

**AUTOMATED QUALITY GRADING AND SORTING OF EGGPLANTS
USING MACHINE LEARNING**

An Undergraduate Thesis

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BACHELOR OF SCIENCE IN COMPUTER ENGINEERING

**JIHARA MAE B. APUT
RALPH B. GALANIDO
ALEXANDRA E. JAGONOS
MARK MADORABLE
JONAS RON FRANCO P. MALAZARTE**
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APPROVAL SHEET

This Thesis entitled: ‘‘AUTOMATED QUALITY GRADING AND SORTING OF EGG-PLANTS USING MACHINE LEARNING’’, prepared and submitted by JIHARA MAE B. APUT, RALPH B. GALANIDO, ALEXANDRA E. JAGONOS, MARK MADORABLE, and JONAS RON FRANCO P. MALAZARTE in, partial fulfillment of the requirements for the degree of **BACHELOR OF SCIENCE IN COMPUTER ENGINEERING** has been examined and approved.

Engr. Darwin Jone H. Jupiter

Adviser

PANEL OF EXAMINERS

Approved by the committee on Oral Examination with a grade of **PASSED**.

Engr. Rodesita S. Estenzo

Chair

Engr. Jasper Jay A. Jementiza

Member

Mrs. Mirasol D. Rizon

Member

Engr. Kristine Mae Dunque

Member

Approved and accepted in partial fulfillment of the requirements for the degree **BACHELOR OF SCIENCE IN COMPUTER ENGINEERING**.

Approved:

Dr. Israel A. Baguhin

Dean, College of Engineering and Architecture

ABSTRACT

This study...

Keywords: *computer vision, grading system, eggplant classification*

This piece of work is wholeheartedly dedicated

to my parents

Papang

and

Nanay

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CHAPTER 1

INTRODUCTION

This chapter presents an overview of the study, outlining its conceptual foundation and research direction. Section 1.1 presents the background of the study, which discusses the growing use of automation, computer vision, and machine learning in postharvest quality assessment. Section 1.2 identifies the statement of the problem, highlighting the challenges in automating the grading and sorting of eggplants. Section 1.3 states the objectives of the study, focusing on the design and development of an automated eggplant grading and sorting system. Section 1.4 discusses the significance of the study, emphasizing its benefits to farmers, traders, consumers, and future researchers. Section 1.5 defines the scope and limitations that set the boundaries of the study's application and performance. Lastly, Section 1.6 provides the definition of key terms to ensure clarity and understanding of important concepts used throughout the research.

1.1 Background of the Study

In recent years, the agricultural sector has increasingly turned to automation and artificial intelligence to enhance postharvest operations. Within this technological shift, machine learning (ML) has become pivotal for automating the qual-

ity grading and sorting of produce (Bansal and Uddin, 2023). This technology facilitates non-destructive inspection by analyzing key visual characteristics (such as color, size, shape, and surface defects) that were traditionally assessed through manual, labor-intensive methods (Khan and AlGhamdi, 2024). By integrating ML with mechatronic systems, automated graders have been developed that perform real-time classification and physical sorting, significantly boosting efficiency and accuracy for a variety of crops, including apples, citrus, and mangoes (Bu et al., 2025; Lee et al., 2023; Xu et al., 2024; Zhang et al., 2021).

Despite these advancements, a significant research gap remains for elongated and irregularly shaped produce like eggplants, as existing systems have primarily been optimized for spherical or root-type crops. For instance, studies on sweet potatoes and mandarins achieved high accuracy but relied on the produce shapes reliant on uniform rotation (Bu et al., 2025; Xu et al., 2024). Similarly, multi-camera setups for apples often struggle to achieve full-surface visibility on non-spherical items (Lee et al., 2023; Zhang et al., 2021). While deep learning has been successfully applied to classify diseases in eggplants (Haque and Sohel, 2022; Kursun and Koklu, 2025)

Addressing this technological gap is critical given the economic and agricultural importance of eggplant. A global crop with centuries of cultivation, eggplant (*Solanum melongena*), also known as aubergine or brinjal, is a major veg-

etable crop. Global production reaches approximately 60.8 million metric tons, cultivated on over 1.9 million hectares (Food and Agriculture Organization of the United Nations, 2025). Its significance is particularly pronounced in countries like the Philippines, where it is locally known as “*talong*” and where the production value alone amounted to P1.027 billion in December 2024 (Philippine Statistics Authority, 2025).

