# LEMON SORTING AND GRADING MACHINE

**Project/Thesis Report**

**Session: 2023**

**Project Supervisor: Engr. Muhammad Faizan**

**Submitted By**

**Syed Muhammad Shariq**
(BEEP/F19/1414-2019)
**Rafi Uddin**
(BEEP/F19/1395-2019)
**Abdur Rehman**
(BEEP/F19/1090-2019)

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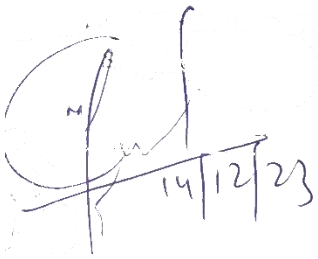
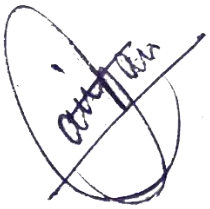
**Faculty of Engineering Sciences and Technology**
Hamdard University, Main Campus, Karachi, Pakistan

# Certification

This is to certify that **Syed Muhammad Shariq**, **BEEP/F19/1414-2019**, **Rafi Uddin**, **BEEP/F19/1395-2019,** and **Abdur Rehman, BEEP/F19/1090-2019** have successfully completed the final project **LEMON SORTING AND GRADING MACHINE,** at the Hamdard University, to fulfill the partial requirement of the degree **Bachelor of Electrical Engineering**



**Chairman**

Department of Electrical Engineering Department,

FEST, Hamdard University.

**Project Supervisor**

Muhammad Faizan

Senior Lecturer

# Lemon Sorting and Grading Machine

Sustainable Development Goals

(Please tick the relevant SDG(s) linked with FYDP)

| SDG No | Description of SDG | SDG No | Description of SDG |
|---|---|---|---|
| SDG 1 | No Poverty | SDG 9 ✓ | Industry, Innovation, and Infrastructure |
| SDG 2 ✓ | Zero Hunger | SDG 10 | Reduced Inequalities |
| SDG 3 | Good Health and Well Being | SDG 11 | Sustainable Cities and Communities |
| SDG 4 | Quality Education | SDG 12 ✓ | Responsible Consumption and Production |
| SDG 5 | Gender Equality | SDG 13 | Climate Change |
| SDG 6 | Clean Water and Sanitation | SDG 14 | Life Below Water |
| SDG 7 | Affordable and Clean Energy | SDG 15 | Life on Land |
| SDG 8 ✓ | Decent Work and Economic Growth | SDG 16 | Peace, Justice and Strong Institutions |
| | | SDG 17 | Partnerships for the Goals |

| Range of Complex Problem Solving | | | |
|---|---|---|---|
| | **Attribute** | **Complex Problem** | |
| 1 | Range of conflicting requirements | Involve wide-ranging or conflicting technical, engineering and other issues. | |
| 2 | Depth of analysis required | Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models. | |
| 3 | Depth of knowledge required | Requires research-based knowledge much of which is at, or informed by, the forefront of the professional discipline and which allows a fundamentals-based, first principles analytical approach. | |
| 4 | Familiarity of issues | Involve infrequently encountered issues | |
| 5 | Extent of applicable codes | Are outside problems encompassed by standards and codes of practice for professional engineering. | |
| 6 | Extent of stakeholder involvement and level of conflicting requirements | Involve diverse groups of stakeholders with widely varying needs. | |
| 7 | Consequences | Have significant consequences in a range of contexts. | |
| 8 | Interdependence | Are high level problems including many component parts or sub-problems | |
| **Range of Complex Problem Activities** | | | |
| | **Attribute** | **Complex Activities** | |
| 1 | Range of resources | Involve the use of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies). | |
| 2 | Level of interaction | Require resolution of significant problems arising from interactions between wide ranging and conflicting technical, engineering or other issues. | |
| 3 | Innovation | Involve creative use of engineering principles and research-based knowledge in novel ways. | |
| 4 | Consequences to society and the environment | Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation. | |
| 5 | Familiarity | Can extend beyond previous experiences by applying principles-based approaches. | |

# Abstract

The Lemon Sorting and Grading Machine project, which redefines the lemon processing sector through a seamless fusion of cutting-edge image processing and precise mechanical sorting, is at the vanguard of agricultural innovation. This project represents a significant advancement in solving the key issues of effectiveness, reliability, and product quality in the lemon processing industry. The revolutionary integration of image processing technology is at the core of the Lemon Sorting and Grading Machine. The machine's watchful eyes are two carefully placed cameras, which take high-resolution pictures of each lemon that passes through its sorting chamber. The main use of this technique is color sorting, which entails accurately detecting and categorizing lemons according to their color characteristics. Even in high-speed processing situations, the machine's dual-camera arrangement assures that no lemon escapes inspection. The image processing capabilities go beyond color sorting to include quality detection. The sophisticated algorithms carefully evaluate each lemon's condition, finding flaws, blemishes, and anomalies that would escape the human sight. Because every lemon is put through the same exact rigorous inspection, this not only improves the quality of the sorted lemons but also assures consistency. A sturdy mechanical framework intended for size sorting complements this image processing skill. The mechanical parts of the device classify lemons according to size, enabling the manufacture of unique classes that satisfy the variety of market demands. These mechanical parts have been carefully honed for accuracy and durability. This mechanical sorting makes sure that lemons of different sizes are properly organized, improving the consistency and market appeal of the finished product. As part of its dedication to usability, the Lemon Sorting and Grading Machine has a user-friendly interface that makes maintenance and operation simple and accessible to operators of all skill levels. Without the need for specialist training, operators can fully utilize this complex system thanks to its simple controls and realtime feedback systems. The Lemon Sorting and Grading Machine project represents a significant transformation in the lemon processing industry, not merely a technological development. It pioneers a future where productivity, dependability, and product quality are not only objectives but essential elements of lemon processing by utilizing the powers of image processing and mechanical precision. This project is a visionary answer to a time when agricultural productivity and sustainability are of the utmost significance. It shows the way to a future where lemon processing is more accurate, efficient, and sustainable. The Lemon Sorting and Grading Machine's core is encapsulated in this abstract, which emphasizes its technological advances and its potential to transform the lemon processing business. It prepares the ground for a thorough investigation of this revolutionary initiative.

# Undertaking

I certify that the project **LEMON SORTING AND GRADING MACHINE** is our own work. The work has not, in whole or in part, been presented elsewhere for assessment. Where material has been used from other sources it has been properly acknowledged/ referred.

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**Syed Muhammad Shariq**
(BEEP/F19/1414-2019)

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**Rafi Uddin**
(BEEP/F19/1395-2019)

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**Abdur Rehman**
(BEEP/F19/1090-2019)

# Acknowledgement

We truly acknowledge the cooperation and help make by Engr. Muhammad Faizan**, Senior Lecturer** of **Hamdard University.** He has been a constant source of guidance throughout the course of this project. We would also like to thank Dr. Muhammad Faisal Khan from **Chairman, Dept. of Electrical Engineering**, **Hamdard University** for his help and guidance throughout this project.

We are also thankful to our friends and families whose silent support led us to complete our project.

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# Chapter 1

## 1. INTRODUCTION

The project is design to obtain better understanding of the "Lemon Sorting and Grading Machine" it is an innovative project created to automate the process of sorting and grading lemons according to numerous quality factors. This project intends to modernize the lemon processing sector, boost productivity, and guarantee constant product quality. In order to accomplish its goals, it makes use of advance technologies such as, computer vision, and machine learning. Color and size are the most important features for accurate classification and sorting of lemon. Because of the ever-growing need to supply high quality food products within a short time. The impetus for these trends can be attributed to increased awareness by consumers about their better health well-being and a response by producers on the need to provide quality guaranteed products with consistency. Automatic inspection and machine vision are essential for quality control and fruit size estimation for packaging, transportation and marketing operations. Computer vision and image processing technology can be used to improve product quality and reduce manual sorting of agricultural sector.

