. Includes hex nuts, cap nuts, inserts, shredded nuts, lugs and much more. Every kind of nut and bolt have a different purpose that they deserve. Nuts and bolts are an integral part of anymachine structure or product. It is very necessary to choose the right nut or bolt to keep the project working. Because so many nuts and bolts look so small, their value has been greatly undermined. Unfortunately, this is not the case because these seemingly insignificant hardwareassets are overlooked. They help to ensure that the equipment or household items are maintainedat all times.

An unstable, bad, and inconsistent union may cause conflict. As well as the effects of matching nuts with the wrong bolts. Therefore, using the wrong combination of nuts and bolts in large quantities has the potential to cause a variety of problems. Some of these include rising financial costs and significant damage. In a few cases, the problem can be so severe that it leads to instability in the structure of the material assembled. This means that it could end up with structural failures such as wardrobe inefficiency. To do this, always try to take seriously the issue of such a combination of nuts and bolts.

Segregation of nuts and bolts according to their sizes becomes a very tedious task manually.

1.3 Research Gap

- In the review of our sample results, we found that there was no novel approach that could carry out both, detection and segregation, efficiently.
- Some prototypes used PCA (Principal Component Analysis) for detection but the same when done with CNN gives more accurate results efficiently.

1.4 Problem Definition and Scope

Design a system which is capable of detecting the nuts and bolts and then segregating them in their respective sections.

Project Scope: -

i. We are developing a system that detects the nuts and bolts and segregates them in their respective sections.

ii. Systems developed using previous techniques can only detect the nuts and bolts. No such method has been developed that could segregate the nuts and bolts.

1.5 Assumptions and Constraints

Table 1: List of Assumptions

Sr No.	Assumptions
1.	The System will be able to detect the nuts and bolts.
2.	Segregate the nuts and bolts in different boxes.

Table 2: List of Constraints

Sr No.	Constraints
1.	If the speed of the conveyor belt is high, the camera will not be able to detect the nuts and bolts due to low camera quality.

1.6 Standards

Table 3: List of Standards

Document	Specification
IEEE 802.11	The standard and amendments provide the basis for wireless network products using the Wi-Fi brand.
IEEE 802.15.4	A technical standard which defines the operation of a low-rate wireless personal area network (LR-WPAN). It specifies the physical layer and media access control for LR-WPANs.

1.7 Approved Objectives

- To design a system that can detect the nuts and bolts and segregate them in their respective sections.
- To provide a reliable, accurate and cost-effective technique to detect nuts and bolts using CNN.

1.8 Methodology Used

- The system developed to detect the target using image processing techniques with the help of computer vision.
- Object detection is done by CNN which is an image classification technique.
- The camera is used for real-time detection of nuts and bolts.
- A robotic hand is used for picking up the object and segregating them in their respective sections.
- A Conveyor belt is used for making the nuts and bolts reach the proximity of the camera and robotic hand.

1.9 Project Outcomes and Deliverables

The implementation of the proposed technique can be deployed in the mechanical industries to help the user detect whether it is nut or bolt without manual effort and then segregate them in their respective boxes. This technique is based on machine learning and image processing CNN, Python and other relevant methods. The final product will be able to detect the nuts and bolts and segregate them in their respective boxes.

1.10 Novelty of work

The proposed solution is unique as none of our competitors provides services with the ease, we aim to provide. The project is based on the idea of making things authentic and more robust in real-world scenarios. The project has an extensive future scope for further development and expansion. The integration and one stop solution make the project unique.

2.REQUIREMENT ANALYSIS

2.1 Literature Survey

Table 4. Literature Survey

S NO.	NAME OF THE AUTHOR	NAME OF THE PAPER	FEATURES	CITATIONS
1.	H. Akbar, A. S. Prabuwono	The design and development of automated visual inspection system for press part sorting	In this research, a manufacturing line simulation is used to design an automated visual inspection system for sorting press parts using CMOS Web cameras.	**[1]**
2.	H. Akbar, A. S. Prabuwono	Webcam-based system for press part industrial inspection	By multiplying the pixel value by the geometrical restrictions, the approach provided allowed for the measurement of dimensions.	**[2]**
3.	H. Akbar, A. S. Prabuwono	Automated visual inspection (AVI) research for quality control in metal stamping manufacturing	This allows the system to determine whether a product that is about to be produced or released complies with its standards and requirements.	**[3]**
4.	M.M. Kyaw, S. K. Ahmed, Z. A. Sharrif	Shape-based sorting of agricultural product using support vector machines in a MATLAB/SIMULINK environment	This study examines a method for classifying agricultural produce based on shape. Support vector machines are the foundation of the approaches.	**[4]**

5.	Z. Zhao, H. Xin, Y. Ren, X. Guo	Application and comparison of BP neural network algorithm in MATLAB	In this research, 8 alternative BP algorithms offered by the MATLAB neural network toolbox are compared for their strengths and limitations in order to select the more efficient and effective strategy for each situation.	**[5]**
6.	F. Lahajnar, R. Bernard, F. Pernus, S. Kovacic	Machine vision system for inspecting electric plates	To cut labor costs and guarantee consistent product quality, this research describes a machine vision system for automated visual inspection of electric cooker plates.	**[6]**
7.	L. Liu, J. Chen, L. Xu	Realization and Application Research of BP neural network based on MATLAB	This paper merely presents information about the BP network and algorithm, then explains the BP tool functions provided by MATLAB for BP neural network research and details how to write programs to use the functions.	**[7]**
8.	A. S. Prabuwono, H. Akbar	PC based weight scale system with load cell for product inspection	A computerized measurement method for determining a product's weight throughout the manufacturing process is the PC-based weight scale system.	**[8]**
9.	A. S. Prabuwono, R. Sulaiman, A. R. Hamdan, A. Hasniaty	Development of intelligent visual inspection system	This study examines the creation of an	**[9]**

		(IVIS) for bottling machine	image processing framework for fault identification in an intelligent visual inspection system (IVIS) for bottling machines.	
10.	H. Saad, A. Hussain	Classification for the ripeness of papayas using artificial neural network (ANN) and threshold rule	The primary goal of this project is to establish a method for categorizing papaya maturity into three categories— immature, mature, and over mature— on the basis of their mean RGB value components.	**[10]**

2.2 Software Requirements Specification

2.2.1 Introduction

2.2.1.1 Purpose

i. It has introduced a system that can detect nuts and bolts and segregate them in their respective sections.

ii. The main objective is to reduce man-power and provide an efficient, cost-effective and precise technique to detect and segregate the objects.

2.2.1.2 Intended Audience and Reading Suggestions

This project is specifically targeted to improve the mechanical industries. This device can be used in mechanical industries to make the work of detection and segregation easier and reduce man-power.

2.2.2 Overall Descriptions

2.2.2.1 Product Features

The Product functions are:

- Recognize and differentiate between nut and bolt.
- Segregate nuts and bolts in their respective sections.

2.2.2.2 Functional Requirements

- The system would be able to classify different types of nuts and bolts accurately using a camera.
- Nuts and Bolts will reach to the proximity of the camera using a conveyor belt.
- At the end of the conveyor belt a robotic hand will segregate nuts and bolts into different sections.

2.2.3 Non-Functional Requirements

- Performance is good and the system is easy to use.
- Easily accessible and scalable.
- Reliable system which will be easy to maintain.

2.3 Cost Analysis

- Belt drive - Rs 1840 per meter
- Arduino - Rs 499
- Robotic Arm -
- Adapter - Rs 289
- Motor speed control module - Rs 209
- DC geared motor - Rs 51
- Relay - Rs 250
- IR Sensor - Rs 102
- Buzzer - Rs 125
- DC-DC Buck - Rs 99
- Webcam - Rs 500

2.4 Risk Analysis

- The camera might not detect the nuts and bolts when the speed of the conveyor belt is high.
- IR Sensor might not detect the object if it is not within its parameters.
- It might not give accurate results or might not detect any object in dim luminosity.