The unique morphology of eggplant poses distinct challenges for automated grading. Its elongated, curved, and irregular shape complicates the capture of a complete surface image, unlike spherical fruits that can be easily rotated. Consequently, specialized multi-angle imaging is necessary to consistently capture defects along the entire stem-end, body, and tip-end. Additionally, the vegetable’s dark purple skin can obscure blemishes, and its susceptibility to specific defects like calyx browning requires highly sensitive computer vision algorithms for accurate quality assessment.

This study will look into developing an integrated computer vision and deep learning system for the real-time grading and sorting of eggplants while considering the plant’s unique morphology. The core innovation is a dedicated imaging station; when an eggplant passes over this station, two synchronized cameras mounted above and below the glass simultaneously capture its top and bottom surfaces. This design eliminates the need for complex mechanical flipping (Awasthi, 2021) and overcomes

the challenges of timing and inconsistent rotation posed by the vegetable's variable size and curvature. Successful validation will demonstrate a scalable system capable of reducing postharvest losses, lowering labor costs, and ensuring consistent quality standards for this high-value crop. By providing a model for grading non-spherical produce, this study will hopefully contribute to broader adoption of precision agriculture in farming. A machine learning model will then process these captured images to perform quality grading, which subsequently actuates a mechatronic sorter (eggplants will be sorted first into binary classification of "Healthy" and "Defect" or "Unhealthy". Afterwards, "Healthy" class will be sorted further into three subclasses: "Extra Class", "Class I", and "Class II," which follows the local criteria provided by the Philippine National Standards (PNS) and Bureau of Agricultural and Fisheries Product Standards (BAFPS) (PNS/BAFPS 52:2007), that is based on visual quality, size, and defect tolerances (Mandigma et al., 2021).

1.2 Statement of the Problem

The adoption of automated grading systems using ML has significantly improved postharvest efficiency for many agricultural crops. However, a critical technological gap exists for elongated and irregularly shaped produce, specifically eggplants. Existing automated systems are predominantly designed and optimized for spherical (e.g., citrus fruits, tomatoes) or root-type crops (e.g., sweet potatoes, pota-

toes), which allow for uniform rotation and straightforward imaging to achieve full-surface visibility.

This gap poses two main challenges – unique morphological features and automation of sorting systems for postharvest quality grading. The produce unique morphology (elongated, curved shape, dark skin) presents distinct challenges (such as darkening of skin leading to obscure defects, and susceptibility to specific blemishes like calyx browning) that current system designs cannot adequately address. These challenges include the inability to capture a complete surface image without complex handling and the need for specialized algorithms to accurately identify defects on a non-uniform, dark surface. While some research has applied deep learning to eggplant disease detection, these studies have not progressed to the development of integrated, real-time mechanical sorting systems for postharvest quality grading. This lack of a tailored automated solution is a significant limitation, given the substantial economic and agricultural importance of eggplant as a widely cultivated crop.

A primary technical obstacle is the lack of an effective imaging mechanism capable of capturing the eggplant's entire surface area in a single, synchronized pass. Conventional conveyor-based systems used for round produce are insufficient because they cannot enable a complete full surface inspection of a curved, elongated vegetable to a camera. Proposed solutions like mechanical flippers or com-

plex multi-roller systems introduce significant drawbacks, including increased cost, mechanical complexity, and high risk of bruising or damaging the delicate skin of the produce, which defeats the purpose of non-destructive inspection.

Consequently, the absence of a suitable automated system for eggplants perpetuates a reliance on manual labor for sorting, which is inherently slow, inconsistent, and economically unsustainable. This reliance leads to significant postharvest losses due to inconsistent grading standards and the slow pace of human inspection, which can bottleneck the entire supply chain. Without a technological solution designed for its specific form, the eggplant industry cannot fully access the benefits of automation, such as enhanced throughput, objective quality control, and improved profitability for farmers. Therefore, the problem necessitates the development of a novel, integrated system that solves the fundamental challenges of imaging and handling eggplants to enable accurate, real-time, and non-destructive automated grading.