In this project the Image processing is used for sorting colors and grade of the lemons by using two cameras. The first camera is placed on the left side of the lemon and captures the image and the second camera is placed on the right top of the lemon which captures the remaining part of the lemon. Both the cameras send the image of lemon to the microprocessor. Then the microprocessor starts the process of image processing, after the conclusion of processing result microprocessor sends the signals to microcontroller for operating the gates and motors according to the image processing results. The gate can be operated in three direction two of them are for colors like yellow and green and one of them for rotten lemons. Further the size sorting is done by mechanical structure. Finally, all the lemons are sorted on their respective buckets.

### 1. 1.1 Image Processing

In computer science and engineering, image processing is a multidisciplinary discipline that deals with the modification, evaluation, and improvement of digital pictures. It includes a variety of methods and algorithms designed to enhance the quality of photos and make them better suited for usage in a variety of applications. Numerous industries, including robotics, computer vision, remote sensing, medical imaging, and entertainment, heavily rely on image processing. It is essential for automating visual information-related activities and has uses in anything from facial recognition to satellite image analysis. The computer uses image processing technologies to recognize and categorize lemons according to their

color characteristics. This is crucial for the lemon sector since ripeness and quality are strongly correlated with color. Each lemon is photographed by the machine using cameras, and it then sorts the photos into the proper groups by examining the color data.

## 2. 1.2 Motivation

The Lemon Sorting and Grading Machine was developed with the goal of enhancing the lemon manufacturing process through increased productivity, consistent quality, waste reduction, and data-driven insights. These advantages not only take care of practical issues, but also put lemon growers in a strong position to succeed in a cutthroat market and advance sustainability objectives

### 1.2.1 Efficiency Improvement:

It takes a lot of time and effort to manually grade and separate lemons. The device is designed to automate this procedure, greatly enhancing processing speed and overall effectiveness. Large-scale lemon growers that want to simplify their operations and cut labor expenses may particularly benefit from this.

### 1.2.2 Consistency in Quality:

Due to things like subjectivity and weariness, human sorting might result in variations in the quality of sorted lemons. The machine assures consistent grading based on predefined criteria, resulting in a higher-quality final product. It is powered by computer vision and machine learning.

### 1.2.3 Reducing Waste:

The device reduces manufacturing waste by precisely recognizing and classifying lemons with flaws or poor quality. By reducing food waste, this not only reduces expenses but also helps with ecological initiatives.

### 1.2.4 Meeting Industry Standards:

For export or sale, the lemon business frequently has stringent quality requirements. The device makes sure that these requirements are regularly met, assisting lemon growers in satisfying market demands and preserving their image.

### 1.2.5 Labor Savings:

Automation has become a desirable alternative for lemon growers as a result of manpower shortages and increased labor expenses in agriculture. By decreasing the need on manual labor for sorting and grading, the machine aids in mitigating these difficulties.

### 1.2.6 Competitive Advantage:

Using this technology, such as the Lemon Sorting and Grading Machine, can provide one an advantage in the lemon market. It enables companies to provide customers and markets with consistently high-quality products, strengthening their position in the market.

## 1.3 Problem Statement:

The hand grading and sorting of lemons presents significant difficulties for the lemon processing business. These issues impede effectiveness, reliability, and quality control, necessitating the urgent need for a novel solution. The labor-intensive nature of conventional lemon sorting and grading techniques lies at the core of the problem. These procedures mainly rely on human labor since they need for personnel to carefully examine and categorize lemons according to a range of characteristics, such as size, color, maturity, and flaws. It is economically difficult to use this manual procedure since it takes a long time and requires a huge staff, especially for larger lemon growers. This problem is made worse by workforce shortages and growing labor prices, endangering the viability of the sector. Furthermore, subjectivity is added to the process during human sorting. The grade of sorted lemons may vary depending on how differently human inspectors perceive the grading standards. The industry's reputation for consistency might be harmed by variations from expected quality standards caused by factors like weariness and inconsistent judgment standards. These issues are made worse by ineffective waste management procedures. When it comes to detecting and separating lemons with flaws or poor quality, traditional approaches frequently lack accuracy. As a result, faulty lemons regularly end out on the market, increasing food waste and perhaps resulting in producer losses. These inefficiencies have an impact on both the economy and the environment, highlighting the need for a more sustainable strategy. Another key problem is regularly meeting industry requirements. Regulating agencies and consumer demands have established tight quality requirements for the lemon business. These requirements cover a range of elements, such as lemon size, color, ripeness, and flawlessness. It is a difficult challenge to guarantee consistent adherence to these requirements throughout human sorting and grading operations. Deviations from these requirements may result in shipments being refused, monetary losses, and reputational harm for the producer. The citrus sector urgently needs an automated method for sorting and grading lemons to overcome these serious issues. The workflow for processing lemons would be revolutionized by a system like this, which would make use of cutting-edge technology like computer vision, machine learning, and robotics. Automation would substantially increase productivity, get rid of subjectivity, cut waste, and always satisfy industry requirements. This ground-breaking idea has the power to revolutionize the processing of lemons, enhancing both the economic viability and the sector's standing as a source of highquality goods.

## 1.4 Proposed Solution:

We offer the Lemon Sorting and Grading Machine a ground-breaking technology created to revolutionize the sorting and grading of lemons in response to the difficulties facing the lemon processing sector. This ground-breaking system provides a comprehensive solution to the inefficiencies, inconsistencies, and waste problems associated with human lemon sorting and grading by utilizing cutting-edge technologies like computer vision, machine learning, and robots. The Lemon Sorting Machine aims to increase the productivity and competitiveness of citrus growers while advancing sustainability objectives by automating the process, assuring uniform quality, cutting waste, and giving useful data-driven insights.

## 1.4.1 Efficiency via Automation:

In order to overcome the labor-intensive aspect of sorting and grading, the Lemon Sorting and Grading Machine automates the processing of lemons. The system automates the procedure, saving time and money by using machine learning and high-resolution cameras.

## 1.4.2 Increasing Consistency Through Technology:

The system uses sophisticated algorithms to make sure that each lemon is regularly assessed according to predefined quality standards. This strategy gets rid of subjective evaluation and builds a reputation for consistent product quality.

## 1.4.3 Effective Waste Reduction:

One of the main functions of the machine is effective waste management. By properly identifying and separating lemons with flaws or poor quality, it minimizes food waste and maximizes resource efficiency.

## 1.4.4 Standard-Meeting and Standard-Exceeding:

The Lemon Sorting Machine is built to constantly meet and exceed industry requirements. To guarantee that lemons continuously meet strict quality requirements, from size and color to ripeness and defect-freeness, it depends on data-driven decision-making.

## 1.4.5 Making Decisions Based on Data:

The machine’s data logging capabilities give manufacturers useful knowledge about the performance and quality of lemons. Producers are able to make well-informed decisions regarding crop management, resource allocation, and marketing tactics by gathering information on the size, color, flaws, and grade for each lemon processed.

### 1.4.6 Labor effectiveness and skill:

The machine addresses labor shortages by automating sorting and grading while freeing up human resources for more specialized jobs like quality control and maintenance.

### 1.4.7 Gaining an advantage through technology:

Citrus farmers get a competitive edge by utilizing cutting-edge technology like the Lemon Sorting Machine. Enhancing operational effectiveness, product quality, and market positioning, it communicates a dedication to innovation and excellence.

## 1.5 Deliverables:

- Deliver a method for classifying colors that can reliably determine the color of lemons as part of the grading and sorting process.
- Create and offer a sophisticated defect identification system that can recognize and categorize defective lemons based on many factors including size, shape, imperfections, and abnormalities.
- Create and put into action an easy-to-use interface that enables operators to interact with the lemon sorting machine. Real-time information, control choices, and simple access to troubleshooting should all be available through this interface.
- Reduce sorting time and increase accuracy by tuning the machine's functioning. To accomplish effective and exact sorting, this entails fine-tuning the machine's hardware and software components, such as conveyor speed and camera settings.

## 1.6 Beneficiaries:

### 1.6.1 Citrus farmers and producers:

- Boost productivity and save labor expenses.
- Reduce waste while boosting revenue.
- fulfill industry requirements on a regular basis.

### 1.6.2 Companies that process lemons:

- Boost the capacity and effectiveness of production.
- Maintain high standards for quality.
- increase total profit.

### 1.6.3 Consumers:

- Get lemons that are regularly of great grade.
- Gain consumers' faith in lemon goods.