3.METHODOLOGY ADOPTED

3.1 Investigative Techniques

Table 5. Investigative Techniques

Sr No.	Investigative Project Techniques	Investigative Technique Description	Investigative Projects Example
1.	Descriptive	Detecting systems designed in the past required a high power supply and had lower accuracy, whereas detecting system designed by us is low power consuming and more accurate.	Food Grading
2.	Comparative	Previously invented techniques used PCA for object detection but it was found that on using models like CNN, more efficient results were observed.	Detection of nuts and bolts using PCA

3.2 Proposed Solution

This project aims to substitute manpower in mechanical industries. The system will detect the nuts and bolts and also segregate them into their respective sections.

3.3 Work Breakdown Structure

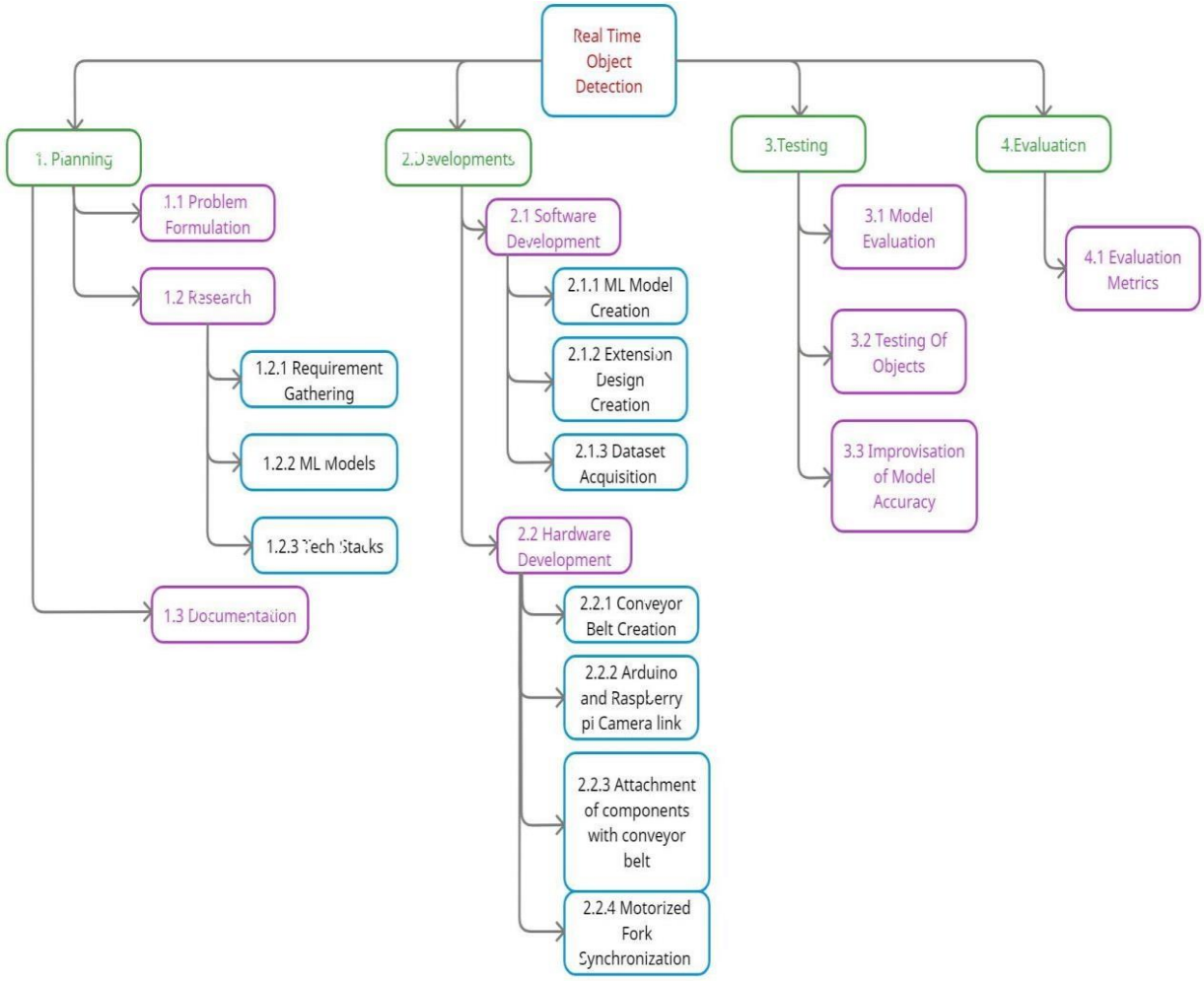


Fig 1. Work Breakdown structure

- In the above diagram we have shown the work breakdown structure of our project.
- It includes four phases: Planning, Development, Testing, and Evaluation
- In the Planning phase, we first identified the problem and then researched the Machine learning models and the tech stack to be used. Lastly, we have made the documentation about the project.

- In the development phase we started with the software development and trained the model with the dataset. After that, we will create the hardware model which includes the conveyor belt creation, Arduino and raspberry pi camera linkage, and attachment of other components.
- After these phases we have our last phases which are testing and evaluation in which we will test our model using nuts and bolts of different sizes.

3.4 Work Breakdown with Gantt Chart

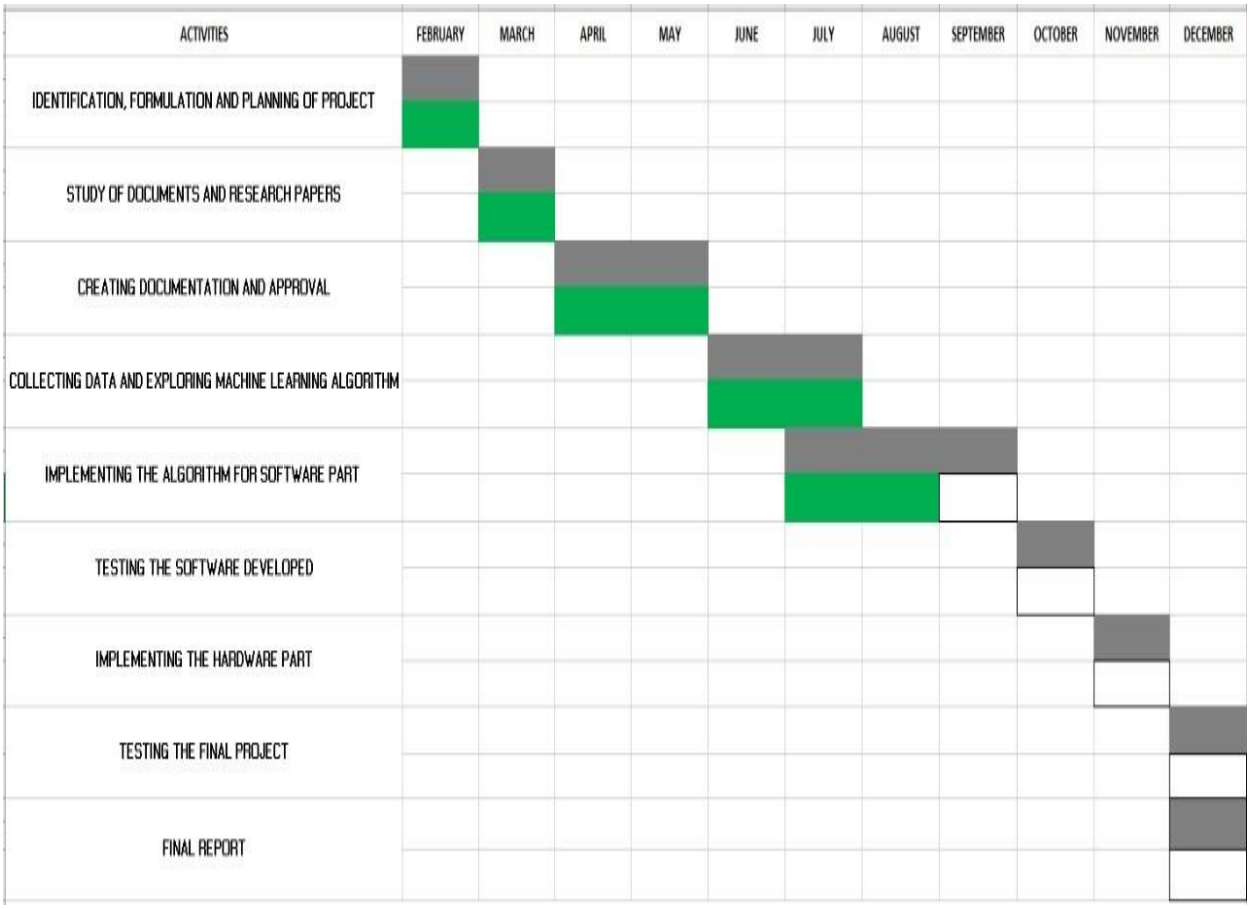


Fig 2. Work Breakdown Structure with Gantt Chart

- In the above Figure we have our workflow structure using the Gantt chart.
- In this figure, the gray color represents the assumptions that we have made to complete a particular task and the green color represents the tasks that we have completed till now.
- According to the above figure we have completed the implementation of our algorithm part.