1.3 Objectives of the Study

This study aims to develop an automated eggplant sorting and grading system using ML to classify eggplants as healthy or defective, and categorize healthy ones into three quality grades (“Extra Class”, “Class I”, “Class II”), reducing manual labor in the sorting process.

Specifically, this study aims:

1. To design and develop a mechatronic sorting mechanism that integrates with a conveyor system to automate the physical separation of eggplants based on quality grade;
2. To develop and train a machine learning model for automatic quality grading by extracting visual features (such as color, shape, and surface defects) from images captured by the dual-camera imaging station; and
3. To evaluate the performance evaluation of the integrated system, measuring its grading accuracy, mechanical reliability, and usability for postharvest operations.

1.4 Significance of the Study

This study enhances the post-harvest process of eggplant production through automated sorting and grading using image processing and machine learning. It addresses the inefficiencies of manual sorting by ensuring accurate and consistent quality classification. The research contributes to agricultural advancement and supports SDG 2 (Zero Hunger), SDG 8 (Decent Work and Economic Growth), and SDG 12 (Responsible Consumption and Production) by promoting productivity, fair trade, and reduced post-harvest waste. Benefiting from the study are the following sectors:

Farmers. Benefit through reduced manual labor and human error in sorting and grading. The system helps them achieve consistent classification results, allowing for fairer pricing. Faster and more accurate sorting increases productivity and reduces post-harvest losses. Farmers also gain stronger market confidence by consistently meeting quality standards required by buyers and distributors.

Middlemen and Traders. Benefit from standardized grading that ensures uniform quality across distributed eggplants. Providing standardized classifications helps minimize rejection from buyers and reduces unnecessary handling and waste. This also promotes efficiency in the post-harvest process by shortening the time between sorting and distribution, ensuring that only high-quality and market-ready produce is delivered. Through improved consistency, traders can build stronger partnerships with retailers and improve the credibility of their supply chain operations.

Consumers. Receive eggplants that are clean, fresh, and free from visible defects or diseases. Consistent grading ensures that only safe and high-quality produce reaches the market, promoting good health and consumer satisfaction. The system also supports fair pricing in markets by clearly distinguishing product grades according to quality.

Future Researchers. Gain a useful reference for developing or enhancing automated grading systems in agriculture. The study offers insights into applying image processing and machine learning for post-harvest classification and quality

control. It also serves as a foundation for future improvements, including system adaptation for other crops and refinement of algorithm accuracy and efficiency.

1.5 Scope and Limitations

The scope of this study focuses on the quality grading of eggplants using machine learning integrated with a mechatronic sorting system. The system is designed to first classify eggplants as either healthy or defective, and then to further classify the healthy eggplants into the quality grades of Extra Class, Class I, and Class II based on color homogeneity and shape. The system is designed to process individual eggplants as they are transported on a conveyor belt, passing through an imaging platform that enables a full surface inspection.

The focus will be on sorting long, elongated, purple eggplants only, as these are the most common type of eggplants available in Cagayan de Oro City. Uncleaned eggplants or those with significant visible foreign matter—such as thick mud—that may occlude the surface and interfere with the system’s classification algorithms are excluded from the study’s scope.

In this study, the conveyor belt will have a width of 400 mm, allowing for the efficient transport of individual eggplants during the sorting process. The system will be designed to handle a maximum weight capacity of 7 kg, ensuring that it can process a sufficient number of eggplants at a time without overloading the mecha-

nism. This weight capacity ensures that the system is capable of handling typical batches of eggplants during postharvest operations, while maintaining smooth and efficient performance.

The system is restricted to detecting only external visible defects for the initial healthy/defective classification; it will not identify the specific type of disease present on defective eggplants. Furthermore, the system is fundamentally limited to detecting only external visible defects and cannot detect diseases or quality issues caused by internal fruit infestation, as these are not visible to the camera. Additionally, since the system is designed for long, elongated types of eggplants, it may struggle with or require recalibration for significantly different varieties or shapes.

1.6 Definition of Terms

Color Homogeneity The degree of uniformity in color across an object's surface.

Feature Extraction The process of identifying and quantifying important characteristics such as color, shape, and texture from images

Hyperparameter Tuning Adjusting model settings to improve its accuracy and performance.