### 1.6.4 Sustainability of the environment and the labor force:

- lessen environmental effect and food waste.
- labor is redistributed to more specialized duties.

# CHAPTER 2

# 2. LITERATURE REVIEW

## 2.1 Sorting of Objects Based on Color by pick and Place Robotic Arm and with Conveyor Belt Arrangement

The 2014 study by D. V. K. Reddy on color-based object sorting utilizing a pick-and-place robotic arm combined with a conveyor belt configuration provides insightful information in the context of Industry 4.0 and automation. This study examines the expanding significance of automation and robots across a range of sectors. In industries like manufacturing, logistics, and quality control, an emphasis on color-based sorting is especially pertinent.

Modern manufacturing and logistics heavily rely on industrial automation in an effort to increase production, decrease human error, and improve efficiency. A key use in this area is color-based item sorting, which streamlines procedures like quality control, packing, and order fulfillment in a variety of sectors.

The use of computer vision and image processing techniques is a key aspect of this study. The system can reliably recognize and categorize objects based on their color properties thanks to these transdisciplinary disciplines. The system's intricacy and potential for very precise sorting are highlighted by its dependence on sophisticated algorithms and sensors.

Automation in color-based sorting solves labor-related issues by lowering the need for human labor, in addition to accuracy. This contributes to overall operational excellence by increasing both production efficiency and error minimization.

In conclusion, D. V. K. Reddy's study has made a sizable impact on the subject of industrial automation. Color-based item sorting, which combines robotics, automation, and computer vision, provides useful insights on how to boost productivity and lessen reliance on labor in a variety of sectors. [1].

## 2.2 Automated fruit grading system

Automation has become a game-changer in the fast-changing agricultural world of today, especially when it comes to fruit sorting and grading. The incisive analysis by Khot and Jadhav from 2018 goes into the area of automated fruit grading systems, highlighting the industrychanging potential of these technologies.

From my vantage point, this research acts as a crucial compass for comprehending the crucial function of automation. Fruit grading clearly requires accuracy, efficacy, and costeffectiveness. The work of Khot and Jadhav demonstrates how automation responds to this request by greatly increasing sorting precision and speed. I am well aware of the significance of these results as I begin my Lemon Sorting and Grading Machine project. The similarities between their discoveries and the goals of my study are obvious; we are both interested in efficient and accurate sorting.

The review's emphasis on computer vision and image processing technology is one of its most notable features. With the use of these technologies, machines are now able to "see" fruits and judge them based on their characteristics, including color, size, and shape. These components form the basis of my project's Lemon Sorting Machine's ability to precisely determine lemon quality. It's not simply useful; understanding the potential of these technologies is essential. Furthermore, the labor-saving feature resonates strongly as I learn more about automated fruit grading. The assessment by Khot and Jadhav emphasizes how labor-intensive and prone to mistake hand sorting is. I concur with their goal of using technology to reduce labor shortages while delivering consistently high-quality outputs. It is comforting to see that the project's objectives are being met since it supports the general industry trend toward higher labor efficiency [2].

## 2.3 Automated fruit grading system using computer vision

In my opinion, the research carried out in 2017 by Pathak, Srivastava, and Srivastava offers an engaging investigation of automated fruit grading systems, illuminating the transformational potential of computer vision in transforming the fruit processing business.

The ideas presented in this article really hit home as I work on my Lemon Sorting and Grading Machine project. Automation, as it is described in their study, offers a way to change the way that fruit is graded. Their investigation into how computer vision might enable computers to precisely evaluate fruits based on characteristics like color is perfectly in line with the main goals of my research. Similar computer vision concepts are crucial to the Lemon Sorting Machine's ability to accurately assess lemon quality.

The analysis also highlights the improvements in efficiency and accuracy made possible by fruit grading technology. Their conclusions concur with my project's goal of streamlining lemon sorting, lowering labor costs, and maintaining high standards of quality. Their observations are in line with the objectives of my research, which supports the revolutionary potential of automation.

The importance of real-time data collecting and decision-making in automated fruit grading systems is also highlighted by Pathak, Srivastava, and Srivastava. This feature is not just technologically fascinating; it also has a significant bearing on the Lemon Sorting Machine project. The key to making sure the machine continually satisfies industry requirements is the capacity to use real-time data for quality control and process improvement.

As a result, the assessment by Pathak, Srivastava, and Srivastava represents more than simply scholarly inquiry; it also represents a vision for the future. Their work, in my opinion, provides not only insightful information but also serves as an inspiration. It highlights how we may transform the lemon processing business to make it more effective, accurate, and technologically sophisticated through creative applications of computer vision and automation. Therefore, their review serves as a compass for my project on the Lemon Sorting and Grading Machine, showing the way to a better and more productive future for lemon processing. [3].

## 2.4 Machine vision-based apple grading technologies

From my perspective, the 2013 research by Karkee and Adhikari marks a critical turning point for systems based on machine vision for fruit grading. Their analysis provides a thorough investigation of how technology might change fruit grading procedures, and I find this point of view to be very pertinent as I start work on my project to develop a lemon sorting and grading machine.

The ideas put forward in Karkee and Adhikari's work have a strong resonance for me as I dig into the complexities of this undertaking. Their analysis emphasizes the precision and efficiency that automation can bring to this crucial area of the agricultural business, stressing the transformational potential of machine vision in fruit grading. Unmistakable similarities exist between their discoveries and the fundamental goals of my study; they both aim to improve fruit sorting efficiency, lessen labor reliance, and guarantee constant adherence to industry standards.

The assessment also emphasizes how important technologies for computer vision and image processing are. These innovations allow machines to "see" and categorize fruits according to characteristics like size, shape, and color. These very technologies form the basis of my Lemon Sorting Machine project's capacity to precisely determine lemon quality. It's essential that you comprehend the potential and possibilities of these technologies.

The goals of my study are well aligned with Karkee and Adhikari's findings on the labor-saving benefits of automated fruit grading. Their analysis highlights how labor-intensive human sorting is and how automation has the ability to both solve these problems and guarantee consistently good outcomes. This cooperation strengthens the general industry trend toward increased worker productivity, which my initiative seeks to promote.

In conclusion, the review by Karkee and Adhikari is more than simply academic inquiry; it embodies a perspective on the direction fruit grading may take in the future.Their evaluation illuminates the way toward a future of improved efficiency and quality in lemon processing, serving as a guiding star for my Lemon Sorting and Grading Machine project. [4].

## 2.5 Automated fruit grading system

In my opinion, the research done by Kaur and Goyal in 2017 marks a significant turning point for automated fruit grading systems. Their assessment goes into great detail on how automation may change how fruit is graded, and as I start my Lemon Sorting and Grading Machine project, I found their advice to be really helpful.

I'm learning more and more about the complexities of this endeavor as I read Kaur and Goyal's study. Their assessment emphasizes the precision, efficiency, and cost-effectiveness that automated systems offer to the agriculture sector, underscoring the transformational potential of automation in fruit grading. Unmistakably, their findings are in accordance with the main goals of my research, which are to simplify fruit sorting, decrease labor reliance, and guarantee constant adherence to industry standards.

Additionally, Kaur and Goyal's assessment explores how automated fruit grading saves labor, which is directly related to the goals of my research. Their research emphasizes how labor-intensive hand sorting is and how automation has the ability to both ease these difficulties and guarantee consistently good outcomes. The industry-wide trend toward higher labor efficiency, which my research wants to support, is reinforced by this alignment.

In conclusion, the assessment by Kaur and Goyal is more than simply scholarly inquiry; it represents a projection for the direction of fruit grading in the future. Their work serves as a source of inspiration for me in addition to offering useful information. It highlights how we may transform the lemon processing business to make it more effective, accurate, and technologically sophisticated through creative applications of automation and technology. Their critique illuminates the route into a future of increased efficiency and quality in lemon processing, serving as a compass for my Lemon Sorting and Grading Machine project. [5].

## 2.6 Advances in fruit sorting techniques

According to me, Singh and Kaur's 2016 research was a crucial investigation of the most current developments in fruit sorting methods. As I begin my Lemon Sorting and Grading Machine project, I find their evaluation to be a very useful analysis of how technology and innovation have changed the fruit sorting scene.