3.5 Tools and Technologies used

Hardware Components

- Adapter - 12V
- Motor speed control module
- DC geared motor
- Relay
- IR sensor
- Buzzer
- DC-DC buck
- Webcam - 2 megapixel
- Transistor
- Resistor
- Arduino

Software Components

- Python
- CNN

4. DESIGN SPECIFICATION

4.1 Use Case Diagram

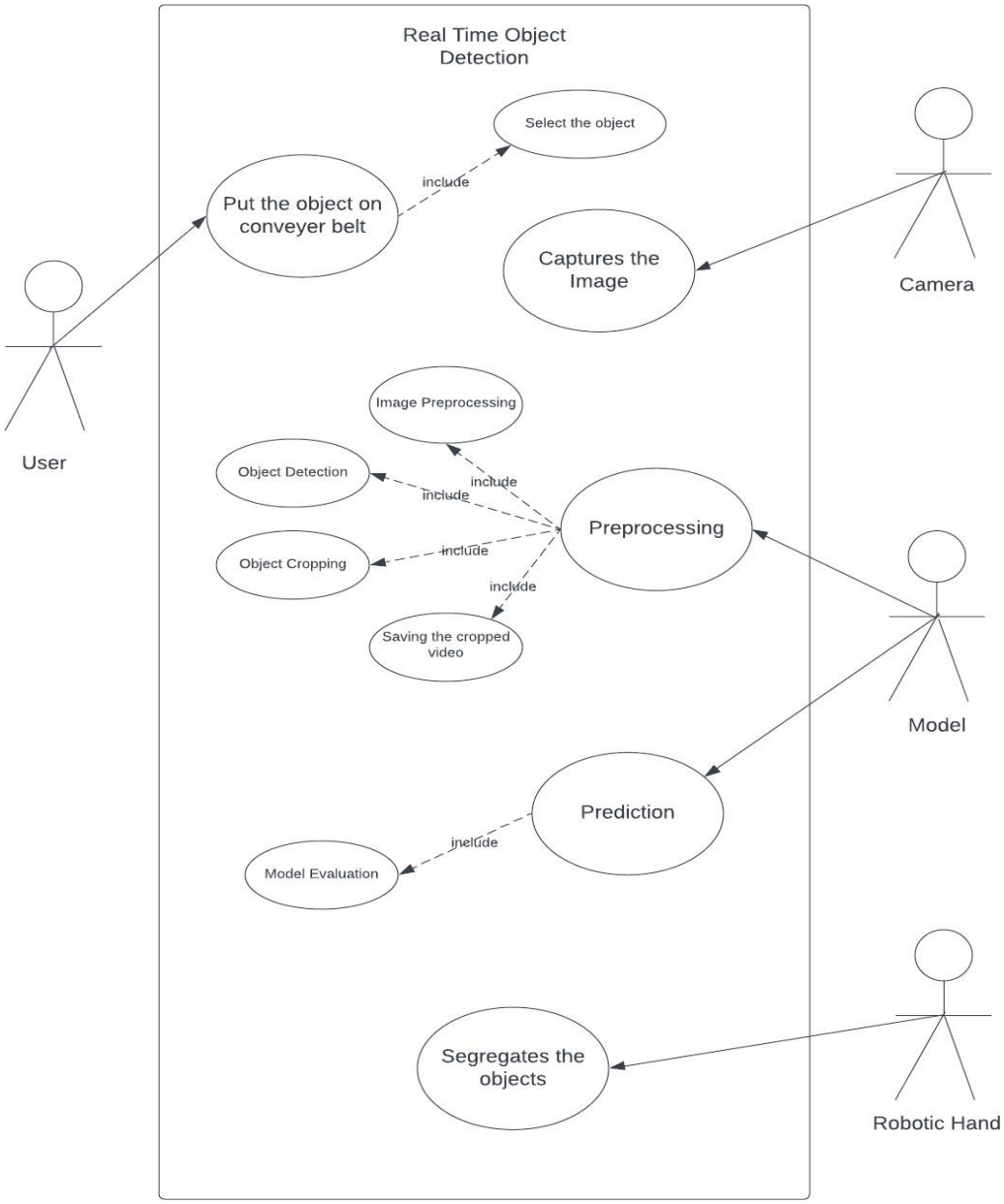


Fig 3. Use Case Diagram

In the above figure, we have shown the use case diagram for our project.

- A use case diagram is essentially a means to condense information about a system and the users within it. It is typically displayed as a graphic representation of how various system components interact with one another. Use case diagrams will detail the system's events and the order in which they occur.
- In this figure we have a user, camera, model, and Robotic hand as our actors who are performing their respective tasks, and the relationship among them is shown through this figure.

4.2 Activity Diagram

4.2.1 Training Phase

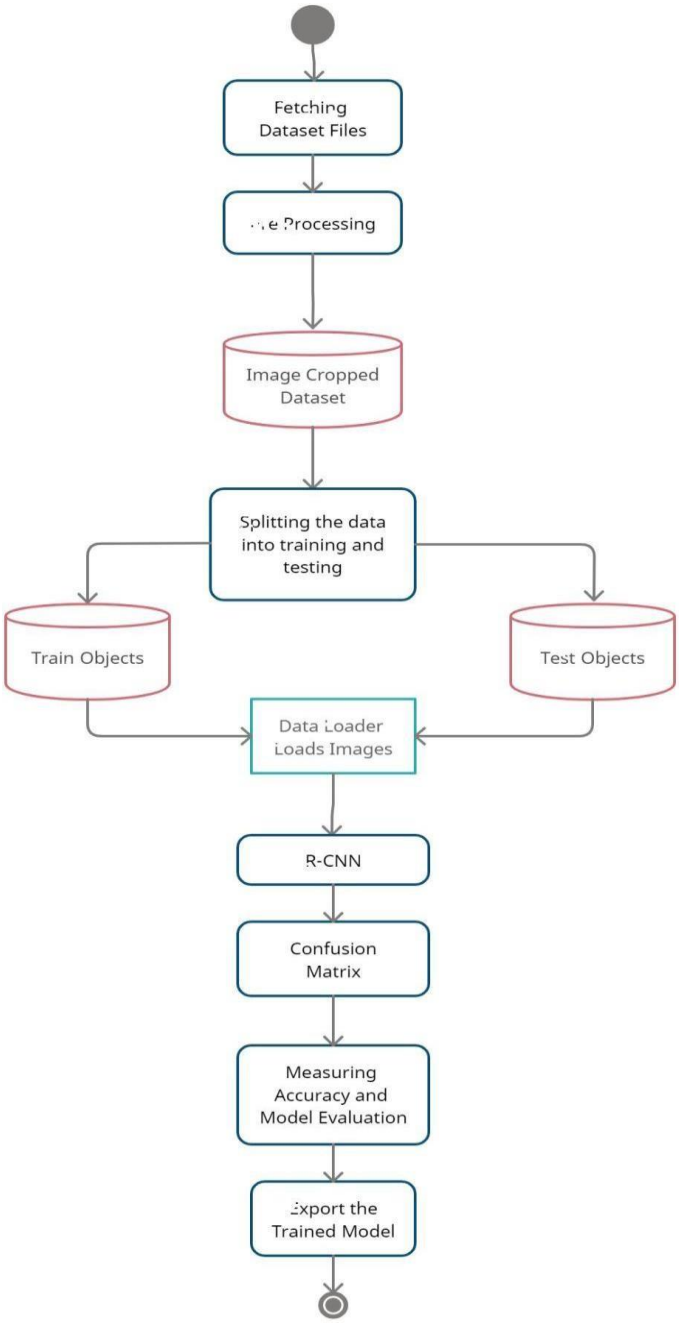


Fig 4. Training Phase

- In the above figure we showed the training phase of an activity diagram of our project.
- An activity diagram basically illustrates the flow from one activity to another through the use of an advanced flowchart.
- Through this figure we are trying to show our flow of activities while training our machine learning model.