Image Preprocessing Enhancement of raw images to reduce noise and improve analysis quality.

Image Segmentation The division of an image into regions to isolate specific objects or areas.

ImageNet A large visual dataset used for pretraining deep learning models in transfer learning applications, advancing deep learning and computer vision through massive, well-labeled datasets that enable highly accurate model training.

Quality Grading The process of evaluating and categorizing items based on visual attributes such as shape, color, and surface condition to determine the overall quality level.

Mechatronics Refers to a field of engineering that integrates mechanical, electrical, computer, and control engineering to create smarter and more efficient systems.

CHAPTER 2

REVIEW OF RELATED LITERATURE

This chapter focuses on related studies or projects that have provided additional relevant information to the proponent. Section 2.1 presents the theoretical background related to machine learning and mechatronics. Section 2.2 specifies the concept of how the system will classify the eggplants by class based on surface defects, color homogeneity, and shape. Section 2.3 presents a review of literature related to the design of employing machine learning and mechatronic integration in agricultural automation for image-based inspection and mechanical sorting applications. Collectively, these reviewed literatures support the concept presented in this study.

2.1 Theoretical Background

The development of an automated eggplant grading system is fundamentally grounded in the integration of theoretical paradigms of computational intelligence and mechanical control. This framework draws from the convergent disciplines of machine learning and mechatronics to create a cyber-physical system capable of perceiving, deciding, and acting. The following subsections detail the core theories that underpin the image analysis, classification, and physical sorting mechanisms of

the proposed system.

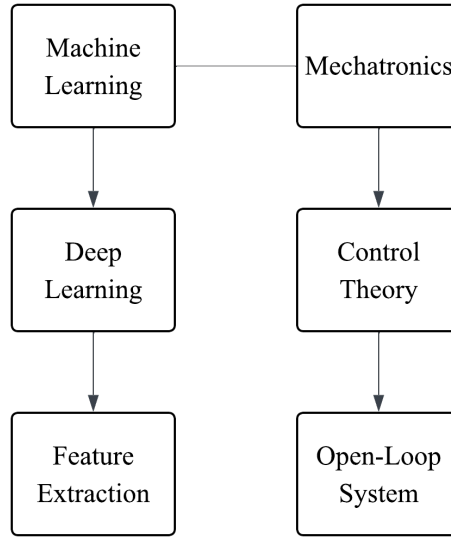


Figure 1: Theoretical Framework

The development of an automated eggplant grading system is fundamentally grounded in the integrated theoretical paradigms of computer vision, deep learning, and mechatronics. The entire process can be conceptualized through a sequential computer vision pipeline, which moves from image acquisition to physical actuation (Szeliski, 2022). This pipeline begins with the digital image formation theory, where a camera sensor captures light reflectance from objects on a conveyor belt, a common setup in food process engineering (Dougherty, 2020). The stability and quality of this initial stage are paramount, as controlled, diffuse illumination is critical to minimize specular reflections and shadows that can obscure critical features

like color and surface defects, thereby ensuring consistent input for subsequent algorithmic processing.

Following acquisition, image pre-processing theories are applied to enhance data quality and standardize inputs. This involves digital signal processing techniques such as noise reduction using Gaussian or median filters (Kumar and Sodhi, 2020) and, crucially, color space transformation. Converting images from the default Red-Green-Blue (RGB) space to Hue-Saturation-Value (HSV) or $CIEL^*a^*b^*$ is a well-established step in agricultural product inspection (Khan and AlGhamdi, 2024). The theoretical underpinning for this conversion lies in the decoupling of color information (chrominance) from intensity (luminance) in these spaces, making the extracted color features more robust to minor variations in lighting conditions, which is essential for accurate color-based grading.

The core of the system resides in the theoretical distinction between traditional machine learning and deep learning for feature extraction. Traditional approaches are based on manual feature engineering, drawing from image processing and pattern recognition theory to hand-craft descriptors for color (e.g., histograms, mean values), shape (e.g., aspect ratio, roundness, area), and texture (e.g., using Gray-Level Co-occurrence Matrix (GLCM) or Local Binary Patterns (LBP)) (Haralick et al., 2007; Ojala et al., 2002). In contrast, deep learning, specifically Convolutional Neural Network (CNN) theory, posits that models can automatically learn

a hierarchical representation of features directly from raw pixel data (Goodfellow et al., 2016; LeCun et al., 2015). The lower layers of a CNN learn generic features like edges and corners, while deeper layers synthesize these into complex, task-specific features relevant to defect identification, thereby eliminating the need for manual feature design.