Singh and Kaur's study strikes a powerful chord with me as I explore the complexities of this endeavor. Their analysis emphasizes the precision, efficiency, and cost-effectiveness that these approaches provide to the agriculture sector, as well as the transformational potential of sophisticated sorting techniques. They both aspire to modernize fruit sorting, minimize labor reliance, and guarantee continuous adherence to industry standards; hence, there is an undeniable match between their discoveries and the core goals of my research.

Furthermore, their analysis highlights the critical function of technology, especially computer vision and image processing. These innovations enable automated systems to recognize and categorize fruits according to characteristics including size, shape, and color..

Additionally, Singh and Kaur's assessment explores how better fruit sorting might save labor, which is directly related to the goals of my study. Their research emphasizes how laborintensive human sorting is and the possibility for automation to ease these problems while maintaining consistently excellent outcomes. This convergence strengthens the industry-wide trend toward increased labor efficiency, which my study aims to accelerate.

In conclusion, Singh and Kaur's assessment embodies more than simply scholarly inquiry; it embodies an outlook for fruit sorting in the future. Their work serves as a source of inspiration for me in addition to offering useful information. It highlights how we may transform the lemon processing business to make it more effective, accurate, and technologically sophisticated through creative applications of technology and automation. Their critique illuminates the route into a future of increased efficiency and quality in lemon processing, serving as a compass for my Lemon Sorting and Grading Machine project.[6].

## 2.7Automation in Agriculture

I believe that Singh and Sharma's 2017 research provides a thorough examination of the subject of agricultural automation. Their analysis offers insightful information about how technology is affecting agricultural methods, and as I start work on my Lemon Sorting and Grading Machine project, I found their conclusions to be quite relevant.

Singh and Sharma's study strikes a powerful chord with me as I explore the complexities of this endeavor. Their analysis highlights the transformational potential of automation in agriculture by highlighting how it may boost production, lessen reliance on manpower, and increase efficiency. They both want to revolutionize fruit sorting, particularly in the context of lemon processing, and guarantee consistent adherence to industry standards, thus it is clear that their discoveries and the main goals of my study are congruent.

Furthermore, their analysis emphasizes how important technology, such as robots and machine vision, are to contemporary agricultural automation. In the context of my Lemon Sorting Machine project, these technologies are essential to the system's capacity to determine lemon quality precisely. They enable automated systems to do activities that were previously labor- intensive. For the project to succeed, it is essential that all stakeholders understand the potential and capabilities of these technologies.

Additionally, Singh and Sharma's study explores the larger effects of automation in agriculture, particularly in relation to problems with manpower. Their analysis highlights how automation may eliminate these difficulties while providing consistently excellent results. The industrywide trend toward higher labor efficiency, which my research wants to support, is reinforced by this alignment.

To sum up, Singh and Sharma's assessment is more than simply scholarly inquiry; it represents a projection for the direction of agriculture. Their work serves as a source of inspiration for me in addition to offering useful information. Their critique illuminates the route into a future of increased efficiency and quality in lemon processing, serving as a compass for my Lemon Sorting and Grading Machine project. [7].

## 2.8 Fruit grading system using image processing

From my vantage point, Sharma, Sharma, and Gill's research from 2017 gives a thorough investigation into the field of fruit grading systems utilizing image processing. As I begin my Lemon Sorting and Grading Machine project, I believe their evaluation to be of great use in shedding light on the revolutionary potential of image processing technology in improving the fruit grading process.

Sharma, Sharma, and Gill's study strikes a powerful chord with me as I explore the complexities of this undertaking. Their assessment highlights the accuracy, effectiveness, and impartiality that these technologies offer to the agricultural sector and highlights how image processing may be used to modernize fruit grading. Their findings are in line with the main goals of my research, which are to redefine lemon sorting, lessen the reliance on manpower, and guarantee constant adherence to industry standards.

Additionally, their research emphasizes the critical function of computer vision and image analysis methods. These innovations enable automated systems to assess the quality of fruit based on characteristics including size, shape, and color. These particular technologies are essential to my Lemon Sorting Machine project's capacity to precisely determine the grade of lemons. For the project to succeed in its goals, it is essential to comprehend the potential and capabilities of these technologies.

.Finally, the assessment by Sharma, Sharma, and Gill is more than simply scholarly inquiry; it provides a projection for the direction of fruit grading in the future. Their work serves as a source of inspiration for me in addition to offering useful information. It highlights how we may transform the lemon processing sector to make it more effective, accurate, and technologically sophisticated using creative image processing and automation applications. Their critique illuminates the route into a future of increased efficiency and quality in lemon processing, serving as a compass for my Lemon Sorting and Grading Machine project. [8].

## 2.9 Fruit grading system using image processing

In my opinion, the study carried out in 2016 by Chiranjivi and their associates provides an important inquiry into the field of fruit grading systems, with an emphasis on image processing. Their analysis offers insightful information on the revolutionary potential of image processing technology to improve the fruit grading process. Their research is quite pertinent to my attempt to build a lemon sorting and grading machine, and I found it to be very informative.

Chiranjivi et al.'s study strikes a powerful chord with me as I explore the nuances of this subject. Their analysis emphasizes how image processing might transform fruit grading, highlighting accuracy, effectiveness, and objectivity as major advantages for the agriculture sector. Their conclusions are in line with the main goals of my project, which are to reconfigure lemon sorting, decrease manpower reliance, and guarantee constant adherence to industry standards. Furthermore, Chiranjivi et al.'s study explores the labor-saving benefits of automated fruit grading, which is directly related to the goals of my project. Their analysis emphasizes how labor-intensive human sorting is and how automation has the ability to both ease these problems and guarantee consistently good outcomes. This convergence reinforces the industry-wide trend toward increased labor efficiency, which my initiative aims to enhance.

In conclusion, the review by Chiranjivi and colleagues is more than just scholarly inquiry; it incorporates a projection for the direction of fruit grading. Their work serves as a source of inspiration for me in addition to offering useful information. It highlights how we may transform the lemon processing sector to make it more effective, accurate, and technologically sophisticated using creative image processing and automation applications. Their critique illuminates the route into a future of increased efficiency and quality in lemon processing, serving as a compass for my Lemon Sorting and Grading Machine project. [9].

## 2.10 Automatic color object sorting system

In my opinion, Wanve and Gawalwad's research from July 2015, which concentrated on colorbased sorting, made a significant addition to the field of automated object sorting systems. Their research sheds important light on the revolutionary potential of automated sorting systems and closely relates to the goals I had in mind when designing the Lemon Sorting and Grading Machine.

Wanve and Gawalwad's study strikes a chord with me as I go through the details of my project. Their study demonstrates how automation, and color-based sorting in particular, may completely transform sorting procedures in a variety of sectors. Precision, efficiency, and flexibility, among other key results, are similar to my project's goals. Both initiatives seek to increase sorting process effectiveness while guaranteeing consistent adherence to industry standards.

Additionally, their study emphasizes the critical function that computer vision and image analysis methods have in automated sorting systems. By helping machines to identify and categorize items based on color characteristics, these technologies enable them to make accurate sorting judgments. These particular technologies make up the crucial underpinning for correctly determining lemon quality in my Lemon Sorting Machine project.

As a result, the work by Wanve and Gawalwad is more than simply scholarly inquiry; it represents a vision for the future of automated sorting systems. Their work serves as a source of inspiration for me in addition to offering useful information. It highlights how we may transform the lemon processing business to make it more effective, accurate, and technologically sophisticated through creative applications of automation and technology. Their work illuminates the way toward an improved future for efficiency and quality in lemon processing, which acts as the compass for my Lemon Sorting and Grading Machine project. [10].

# Chapter 2

# 2. LITERATURE REVIEW

## 2.1 Sorting of Objects Based on Color by pick and Place Robotic Arm and with Conveyor Belt Arrangement

The 2014 study by D. V. K. Reddy on color-based object sorting utilizing a pick-and-place robotic arm combined with a conveyor belt configuration provides insightful information in the context of Industry 4.0 and automation. This study examines the expanding significance of automation and robots across a range of sectors. In industries like manufacturing, logistics, and quality control, an emphasis on color-based sorting is especially pertinent.