4.2.2 Testing Phase

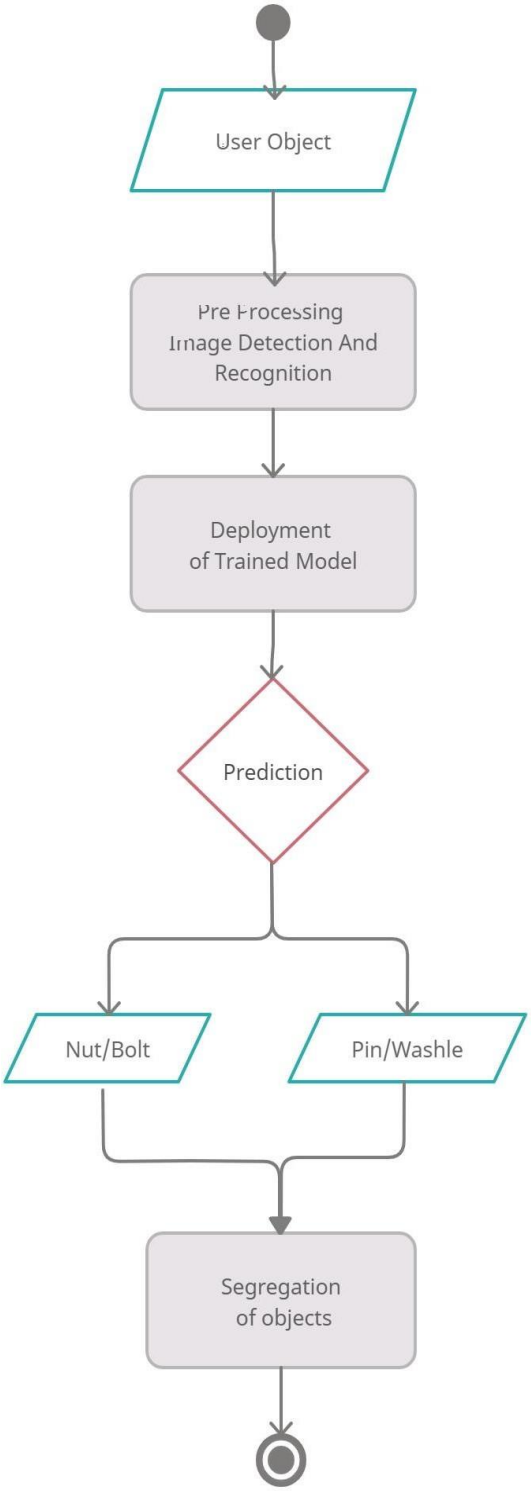


Fig 5. Testing Phase

- In the above figure we showed the testing phase of the activity diagram of our project.

- Through this figure we are trying to show the flow of our activities while testing the model on nuts and bolts of different types and sizes.
- In this we also tested how much accuracy our model is predicting the result.

4.3 Sequence Diagram

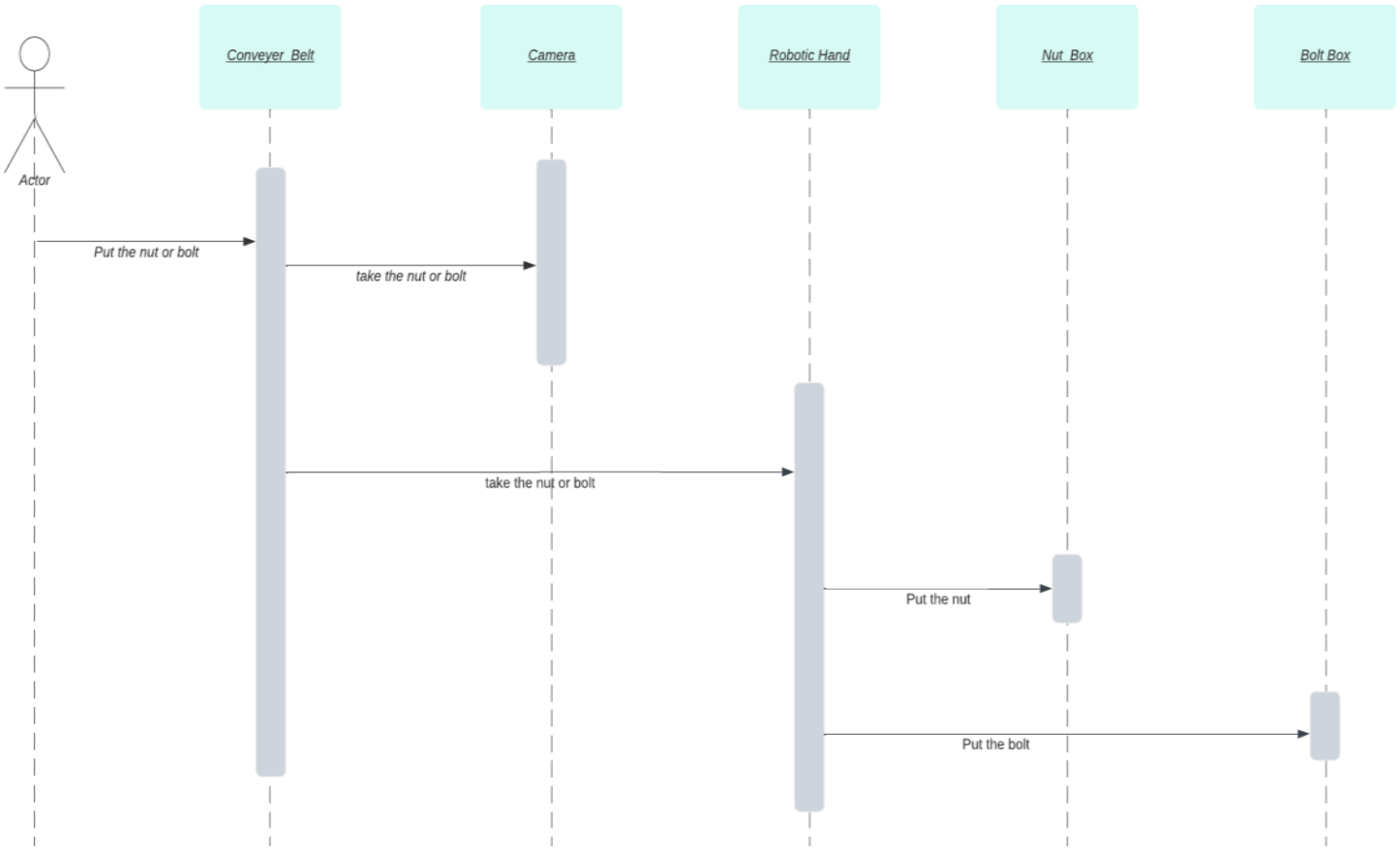


Fig 6. Sequence Diagram

In the above figure, we showed the sequence diagram for our project.

- Basically, Sequence Diagrams are interaction diagrams that describe the steps used to complete an operation. They depict how items interact within the framework of cooperation. Sequence Diagrams are time-focused and use the vertical axis of the diagram to indicate time, what messages are received when, and how the interaction is organized graphically.
- Through this diagram we are trying to show the interactions of actors and objects with the components of our model.