For the classification task itself, the theoretical models diverge. Machine learning classifiers operate on the principles of statistical learning theory, finding optimal hyperplanes to separate classes or constructing ensembles of decision trees, respectively, based on the handcrafted features (Breiman, 2001; Hearst et al., 1998). Conversely, an end-to-end deep learning model uses a fully connected output layer with a normalized exponential function (also known as *Softmax*) to perform classification based on the high-level features it learned itself. The theoretical advantage of CNNs is their superior ability to model complex, non-linear relationships in visual data, a capability that has been demonstrated to outperform traditional methods in numerous agricultural applications (Bharman et al., 2022).

The integrity of any supervised learning system is dependent upon the quality of its labeled dataset. The establishment of a reliable ground truth is a theoretical problem rooted in psychometrics and expert systems. The grading labels for the eggplant images must be derived from standardized agricultural protocols, such as those provided by the United States Department of Agriculture (USDA) or equiva-

lent bodies, which define quality classes based on size, color uniformity, and defect tolerances (USDA, 2013). Locally, the project will utilize the criteria defined by the Philippine National Standard (PNS), and Bureau of Agricultural and Fisheries Product Standards (BAFPS) (specifically the PNS/BAFPS 52:2007), which classifies eggplants into Extra Class, Class I, and Class II based on visual quality, size, and defect tolerances (BAFPS, 2007; PNS, 2019). To ensure scientific rigor, the concept of inter-rater reliability, often measured by Cohen's Kappa statistic (κ), must be applied to quantify the agreement between human experts who label the dataset, thereby validating the consistency of the training labels (He et al., 2022; McHugh, 2012).

The closed-loop system theory integrates the digital classification with physical actuation. The decision output from the classification model (e.g., a specific grade) is transmitted via a software-to-hardware interface to a Programmable Logic Controller (PLC) or microcontroller (Bolton, 2015). This triggers a mechatronic actuator, such as a pneumatic pusher or a servo-controlled diverter, which physically sorts the eggplant into its designated bin on the conveyor line. This final stage embodies the principle of cyber-physical systems, where computational intelligence directly controls a physical process to achieve full automation, replicating and potentially surpassing human grading efficiency (Lee, 2008; Zhang et al., 2022).

CHAPTER 3

METHODOLOGY

This chapter details the design and development of the automated eggplant sorting and grading system, following the Modified Waterfall SDLC model. Section 3.1 discusses the research design and procedural framework. Section 3.2 focuses on the hardware development, describing the design, architecture, and components essential of the conveyor and sorting mechanism. Section 3.3 explains the software development process, detailing the algorithms, tools, and models used for image processing, feature extraction, and classification. Section 3.4 elaborates on the system integration, illustrating how the hardware and software components interact to

achieve seamless automation. Collectively, this chapter provides a comprehensive overview of the methods used to ensure the system's accuracy and reliability.

3.1 Research Design and Procedure

This study adopts the Modified Waterfall System Development Life Cycle (SDLC) model as the primary framework for the systematic development of the project. The Modified Waterfall model follows a structured and sequential design process, allowing limited feedback between phases when necessary. This approach ensures that each stage is properly analyzed and refined before proceeding to the next, promoting accuracy, consistency, and efficiency throughout system development. The research design of the study follows these distinct phases, as represented