Modern manufacturing and logistics heavily rely on industrial automation in an effort to increase production, decrease human error, and improve efficiency. A key use in this area is color-based item sorting, which streamlines procedures like quality control, packing, and order fulfillment in a variety of sectors.

The use of computer vision and image processing techniques is a key aspect of this study. The system can reliably recognize and categorize objects based on their color properties thanks to these transdisciplinary disciplines. The system's intricacy and potential for very precise sorting are highlighted by its dependence on sophisticated algorithms and sensors.

Automation in color-based sorting solves labor-related issues by lowering the need for human labor, in addition to accuracy. This contributes to overall operational excellence by increasing both production efficiency and error minimization.

In conclusion, D. V. K. Reddy's study has made a sizable impact on the subject of industrial automation. Color-based item sorting, which combines robotics, automation, and computer vision, provides useful insights on how to boost productivity and lessen reliance on labor in a variety of sectors. [1].

## 2.2 Automated fruit grading system

Automation has become a game-changer in the fast-changing agricultural world of today, especially when it comes to fruit sorting and grading. The incisive analysis by Khot and Jadhav from 2018 goes

into the area of automated fruit grading systems, highlighting the industrychanging potential of these technologies.

From my vantage point, this research acts as a crucial compass for comprehending the crucial function of automation. Fruit grading clearly requires accuracy, efficacy, and costeffectiveness. The work of Khot and Jadhav demonstrates how automation responds to this request by greatly increasing sorting precision and speed. I am well aware of the significance of these results as I begin my Lemon Sorting and Grading Machine project. The similarities between their discoveries and the goals of my study are obvious; we are both interested in efficient and accurate sorting.

The review's emphasis on computer vision and image processing technology is one of its most notable features. With the use of these technologies, machines are now able to "see" fruits and judge them based on their characteristics, including color, size, and shape. These components form the basis of my project's Lemon Sorting Machine's ability to precisely determine lemon quality. It's not simply useful; understanding the potential of these technologies is essential. Furthermore, the labor-saving feature resonates strongly as I learn more about automated fruit grading. The assessment by Khot and Jadhav emphasizes how labor-intensive and prone to mistake hand sorting is. I concur with their goal of using technology to reduce labor shortages while delivering consistently high-quality outputs. It is comforting to see that the project's objectives are being met since it supports the general industry trend toward higher labor efficiency [2].

## 2.3 Automated fruit grading system using computer vision

In my opinion, the research carried out in 2017 by Pathak, Srivastava, and Srivastava offers an engaging investigation of automated fruit grading systems, illuminating the transformational potential of computer vision in transforming the fruit processing business.

The ideas presented in this article really hit home as I work on my Lemon Sorting and Grading Machine project. Automation, as it is described in their study, offers a way to change the way that fruit is graded. Their investigation into how computer vision might enable computers to precisely evaluate fruits based on

characteristics like color is perfectly in line with the main goals of my research. Similar computer vision concepts are crucial to the Lemon Sorting Machine's ability to accurately assess lemon quality.

The analysis also highlights the improvements in efficiency and accuracy made possible by fruit grading technology. Their conclusions concur with my project's goal of streamlining lemon sorting, lowering labor costs, and maintaining high standards of quality. Their observations are in line with the objectives of my research, which supports the revolutionary potential of automation.

The importance of real-time data collecting and decision-making in automated fruit grading systems is also highlighted by Pathak, Srivastava, and Srivastava. This feature is not just technologically fascinating; it also has a significant bearing on the Lemon Sorting Machine project. The key to making sure the machine continually satisfies industry requirements is the capacity to use real-time data for quality control and process improvement.

As a result, the assessment by Pathak, Srivastava, and Srivastava represents more than simply scholarly inquiry; it also represents a vision for the future. Their work, in my opinion, provides not only insightful information but also serves as an inspiration. It highlights how we may transform the lemon processing business to make it more effective, accurate, and technologically sophisticated through creative applications of computer vision and automation. Therefore, their review serves as a compass for my project on the Lemon Sorting and Grading Machine, showing the way to a better and more productive future for lemon processing. [3].

## 2.4 Machine vision-based apple grading technologies

From my perspective, the 2013 research by Karkee and Adhikari marks a critical turning point for systems based on machine vision for fruit grading. Their analysis provides a thorough investigation of how technology might change fruit grading procedures, and I find this point of view to be very pertinent as I start work on my project to develop a lemon sorting and grading machine.

The ideas put forward in Karkee and Adhikari's work have a strong resonance for me as I dig into the complexities of this undertaking. Their analysis emphasizes the precision and efficiency that automation can bring to this crucial area of the agricultural business, stressing the transformational potential of machine vision in fruit grading. Unmistakable similarities exist between their discoveries and the fundamental goals of my study; they both aim to improve fruit sorting efficiency, lessen labor reliance, and guarantee constant adherence to industry standards.

The assessment also emphasizes how important technologies for computer vision and image processing are. These innovations allow machines to "see" and categorize fruits according to characteristics like size, shape, and color. These very technologies form the basis of my Lemon Sorting Machine project's

capacity to precisely determine lemon quality. It's essential that you comprehend the potential and possibilities of these technologies.

The goals of my study are well aligned with Karkee and Adhikari's findings on the labor-saving benefits of automated fruit grading. Their analysis highlights how labor-intensive human sorting is and how automation has the ability to both solve these problems and guarantee consistently good outcomes. This cooperation strengthens the general industry trend toward increased worker productivity, which my initiative seeks to promote.

In conclusion, the review by Karkee and Adhikari is more than simply academic inquiry; it embodies a perspective on the direction fruit grading may take in the future.Their evaluation illuminates the way toward a future of improved efficiency and quality in lemon processing, serving as a guiding star for my Lemon Sorting and Grading Machine project. [4].

## 2.5 Automated fruit grading system

In my opinion, the research done by Kaur and Goyal in 2017 marks a significant turning point for automated fruit grading systems. Their assessment goes into great detail on how automation may change how fruit is graded, and as I start my Lemon Sorting and Grading Machine project, I found their advice to be really helpful.

I'm learning more and more about the complexities of this endeavor as I read Kaur and Goyal's study. Their assessment emphasizes the precision, efficiency, and cost-effectiveness that automated systems offer to the agriculture sector, underscoring the transformational potential of automation in fruit grading. Unmistakably, their findings are in accordance with the main goals of my research, which are to simplify fruit sorting, decrease labor reliance, and guarantee constant adherence to industry standards.

Additionally, Kaur and Goyal's assessment explores how automated fruit grading saves labor, which is directly related to the goals of my research. Their research emphasizes how labor-intensive hand sorting is and how automation has the ability to both ease these difficulties and guarantee consistently good outcomes. The industry-wide trend toward higher labor efficiency, which my research wants to support, is reinforced by this alignment.

In conclusion, the assessment by Kaur and Goyal is more than simply scholarly inquiry; it represents a projection for the direction of fruit grading in the future. Their work serves as a source of inspiration for me in addition to offering useful information. It highlights how we may transform the lemon processing business to make it more effective, accurate, and technologically sophisticated through

creative applications of automation and technology. Their critique illuminates the route into a future of increased efficiency and quality in lemon processing, serving as a compass for my Lemon Sorting and Grading Machine project. [5].

## 2.6 Advances in fruit sorting techniques

According to me, Singh and Kaur's 2016 research was a crucial investigation of the most current developments in fruit sorting methods. As I begin my Lemon Sorting and Grading Machine project, I find their evaluation to be a very useful analysis of how technology and innovation have changed the fruit sorting scene.

Singh and Kaur's study strikes a powerful chord with me as I explore the complexities of this endeavor. Their analysis emphasizes the precision, efficiency, and cost-effectiveness that these approaches provide to the agriculture sector, as well as the transformational potential of sophisticated sorting techniques. They both aspire to modernize fruit sorting, minimize labor reliance, and guarantee continuous adherence to industry standards; hence, there is an undeniable match between their discoveries and the core goals of my research.

Furthermore, their analysis highlights the critical function of technology, especially computer vision and image processing. These innovations enable automated systems to recognize and categorize fruits according to characteristics including size, shape, and color..