4.4 State Chart Diagram

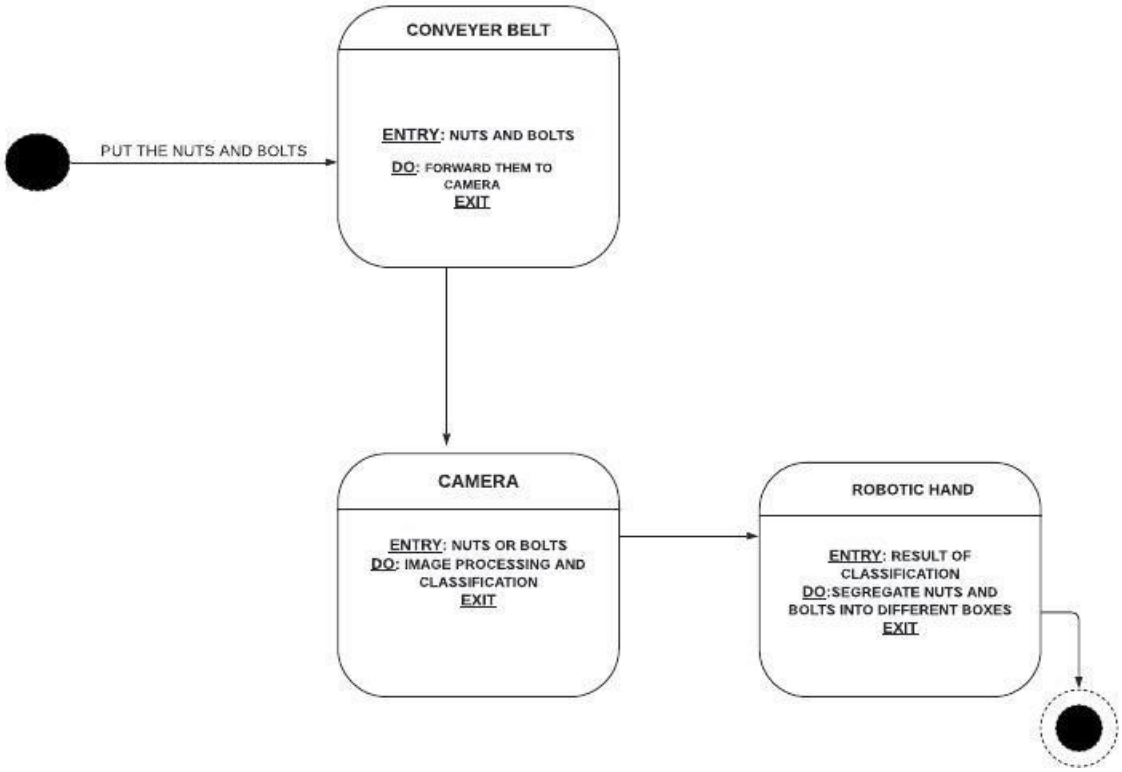


Fig 7. State Chart Diagram

- In the above figure we have shown the state chart diagram of our project.
- In essence, it specifies the various states that a system component can be in. The states are unique to a particular system object or component.
- In our project we have majorly three different stages through which a nut or bolt will pass and they are: Conveyer belt, camera, and robotic hand.
- In this figure we have shown the input and particular task a component is performing.

4.5 Design Level

4.5.1 DFD Level 0

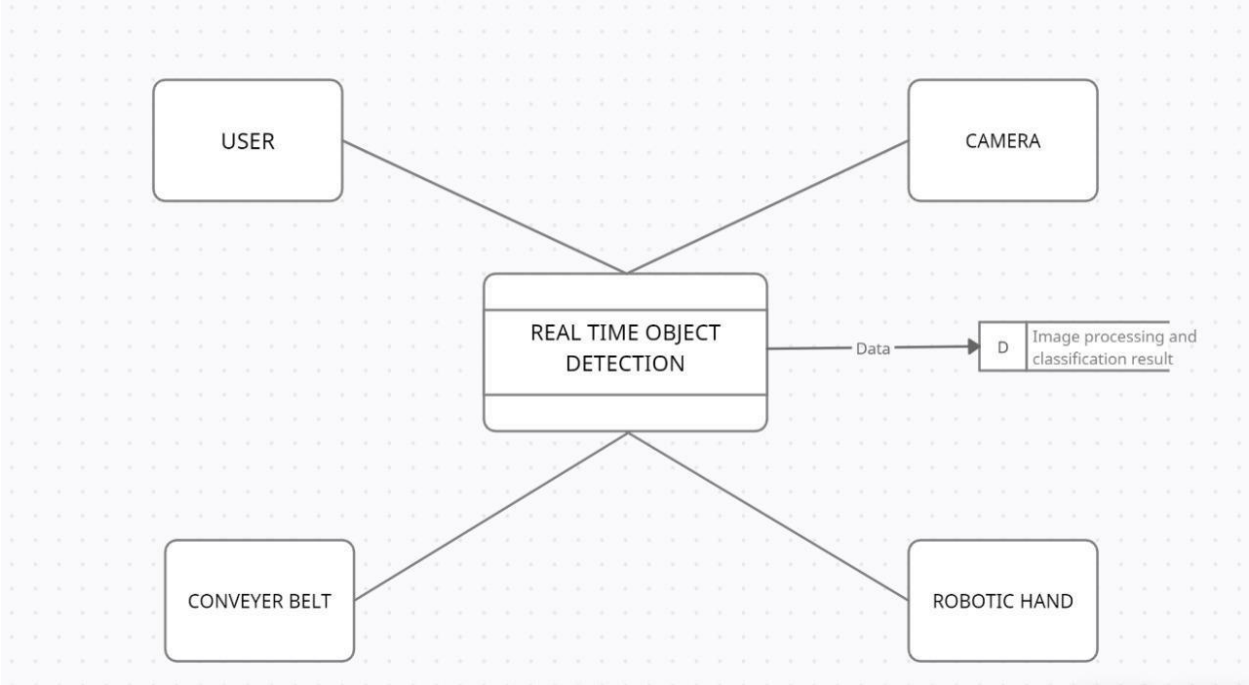


Fig 8. DFD Level 0

- In the above figure we have shown the basic data flow diagram of our model.
- An information system's data flow is graphically depicted in a data flow diagram (DFD), a sort of flowchart. It's also referred to as a process diagram, function diagram, or data flow diagram. Data flow diagrams are used to create an information system's architecture and to record all of its functional components.