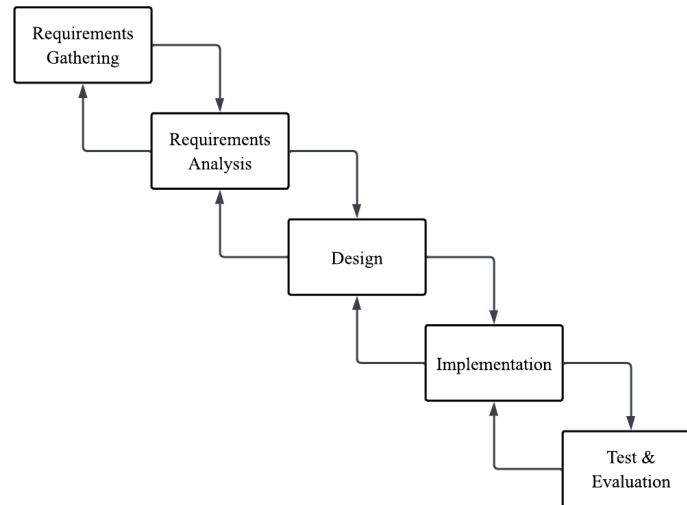


Figure 2: Modified Waterfall Model of SDLC

in Figure 2.

The development will begin with requirements gathering, where the researchers will collect relevant information from local farmers and agricultural experts to determine the necessity and specifications for automating eggplant sorting and disease detection. This will be followed by requirements analysis, where the system's functional requirements and non-functional requirements will be formally defined.

During the design phase, the overall system architecture will be planned.

This includes the hardware setup, featuring camera modules for image capture and conveyors with actuators for sorting. The software framework will also be designed to manage image processing, feature extraction, and machine learning-based classification for grading.

In the implementation phase, the designed hardware and software components will be developed and integrated. The program will be coded and linked to the physical components such as cameras, motors, actuators, and controllers to perform automated grading and sorting. Finally, the testing and evaluation phase will assess the prototype's grading accuracy. The results will be analyzed to identify errors or

limitations, guiding refinements to improve the system's accuracy, and reliability.



3.2 Hardware Development


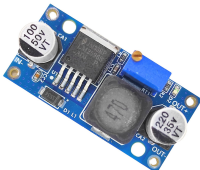




This section presents the design and integration of the system's mechanical and electronic components. The hardware consists of a conveyor system, camera modules, actuators, and a microcontroller that operate together to transport, classify, and sort eggplants. Each component is configured to function in coordination with the software, ensuring synchronized operation and accurate sorting based on the detected quality of the eggplant.

3.2.1 Hardware Requirements

The hardware requirements include all the physical components essential for constructing the system. Each component is selected based on its purpose and function in the automated eggplant grading and sorting system, ensuring effective integration and reliable operation to achieve accurate grading and sorting performance.

Table 1: Hardware Requirements

Component	Image	Function
DC Motor		This component powers the conveyor belt by converting electrical energy into mechanical motion.
Power Supply Adapter		This component supplies the necessary electrical power for the Arduino to operate effectively.

Arduino		Functions as the control unit for the conveyor belt and actuators, managing the movement and sorting operations of the system based on the classification results.
Buck Converter		Regulates the 12 V input into required voltages: 6 V for the servos and 5 V for the relay and control circuits.
NPN Transistor		Serves as a relay driver that amplifies the Arduino's control signal to energize the relay coil.
Flyback Diode		Protects the transistor and other components from voltage spikes generated by inductive loads.
Servo Motor		Controls the sorting gates that direct eggplants into Grades Extra Class, Class I, Class II, or Rejected bins after classification.
Ball Bearings		This part enables the smooth rotation of the conveyors rollers by minimizing friction. It supports the conveyor belt's movement, allowing efficient loading and consistent operation of the rollers.

Bolts & Nuts



This component is used to firmly attach and hold together parts of the conveyor system, such as the motors, frame, and rollers, to keep everything stable and properly aligned.

Wood Screws



This component is used to join and secure the parts of the conveyor belt system, including the wooden frame, rollers, and other sections, ensuring they are firmly attached and properly assembled.

Conveyor Rollers



The conveyor rollers enable the smooth movement of the conveyor belt, allowing the eggplants placed on top to be transported efficiently. They also help keep the belt properly aligned to ensure stable and consistent motion during operation.

Timing Belt
Pulley

The timing belt pulley transfers the motor's rotation to the rollers through a timing belt, ensuring synchronized and slip-free movement. Its toothed design keeps the rollers turning accurately and at the same time, allowing smooth and consistent movement of eggplants along the conveyor.

Acetate Plastic



The acrylic glass platform serves as a transparent base that allows the cameras positioned above and below to capture clear images of both sides of the eggplant.