Additionally, Singh and Kaur's assessment explores how better fruit sorting might save labor, which is directly related to the goals of my study. Their research emphasizes how laborintensive human sorting is and the possibility for automation to ease these problems while maintaining consistently excellent outcomes. This convergence strengthens the industry-wide trend toward increased labor efficiency, which my study aims to accelerate.

In conclusion, Singh and Kaur's assessment embodies more than simply scholarly inquiry; it embodies an outlook for fruit sorting in the future. Their work serves as a source of inspiration for me in addition to offering useful information. It highlights how we may transform the lemon processing business to make it more effective, accurate, and technologically sophisticated through creative applications of technology and automation. Their critique illuminates the route into a future of increased efficiency and quality in lemon processing, serving as a compass for my Lemon Sorting and Grading Machine project.[6].

## 2.7Automation in Agriculture

I believe that Singh and Sharma's 2017 research provides a thorough examination of the subject of agricultural automation. Their analysis offers insightful information about how technology is affecting agricultural methods, and as I start work on my Lemon Sorting and Grading Machine project, I found their conclusions to be quite relevant.

Singh and Sharma's study strikes a powerful chord with me as I explore the complexities of this endeavor. Their analysis highlights the transformational potential of automation in agriculture by highlighting how it may boost production, lessen reliance on manpower, and increase efficiency. They both want to revolutionize fruit sorting, particularly in the context of lemon processing, and guarantee consistent adherence to industry standards, thus it is clear that their discoveries and the main goals of my study are congruent.

Furthermore, their analysis emphasizes how important technology, such as robots and machine vision, are to contemporary agricultural automation. In the context of my Lemon Sorting Machine project, these technologies are essential to the system's capacity to determine lemon quality precisely. They enable automated systems to do activities that were previously labor- intensive. For the project to succeed, it is essential that all stakeholders understand the potential and capabilities of these technologies.

Additionally, Singh and Sharma's study explores the larger effects of automation in agriculture, particularly in relation to problems with manpower. Their analysis highlights how automation may eliminate these difficulties while providing consistently excellent results. The industrywide trend toward higher labor efficiency, which my research wants to support, is reinforced by this alignment.

To sum up, Singh and Sharma's assessment is more than simply scholarly inquiry; it represents a projection for the direction of agriculture. Their work serves as a source of inspiration for me in addition to offering useful information. Their critique illuminates the route into a future of increased efficiency and quality in lemon processing, serving as a compass for my Lemon Sorting and Grading Machine project. [7].

## 2.8 Fruit grading system using image processing

From my vantage point, Sharma, Sharma, and Gill's research from 2017 gives a thorough investigation into the field of fruit grading systems utilizing image processing. As I begin my Lemon Sorting and Grading Machine project, I believe their evaluation to be of great use in shedding light on the revolutionary potential of image processing technology in improving the fruit grading process.

Sharma, Sharma, and Gill's study strikes a powerful chord with me as I explore the complexities of this undertaking. Their assessment highlights the accuracy, effectiveness, and impartiality that these technologies offer to the agricultural sector and highlights how image processing may be used to modernize fruit grading. Their findings are in line with the main goals of my research, which are to redefine lemon sorting, lessen the reliance on manpower, and guarantee constant adherence to industry standards.

Additionally, their research emphasizes the critical function of computer vision and image analysis methods. These innovations enable automated systems to assess the quality of fruit based on characteristics including size, shape, and color. These particular technologies are essential to my Lemon Sorting Machine project's capacity to precisely determine the grade of lemons. For the project to succeed in its goals, it is essential to comprehend the potential and capabilities of these technologies.

.Finally, the assessment by Sharma, Sharma, and Gill is more than simply scholarly inquiry; it provides a projection for the direction of fruit grading in the future. Their work serves as a source of inspiration for me in addition to offering useful information. It highlights how we may transform the lemon processing sector to make it more effective, accurate, and technologically sophisticated using creative image processing and automation applications. Their critique illuminates the route into a future of increased efficiency and quality in lemon processing, serving as a compass for my Lemon Sorting and Grading Machine project. [8].

## 2.9 Fruit grading system using image processing

In my opinion, the study carried out in 2016 by Chiranjivi and their associates provides an important inquiry into the field of fruit grading systems, with an emphasis on image processing. Their analysis offers insightful information on the revolutionary potential of image processing technology to improve the fruit grading process. Their research is quite pertinent to my attempt to build a lemon sorting and grading machine, and I found it to be very informative.

Chiranjivi et al.'s study strikes a powerful chord with me as I explore the nuances of this subject. Their analysis emphasizes how image processing might transform fruit grading, highlighting accuracy, effectiveness, and objectivity as major advantages for the agriculture sector. Their conclusions are in line with the main goals of my project, which are to reconfigure lemon sorting, decrease manpower reliance, and guarantee constant adherence to industry standards. Furthermore, Chiranjivi et al.'s study explores the labor-saving benefits of automated fruit grading, which is directly related to the goals of my project. Their analysis emphasizes how labor-intensive human sorting is and how automation has

the ability to both ease these problems and guarantee consistently good outcomes. This convergence reinforces the industry-wide trend toward increased labor efficiency, which my initiative aims to enhance.

In conclusion, the review by Chiranjivi and colleagues is more than just scholarly inquiry; it incorporates a projection for the direction of fruit grading. Their work serves as a source of inspiration for me in addition to offering useful information. It highlights how we may transform the lemon processing sector to make it more effective, accurate, and technologically sophisticated using creative image processing and automation applications. Their critique illuminates the route into a future of increased efficiency and quality in lemon processing, serving as a compass for my Lemon Sorting and Grading Machine project. [9].

## 2.10 Automatic color object sorting system

In my opinion, Wanve and Gawalwad's research from July 2015, which concentrated on colorbased sorting, made a significant addition to the field of automated object sorting systems. Their research sheds important light on the revolutionary potential of automated sorting systems and closely relates to the goals I had in mind when designing the Lemon Sorting and Grading Machine.

Wanve and Gawalwad's study strikes a chord with me as I go through the details of my project. Their study demonstrates how automation, and color-based sorting in particular, may completely transform sorting procedures in a variety of sectors. Precision, efficiency, and flexibility, among other key results, are similar to my project's goals. Both initiatives seek to increase sorting process effectiveness while guaranteeing consistent adherence to industry standards.

Additionally, their study emphasizes the critical function that computer vision and image analysis methods have in automated sorting systems. By helping machines to identify and categorize items based on color characteristics, these technologies enable them to make accurate sorting judgments. These particular technologies make up the crucial underpinning for correctly determining lemon quality in my Lemon Sorting Machine project.

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business to make it more effective, accurate, and technologically sophisticated through creative applications of automation and technology. Their work illuminates the way toward an improved future for efficiency and quality in lemon processing, which acts as the compass for my Lemon Sorting and Grading Machine project. [10].

# Chapter 3

# METHOD AND MATERIAL/EXPERIMENTAL SETUP AND PROCEDURE

## 3.1 LIST OF COMPONENTS:

1. Microcontroller Arduino Uno
2. IR Sensor 16mm 5V
3. Microcontroller Arduino NANO
4. Proximity Sensor 16mm 5V
5. USB to TTL module FYDI232
6. 12V DC Gear Motor
7. ESP32 DOT KIT Microcontroller
8. Webcam 1080p 30fps
9. Webcam 720p 30fps
10. Relay Module
11. Servo Motor

### 3.1.2 IR Sensor 16mm 5V

The IR Sensor 16mm 5V is essential to our project's ability to recognize and react to infrared (IR) signals. The small 16mm form size and 5V power source of this sensor make it unique. It makes use of infrared technology to detect the presence of items or modifications in the surroundings. There are two IR transmitters and receivers in the IR Sensor 16mm 5V. The receiver picks up the reflected or emitted IR radiation from the transmitter, which produces infrared light. When anything or an obstruction is close to the sensor, it either reflects or absorbs the IR light, changing the sensor's output. For tasks like object identification, obstacle avoidance, or even remote-control applications, we use the IR Sensor 16mm 5V in our project. It may be used for many applications due to its tiny size and low power needs, which improves the project's usefulness and potential.