4.5.2 DFD Level 1

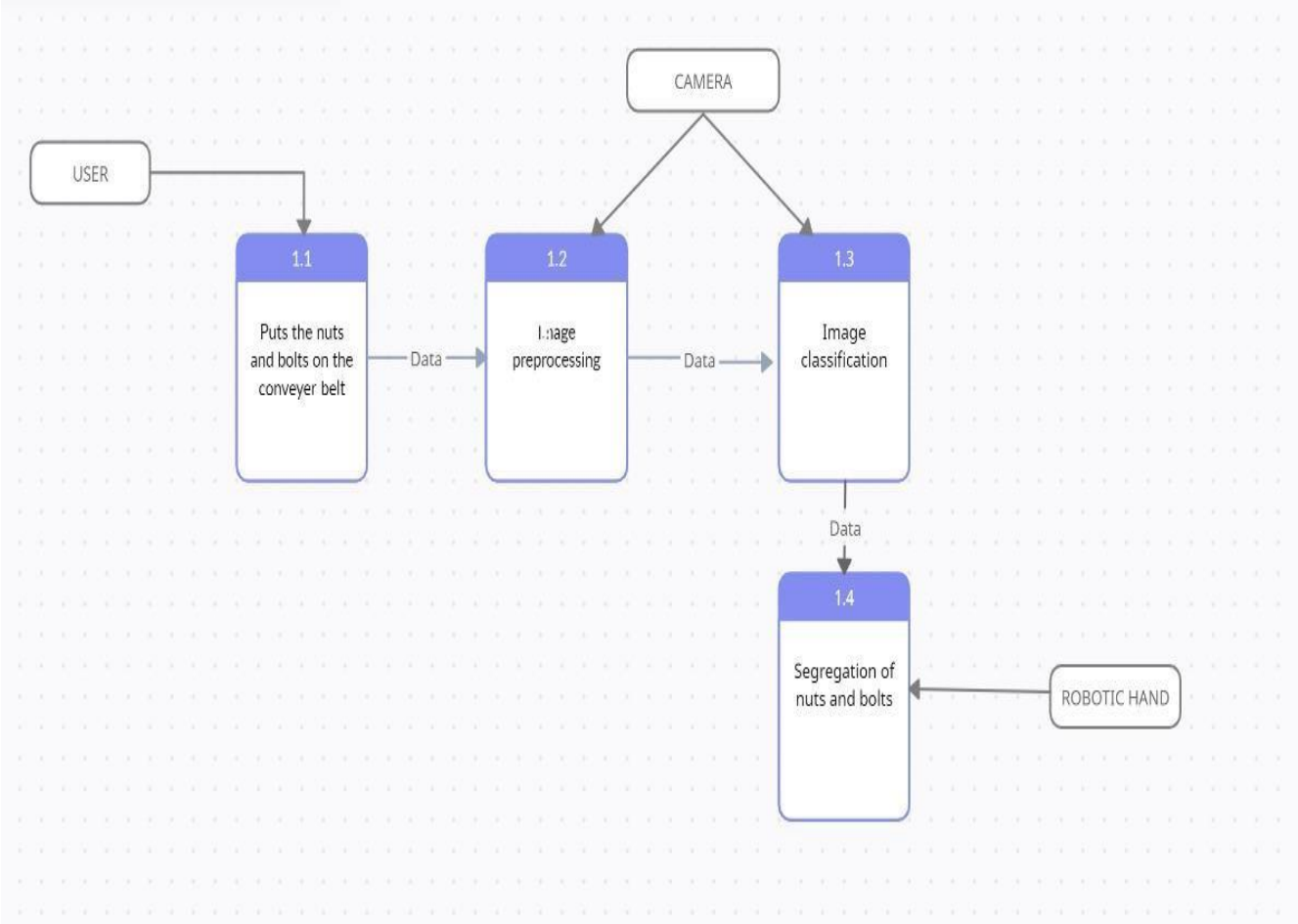


Fig 9. DFD Level 1

- In the above figure we have shown the data flow diagram of a component of our model which is a camera.
- It is depicting how data is flowing in all components of our model.

4.6 Architecture Diagram

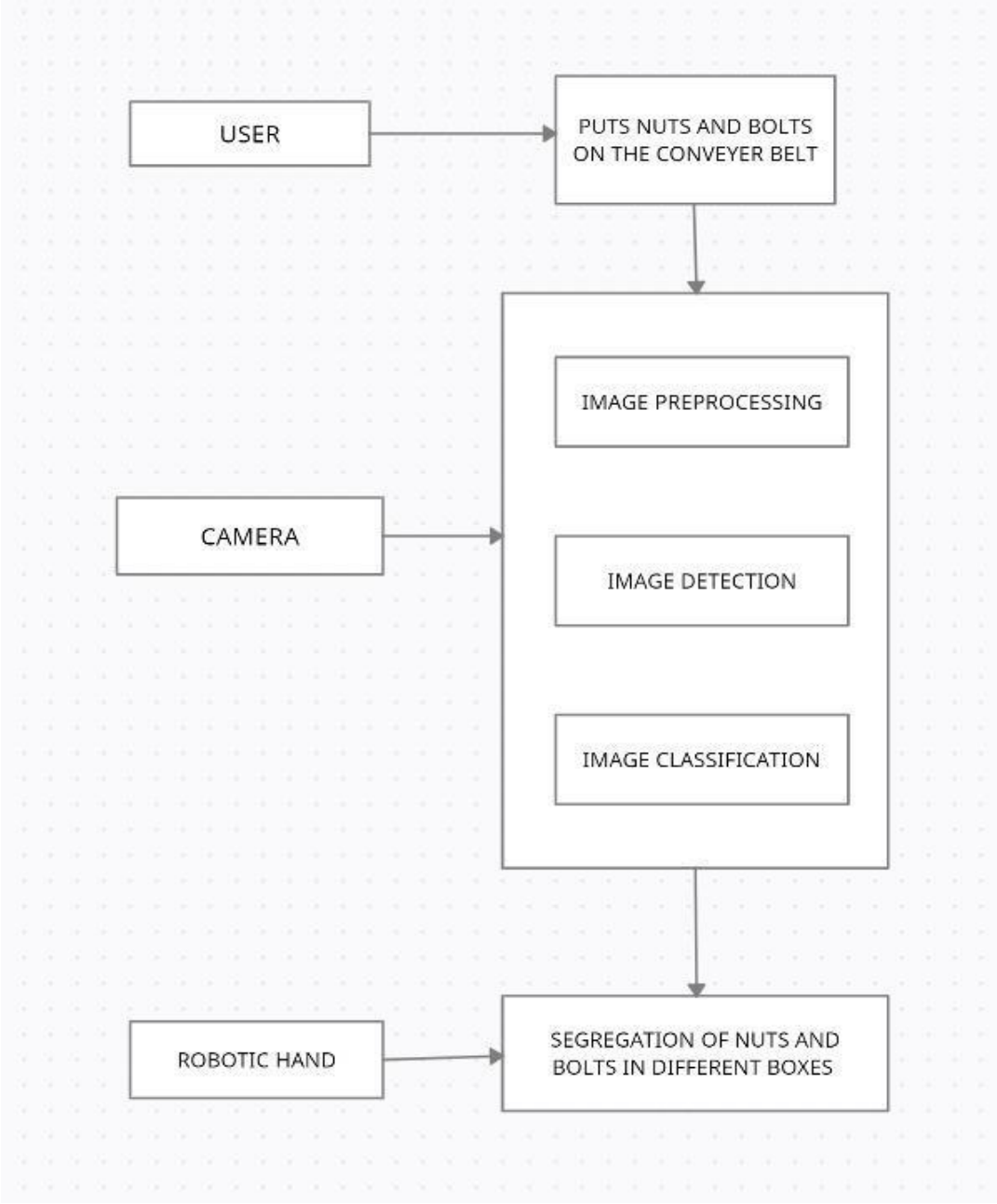


Fig 10. Architecture Diagram

In the above figure, we have shown the architecture diagram of our model.

- Basically, an architecture diagram is a network map used to describe the general structure of a software program as well as the interactions, restrictions, and limits between elements.

- Through this diagram we have shown the basic architecture of our model.
- **4.7 Block Diagram**