HD Webcam (Srihome SH003)



This hardware component captures real-time images or video of the eggplants on the conveyor belt. The captured data is then used for image processing and analysis to identify quality and classify the eggplants accordingly.

LED Strips



The LED strips give the camera the right amount of light, helping to improve the accuracy of sorting and classifying eggplants by their quality.

Sorting Plate



Functions to redirect eggplants into their designated bins. Its smooth, durable surface minimizes friction and prevents damage during the sorting process.

Flat Bar



This part will be used as a structural foundation for the camera to mount on top of the conveyor belt.

Wooden Planks



Serves as the base frame that securely holds all components of the conveyor belt, ensuring the entire system remains steady during operation.

Enclosure Box



This will be used to keep the components (Arduino, switch, power supply, relay) arranged in one container.

Conveyor Belt



Serves as the main transport surface for the eggplants, ensuring smooth and hygienic movement along the sorting path. Its non-toxic and easy-to-clean material makes it suitable for handling fresh produce while maintaining consistent motion for accurate image capture and sorting.

Relay Module



Controls the DC motor by switching the 12 V supply line through a transistor-based driver circuit.

3.2.2 Hardware Cost

The estimated prices of the components required to construct the conveyor belt system are shown in Table 2. The cost, which is approximately P8,863.00 reflects the parts needed for the construction of the conveyor belt system. The selected components ensure a balance between performance and affordability, making the

system cost-effective without compromising functionality or durability using widely

available materials.

Table 2: Hardware Cost

Components	Model	Price
DC Motor	775 DC Motor	P769.00
Power Supply Adapter		P118.00
Arduino	Arduino Uno R3	P540.00
2×	LM2596S DC-DC Step-Down	P60.00
NPN Transistor	2N2222	P30.00
Flyback Diode	1N4007	P14.00
LED Strip Lights		P199.00
Ball Bearings		P100.00
Bolts & Nuts		P200.00
5×	MG946R Full Metal Gear High Torque Servo	P436.00
5×	Sorting Gates	P470.00
Wood Screws	UHMW-PE	P80.00
Conveyor Rollers		P266.00
Timing Belt Pulley	60 teeth - 20 teeth 5mm	P200.00
Acetate Plastic		P125.00
2×	HD Webcam	P2,800
Flat Bar	SRICAM SriHome SH003	P300.00
Wooden Planks	1'' × 1''	P400.00
Enclosure Box	IP65	P150.00
Conveyor Belt	PVC Food-Grade Conveyor Belt	P1,900.00
Relay Module	SRD-05VDC-SL-C Power Relay	P45.00
Total Estimated Cost:		P8,863.00

Table 3 – continued from previous page

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Table 4: Sample Data Table

Item	Quantity	Price (\$)
Apples	10	0.50
Bananas	5	0.30
Cherries	20	1.20
Dates	50	2.50