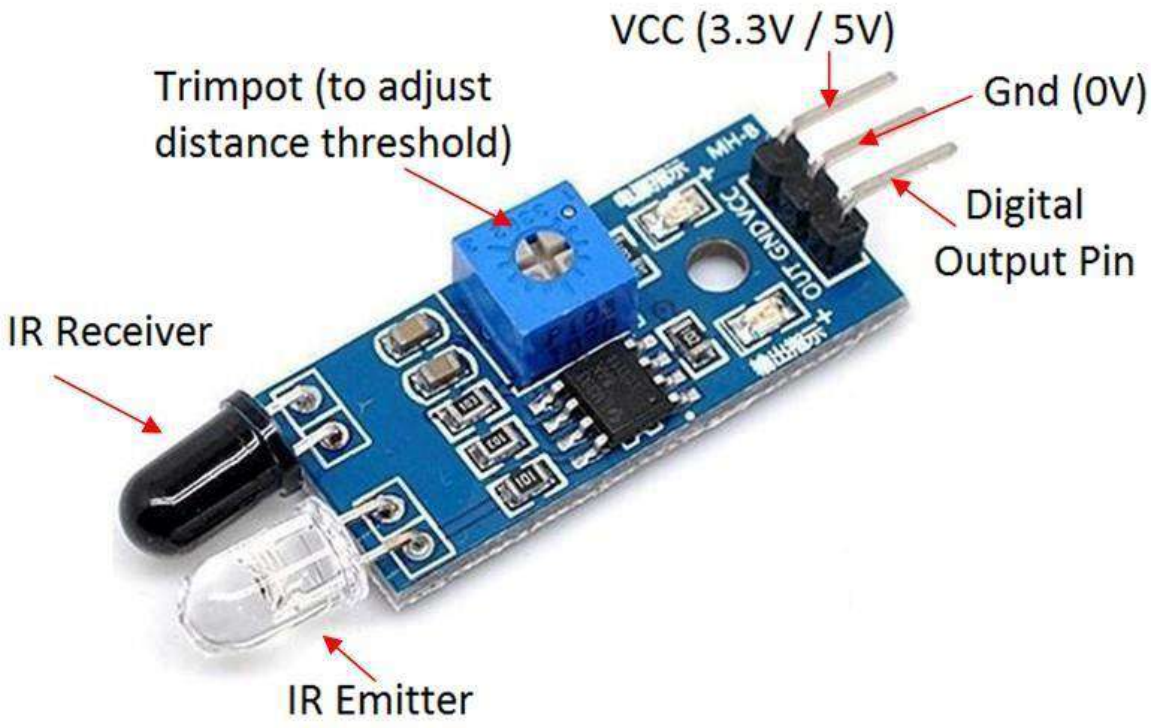



**Fig 3.2 IR Sensor 16mm 5V**

### 3.1.3 Microcontroller Arduino NANO

The Arduino Nano is a small and adaptable microcontroller board that resembles its bigger sibling, the Arduino Uno, in many ways. This microcontroller was created by Arduino and is ideal for embedded and small applications since it is intended for projects where space is at a premium.

The Atmega328P microcontroller serves as the foundation for the Arduino Nano, which has a wealth of capabilities like 22 digital input/output pins, 8 analog inputs, a 16 MHz quartz crystal, a USB interface for programming and communication, and a power connection. The fundamental features of the Arduino Uno are still there despite its compact size, enabling easy code interchange between the two boards. The size of the Arduino Nano is one of its main benefits. Since it is substantially more compact and smaller than the Arduino Uno, it is appropriate for applications with limited space. Without sacrificing functionality, this microcontroller may be quickly and simply incorporated into many different products and prototypes.

The Arduino Nano benefits from the open-source Arduino IDE, which streamlines code development, much like other Arduino boards. Rapid prototyping and development are made possible by the huge Arduino community and library support, which provide users access to a broad variety of pre-written code.

The Arduino Nano is used in our project as the system's brain, handling data processing, control logic, and communication functions. Its small size and substantial feature set make it the perfect fit for the needs of our project, providing effective and dependable operation within the confines of the available area.

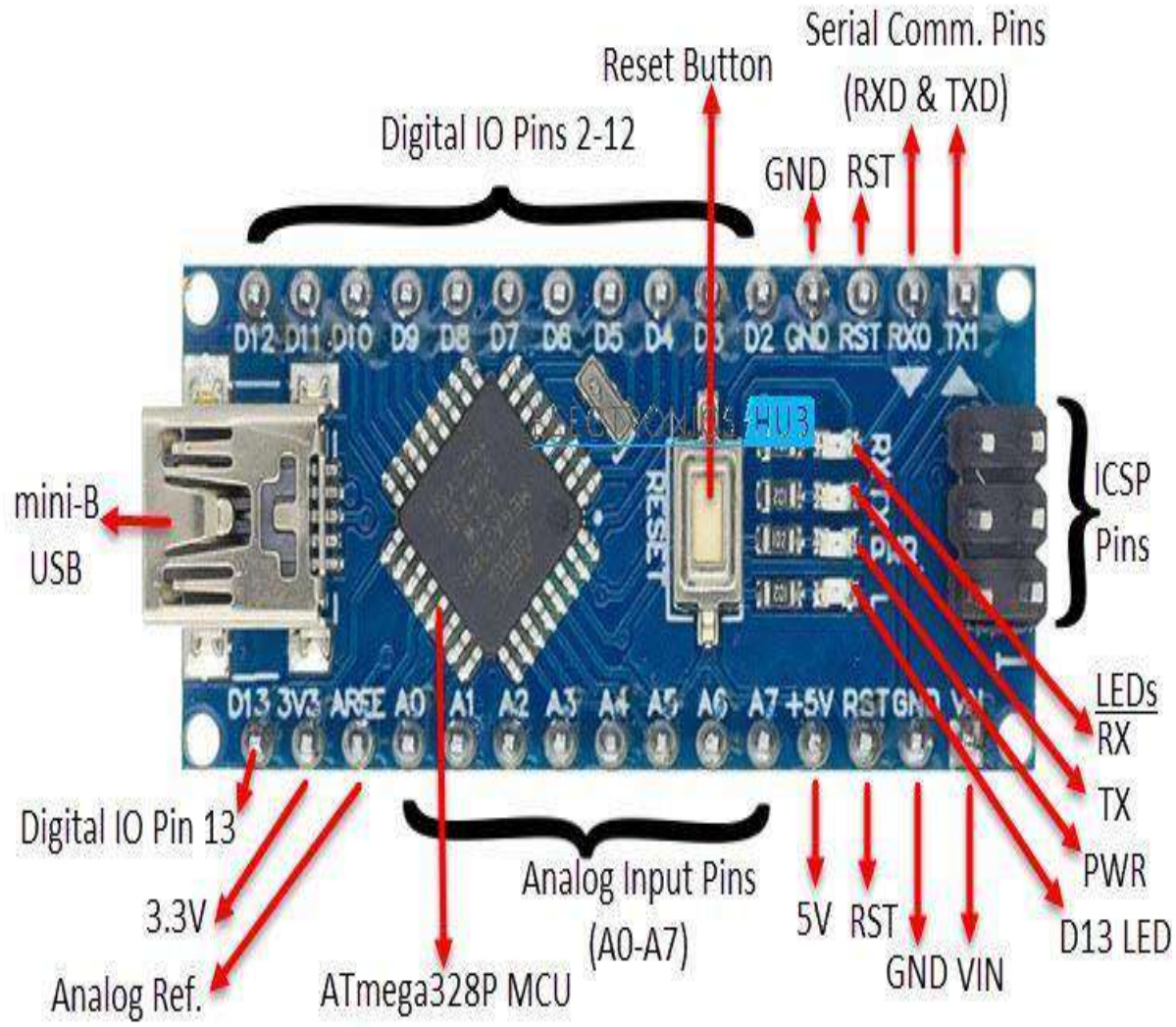



**Fig 3.3 Microcontroller Arduino NANO**

### 3.1.4 Proximity Sensor 16mm 5V

Our project's Proximity Sensor 16mm 5V is essential since it provides a trustworthy way to determine whether items are present or absent within its detection range. This sensor has an ultra-compact 16mm form size and is made to run on a 5V power source.