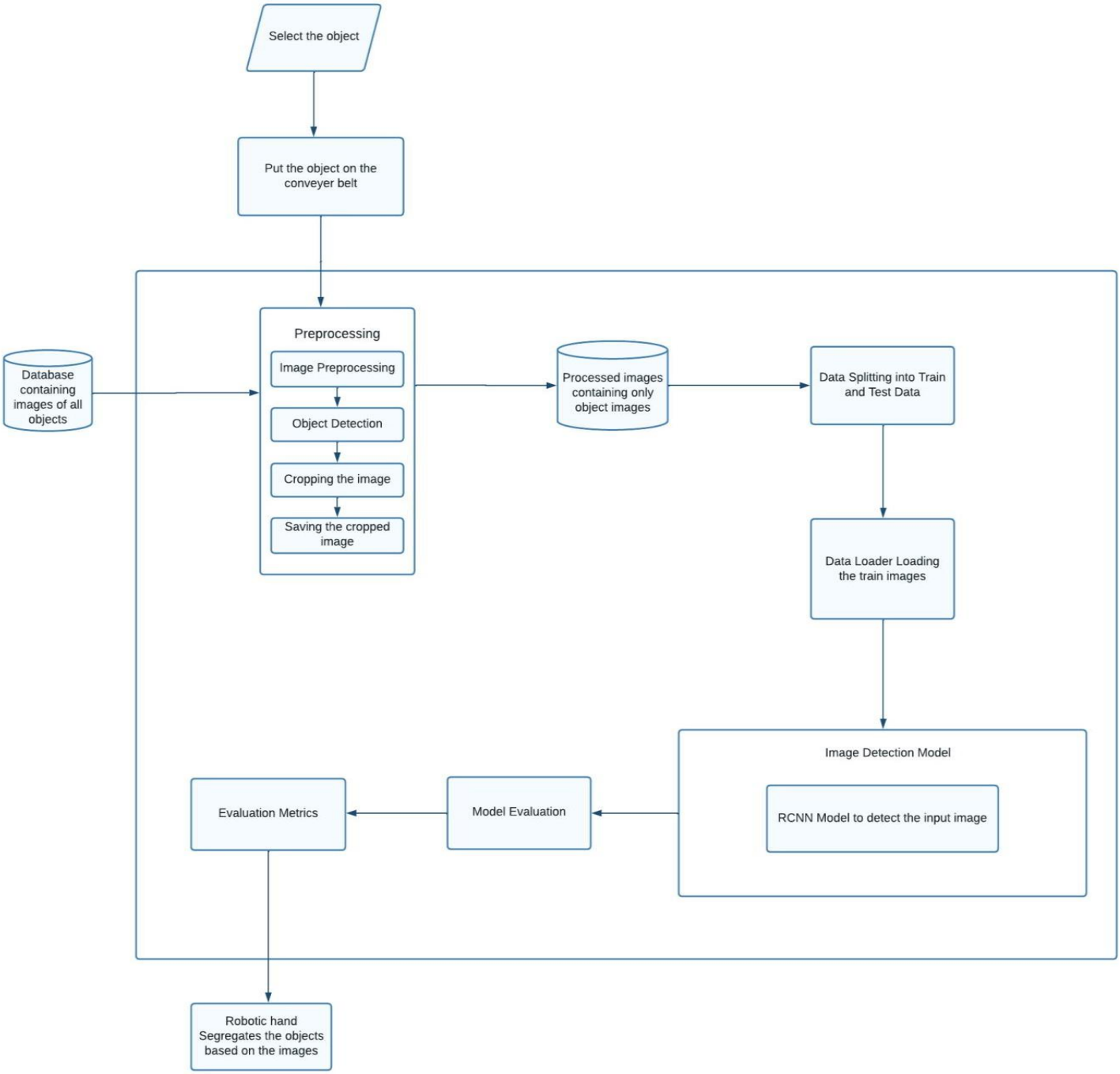


Fig 11. Block Diagram

- In the above figure we have shown the block diagram of our project.
- A block diagram is a system's representation of its main components or functions through the use of blocks connected by lines that reveal the connections between the blocks.
- In this diagram we are trying to show the major operations that are occurring in our working model.
- It consists of both software operations as well as operations are done by hardware components.

5. IMPLEMENTATION AND EXPERIMENTAL RESULT

5.1 Experimental Setup

We have made a hardware setup consisting of a wooden platform, conveyer belt, camera, and robotic hand to segregate the nut or bolt. Our model is a CNN. We have used a dataset available on Kaggle to train our model. After that, we tested the model on a significant amount of data.

5.2 Experimental Analysis

5.2.1 Data

For making the model efficient for real-time prediction. We have gathered the data from available data-set like images-of-mechanical-parts-bolt-nut-washer pin which are available on Kaggle. It is the only dataset with a large number of images for each mechanical part.

5.2.2 Performance Parameters

- Response time for Nut/bolt detection
- Time is taken for nut/bolt recognition
- Minimum size of nut/bolt detected by the camera.
- Throughput of the conveyor belt.
- Response time of robotic hand for a nut/bolt.

5.3 Working on Project

5.3.1 Procedural Workflow

Project task set Major Tasks in the Project stages are:

- **Task 1:** Collection of components. This task consists of evaluating the components and spare parts for better actuation.
- **Task 2:** Compiling the components in such a way that the desired outcome can be generated.
- **Task 3:** Testing the workability of the assembly of hardware elements.
- **Task 4:** Data-set gathering and analysis This task consists of downloading the dataset. Analyzing the dataset and making the dataset ready for pre-processing.
- **Task 5:** Pre-processing includes the creation of the new dataset which includes better feature extraction.
- **Task 6:** Training the final model. The final model on a large dataset is trained based on the generated dataset.
- **Task 7:** Final testing is done for the expected output on the hardware.

5.3.2 Algorithmic Approaches Used

5.3.2.1 Pre-processing Details

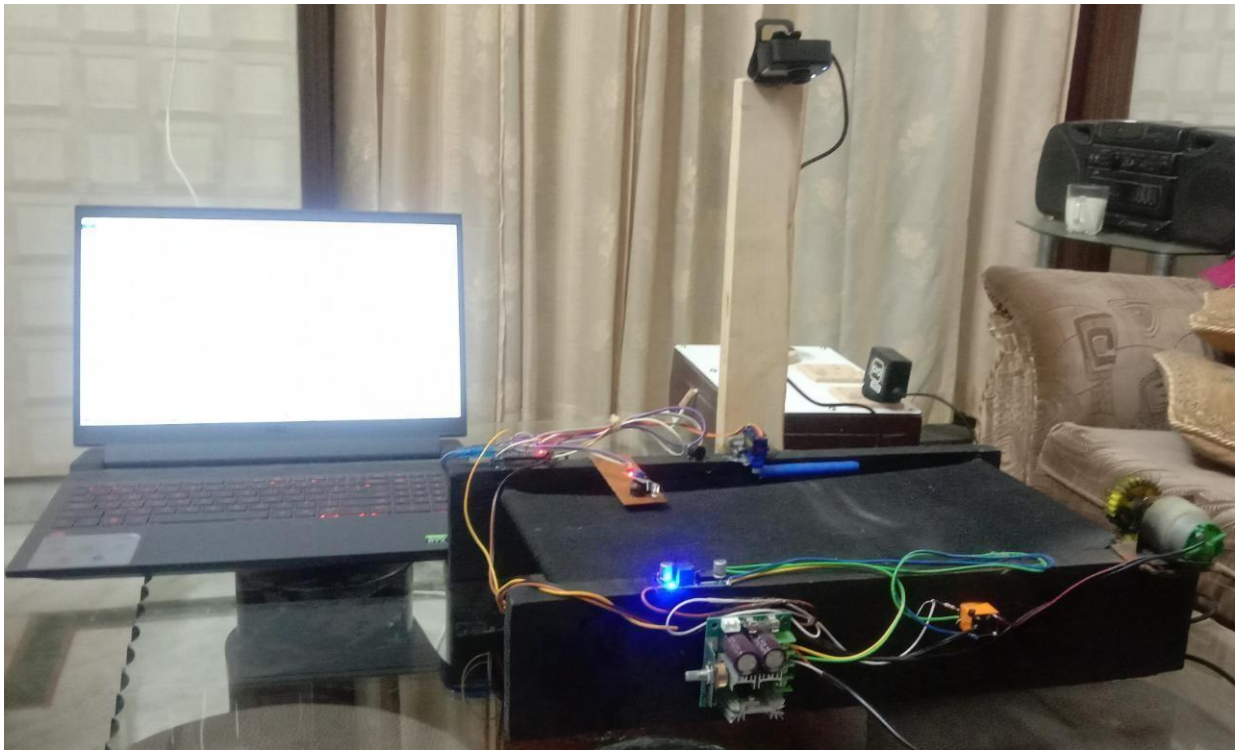
- The webcam produced RGB images, but since we don't need color information, the image was changed to grayscale.
- The image is converted to binary form using the thresholding procedure, making it eligible for further recognition.
- Furthermore, we use the Canny and Sobel operator to conduct the first edge detection.
- The image is finally cropped and normalized to 50 by 50 pixels so that it may be used as an access input.

5.3.2.2 Model Details

Keras

A convolutional neural network (CNN, or ConvNet) is a class of artificial neural networks (ANN), most commonly applied to analyze visual imagery. CNNs are also known as Shift Invariant or Space Invariant Artificial Neural Networks (SIANN). They have applications in image and video recognition, recommender systems, image classification, etc.

5.3.3 System Screenshots



5.4 Testing Process

5.4.1 Test Plan

The primary testing plan involves the following:
Train Test Split: The dataset is split into train and test datasets with a ratio of 80% train photos and 20% test photos. The train and test split are almost a balanced split of photos in each action.

5.4.2 Features to be Tested

We must test our system, which involves sending and capturing the component (nut or bolt) on the conveyer belt and then segregating it on the basis of 1 and 0.

5.4.3 Test Strategy

- Define the testing goal
- Planning the approach
- Predict the result
- Select testing tools
- Test case design
- Test case execution
- Collection and Analysis of results

5.4.4 Test Techniques

Functional testing techniques:

- Unit Testing
- Integration Testing
- System Testing
- Interface Testing

Non-functional testing techniques:

- Performance
- Load Testing
- Compatibility Testing

5.4.5 Test Cases

1. Start the conveyor belt
2. Place the Nut or Bolt on the moving belt
3. Camera will begin its detection
4. Prediction will be made with the help of algo
5. Segregation will be done as per generated output.