3.5 Images

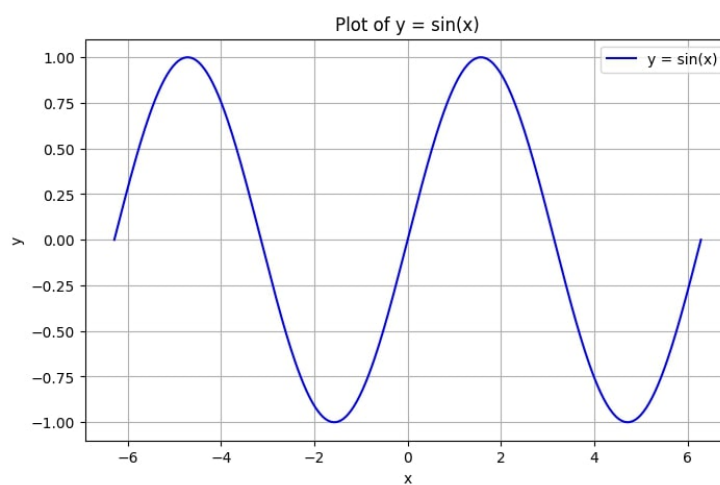


Figure 3

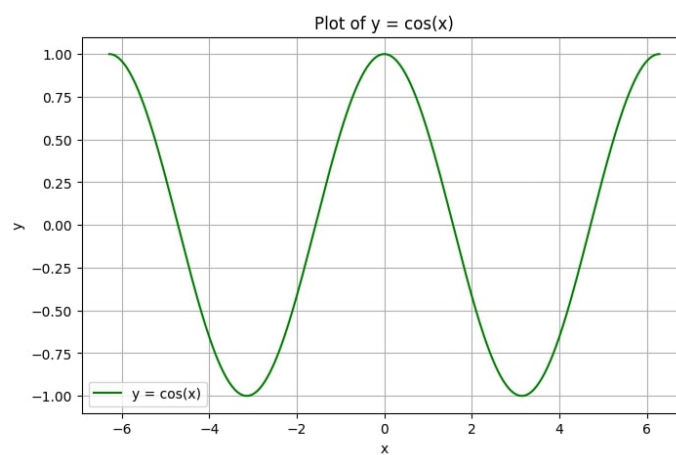


Figure 4: Cosine Graph

CHAPTER 4

RESULTS AND DISCUSSION

This chapter presents the findings from the research conducted and provides

a thorough analysis and interpretation of these results.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

This chapter provides the summary of the results obtained in this study and gives some recommendations for further investigation.

5.1 Summary of Findings

The study's findings address the initial research questions by confirming the effectiveness, reliability, and diverse applications of telemetry systems. The "Summary of Findings" section provides a concise overview of the key results from your research. This section should be factual and focus on presenting the data without interpretation. It should include:

Key Results:

Briefly summarize the most significant findings. Use bullet points or numbered lists for clarity if appropriate. Present the data as it was found, highlighting major patterns, relationships, or trends. Data Presentation:

Include tables, graphs, or charts that succinctly summarize the data. Make sure each visual aid is clearly labeled and includes a brief description. Coverage of

Research Questions:

Address each of the research questions or hypotheses posed at the beginning of the study. Summarize the results relevant to each question.

5.2 Conclusion

The "Conclusions" section interprets the findings and discusses their implications. This section should:

Interpret Findings:

Provide an interpretation of the data summarized in the previous section.

Discuss what the results mean in the context of the research questions or hypotheses.

Implications:

Explain the significance of the findings. Discuss how the results contribute to the field of study or practical applications. Limitations:

Acknowledge any limitations in the study that may affect the results or their

interpretation.

5.3 Recommendations

The "Recommendations" section provides actionable suggestions based on the study's findings and conclusions. This section should:

Practical Applications:

Offer specific recommendations for practitioners, policymakers, or other stakeholders based on the findings. Future Research:

Suggest areas for further investigation that could address the study's limitations or build on its findings. Implementation:

Provide guidance on how the recommendations can be implemented effectively.

APPENDICES

Type your appendix here.

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CURRICULUM VITAE

Name: **Jodie Rey D. Fernandez**

Date of Birth: July 27, 1992

Place of Birth: Alae, Manolo Fortich, Bukidnon

Home Address: Zone 5, Alae, Manolo Fortich, Bukidnon

E-mail Address: jodierey.fernandez@ustp.edu.ph

EDUCATIONAL BACKGROUND:

Master's Degree: MSU-Iligan Institute of Technology
Tibanga, Iligan City
Master of Science in Computer Applications
June 2020

Undergraduate Degree: Mindanao University of Science and Technology
Lapasan, Cagayan de Oro City
Bachelor of Science in Computer Engineering
April 2013

Secondary: Alae National High School

Alae, Manolo Fortich, Bukidnon

March 2008

Elementary:

Alae Elementary School

Alae, Manolo Fortich, Bukidnon

March 2004

CERTIFICATE OF AUTHENTIC AUTHORSHIP

I hereby declare that this submission is my own work and, to the best of my knowledge, it contains no materials previously published or written by another person, nor material which, to a substantial extent, has been accepted for the award of any other degree or diploma at USTP or any other educational institution, except where due acknowledgement is made in the manuscript. Any contribution made to the research by others, with whom I have worked at USTP or elsewhere, is explicitly acknowledged in the manuscript.

I also declare that the intellectual content of this manuscript is the product of my own work, except to the extent that assistance from others in the project design and conception or in style, presentation and linguistic expression is acknowledged.

JODIE REY D. FERNANDEZ

JODIE REY D. FERNANDEZ

JODIE REY D. FERNANDEZ

Date: "insert date signed