5.6 Inference Drawn

- The high-speed camera could be perfectly adapted to capture the image of each nut.
- The success rate can be improved by up to 98 % if we had used an additional spotlight on the object instead of the room fluorescent lighting, with a better belt conveyor (without any black spots).
- The speed can also be increased if we had used a laser pointer which has a better response time.

5.7 Validation of Objective

We presented a neural network-based approach to segregate the components. Our method is capable of predicting the output by 92%, at 9 cm/sec speed, and 90% success rate, at 5cm/sec speed.

6. CONCLUSION AND FUTURE SCOPE

6.1 Work Accomplished

We proposed a system that will detect whether a mechanical part on the conveyor belt is a nut or bolt and segregate the nuts and bolts. The hardware component is simple and there is ease for small hardware businesses to get the desired results.

6.2 Conclusions

We presented a neural network-based approach to classify nuts and bolts. Our method is capable of predicting the output with good accuracy. We implemented the CNN model by training it with 70%of the data set and the remaining 30% is used for the testing of the model. A conveyor belt along with a camera and robotic hand is used to move the nut/bolt on the platform.

6.3 Environmental/Economic/Social Benefits

Nuts and bolts are very small yet very important components in every object. Segregating these nuts and bolts manually is very tedious as well as time-consuming. So, we aim to solve this problem using hardware and the best models of deep learning. Actually, it is a kind of serious problem if we place the wrong nut/bolt in place of any other nut/bolt. Also, very huge machinery is not affordable for small shopkeepers. So, our model will address these kinds of audiences very efficiently. Deep learning-based detection methods can be applied more successfully for nut/bolt detection than traditional methods.

6.4 Future Work Plan

There is always a scope for enhancements in any developed system, especially when the project builds using the latest trending technology and has a good scope in the future.

- Quality of the camera used for image extraction can be improved
- Make our system segregate the nuts/bolt based on their sizes.

With more time to work on this project, we would explore multiple other strategies for detecting nut/bolts and find other models with higher accuracy. For now, we have used and tested only preexisting models that we have till the time, in future, we aim to create our own model that will be useful for only this type of prediction.

7. PROJECT METRICS

7.1 Challenges Faced

No achievement is possible without encountering challenges it's way, we also faced a lot of challenges but with the support of all stakeholders of the project, we completed the project successfully. Some of the challenges we faced are -:

- Coordinating the speed of the conveyor belt and the camera was a tedious task.
- Used the hit and trial method for the distance between the camera and the conveyor belt so that the object can be detected accurately.
- It was a cumbersome task with the wiring and assembling of the component.

7.2 Relevant Subjects

- Computer Vision
- Machine Learning
- Artificial Intelligence
- Software Engineering
- Engineering Design
- Physics
- Mathematics
- Object Oriented Programming

7.3 Interdisciplinary Knowledge Sharing

- **Mathematics -** Concepts of mathematics were used in shaping the overall workflow of the system as speed and accuracy were key parameters.

- **Physics -** Basic concepts of mechanics were used to shape the body of the system and to maintain its stability.

- **Engineering Design -** The design model used to complete a project is implemented. This helps to understand how to pursue the project in a manner to successfully fulfill it.

- **Software Engineering -**All the different skills learned in software engineering are used in this project. Such as the coding part is used to build models to run the target detection and segregation. Also, the testing part is done simultaneously such as to minimize the failures while running the code.

- **Machine Learning -** Algorithms of Artificial Intelligence along with Computer Vision was used to set up a Target Identification module that can detect targets in a real-time environment.

7.4 Peer Assessment Matrix

Here you need to present a Matrix on 1 (min) to 5 (max) rating of the contribution of each member.

Table 6. Peer Assessment Matrix

		Evaluation Of		
		S1	**S2**	**S3**
Evaluation By	**S1**	5	5	5
	S2	5	5	5
	S3	5	5	5

Here,
S1 - Parneet Kaur Rakhra
S2 - Simran Kumari
S3 - Vidushi Mahajan

7.5 Student Outcomes Description and Performance Indicators (A-K Mapping)

Table 7. A-K Mapping

SO	DESCRIPTION	OUTCOME
A1	Applying mathematical concepts to obtain analytical and numerical solutions.	Used mathematical concepts to estimate real-time position in case of moving targets. These concepts were also used to interpret and analyze the results.
A2	Applying basic principles of science toward solving engineering problems.	Used concepts of physics like the range in the process of estimating the range between the camera and the conveyor belt.
A3	Applying engineering techniques for solving computing problems.	Used our previous knowledge of Arduino, Machine Learning, Networking, etc. To build this prototype.
B1	Identify the constraints, assumptions, and models for the problems.	Constraints that the speed of the conveyor belt should be favorable and the assumption that lighting conditions remain favorable at all

		hours, etc.
B2	Use appropriate methods, tools, and techniques for data collection.	Used labeling for graphical annotation of images to create a custom dataset.
B3	Analyze and interpret results with respect to assumptions, constraints, and theory.	Assumption while using the normal camera is that the environmental conditions and lighting will be as required for the model to make correct assessments. Analyzed the success rate of our system with a constraint on its range.
C1	Fulfill assigned responsibility in multidisciplinary teams.	Created several group reports, ppt, and other presentations by voluntarily dividing the work equally and submitting them on time.
C2	Can play different roles as a team player.	Posed as colleagues and sometimes as mentors to teach each other new skill sets, learned to work in a team, and take up each other's responsibilities when required.
D1	Identify engineering problems.	Problems such as battery life and finding alternatives other than the existing options were resolved.
D2	Develop appropriate models to formulate solutions	Created a system that can detect and segregate the nuts and bolts in their respective sections.
D3	Use analytical and computational methods to obtain solutions.	Used fast Keras and TensorFlow to train the custom object detection model.
E1	Showcase professional responsibility while interacting with peers and professional communities.	By helping each other learn the different required skills during the duration of the project.
E2	Able to evaluate the ethical dimensions of a problem.	Ethical dimensions like accuracy and precision were considered to ensure a high success rate of the system to ensure an increase in the man downtime for users.
F1	Produce a variety of documents such as laboratory or project reports using appropriate formats.	Used EDraw, Excel and other tools to generate various flowcharts and graphs in desired formats.

F2	Deliver well-organized and effective oral presentations.	Used video, ppt, poster, website, and other visual tools for an effective presentation.

7.6 Brief Analytical Assessment

Q1. What sources of information did your team explore to arrive at the list of possible Project Problems?

Ans: When we started the capstone project, we tried searching on the internet for basic problems that can be solved. We observed the problem initially in the world around us, and after thinking of an

initial solution we did an extensive study on existing technologies, solutions, and literature available on the challenges faced by the people of the country. From there on, we started exploring similar examples of problems faced by certain people. After a couple of discussions, We decided to build a system that would help the user in detecting the nuts and bolts and also segregate them with reduced manpower.

Q2. What analytical, computational, and/or experimental methods did your project team use to obtain solutions to the problems in the project?

Ans: The techniques used throughout the study are descriptive and experimental in nature. We tried surveying people and researching previous projects that have been attempted for the same problem and what kind of problems they faced. We also looked at various successful projects with the same solutions.

Q3. Did the project demand demonstration of knowledge of fundamentals, scientific and/or engineering principles? If yes, how did you apply?

Ans: Yes, the project required knowledge of Keras and TensorFlow libraries. These concepts involved principles from computer science like deep learning and machine learning. Concepts of software engineering helped us organize our workflow and plan the implementation and testing of our project.

Q4. How did your team shares responsibility and communicate the information of the schedule with others in the team to coordinate design and manufacturing dependencies?

Ans: WhatsApp, zoom, GitHub and google meet were the platforms we used to regularly collaborate on. We worked on every aspect of the project on calls where everyone gave their input regarding the project. We also established regular communication with our project mentors by meeting them in person.

Q5. What resources did you use to learn new materials not taught in the class for the course of the project?

Ans: We used the internet for new materials that we had not learned in class and also sought

guidance from our mentors and professors. A variety of papers and articles were available for us to familiarize ourselves with the modules that were not taught in class. Also, we learnt object detection, Keras and TensorFlow libraries from the internet.

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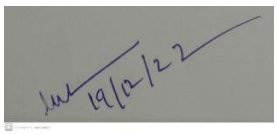

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