The Proximity Sensor 16mm 5V's main job is to recognize barriers or objects without coming into touch with them. To do this, it makes use of a variety of technologies, including capacitive sensors,

ultrasonics, and infrared (IR). It makes use of [insert the specific technology, like infrared] technology in our particular implementation.

The sensor works by sending out a signal—such as an IR beam—and then timing how long it takes for the signal to return after coming into contact with an item. The distance to the object is then calculated using this time delay, enabling the sensor to assess whether an object is present within its detecting range. The Proximity Sensor 16mm 5V is used in our project to do activities like object identification, obstacle avoidance, or initiating particular actions when an item is in close proximity. It is an efficient option for many applications because to its small size and ability to work with a 5V power source. To improve this sensor's capabilities and offer strong object detecting and interaction features, we have integrated it into our project.

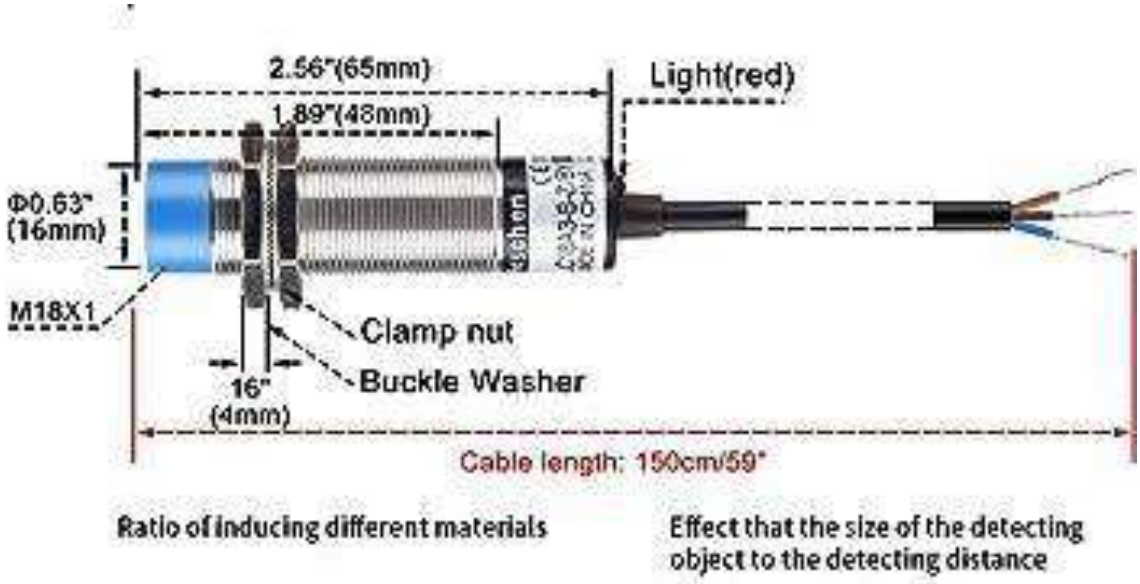



**Fig 3.4 Proximity Sensor 16mm 5V**

### 3.1.5 USB to TTL module FYDI232

A crucial electronic part of our project, the USB to TTL Module FYDI232 acts as a link between the USB interface of a computer and TTL-level serial communication. This module is an essential tool for programming, debugging, and data interchange since it makes it easier to communicate between a computer and a microcontroller or other TTL-level device.

A USB Type-A connector for quick connection to a computer and a TTL-level serial interface with pins for Transmit (TX), Receive (RX), Ground (GND), and optional Power (VCC) connections are among the key characteristics of the USB to TTL Module FYDI232. It runs at different voltage levels

and frequently supports both 3.3V and 5V TTL signals, making a wide range of microcontrollers and embedded systems compatible with it.

The simplicity and use of this module are two noteworthy benefits. Users may talk to and program their microcontrollers by connecting it to a computer through USB and setting up the proper serial connection settings. It is frequently used for operations like serial data transfer, firmware uploading, and debugging.

In our project, the USB to TTL Module FYDI232 is essential to provide a trustworthy communication channel between our computer and the microcontroller we're utilizing (such as the Arduino Nano). This enables us to send commands to manage different components of our project, get data from sensors, and upload and debug code. It is an essential instrument for the growth and functionality of our project because of its adaptability and simple operation.

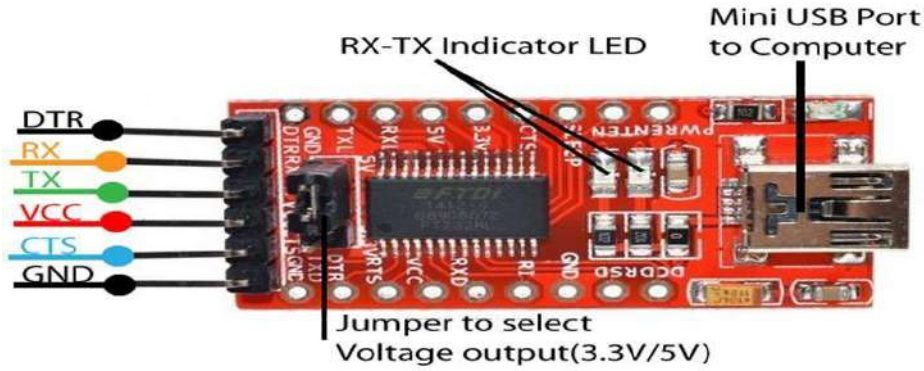



**Fig 3.5 USB to TTL module FYDI232**

## 3. 3.1.6 12V DC Gear Motor

The 12V DC Gear Motor is a crucial part of our project since it provides a reliable and effective way to transform electrical energy into mechanical motion. This motor's gear system, which improves torque and control, is designed to run on a 12-volt direct current (DC) power source. The 12V DC Gear Motor's small size, strong torque production, and silent operation are some of its standout characteristics. Precision-engineered gears make up the gear mechanism, which converts the motor's high-speed, low-torque output to a lower-speed, high-torque output. This makes the gear mechanism suited for a variety of applications where exact control and torque are crucial.

The 12V DC Gear Motor is used in our project to perform operations including actuation, movement, and mechanical control. Its compatibility with a 12V power source fits in well with the power demands of our project, and because to its adaptability, we can adjust its speed and rotational direction to suit our particular requirements.

External circuitry, such as motor drivers or H-bridge modules, is generally used to control the motor, allowing us to use microcontroller signals to control the motor's speed and direction. In order to achieve accurate motions and automation in our project, this degree of control is essential.

The mechanical system of our project is built on the 12V DC Gear Motor because of its dependable performance, manageable size, and versatility. This allows us to efficiently integrate motion and control solutions. It's dependability and high torque production improve the project's overall functioning, making it a key element in attaining our project's goals.

**Fig 3.6 12v DC Gear Motor**

### 3.1.8 Webcam 1080p 30fps

The Webcam 1080p 30fps is a crucial part of our project since it acts as the main visual input tool for recording high-quality video and still photographs. With a frame rate of 30 frames per second (fps), this camera can record video at a breathtaking 1920x1080 pixel quality and has a resolution of 1080p.

The Webcam 1080p 30fps's high-definition image quality, real-time 30fps video capture, and plug-and-play capability are among its key characteristics. It has a high-quality lens and sensor that allow it to offer sharp and clear images, making it appropriate for a variety of applications, such as video conferencing, live streaming, and video recording.

Our project's ability to capture small details and deliver a high level of visual clarity is made possible by the 1080p resolution, which is crucial for activities like image analysis, object recognition, or visual monitoring. The smooth and realistic action in films that are captured is made possible by the 30fps frame rate, which also lessens motion blur and improves the watching experience.

The Webcam 1080p 30fps acts as the main visual input source for our project, allowing us to record real-time video and photos. The high-definition capabilities of this camera improve the collecting and analysis of visual data for our project, whether it be for surveillance, remote monitoring, or interactive

applications. It can be easily integrated into our project's setup because of its plug-and-play compatibility with common USB interfaces, which makes it a useful and accessible part of the system.


**Fig 3.8 Webcam 1080p 30fps**

### 3.1.9 Webcam 720p 30fps

The Webcam 720p 30fps serves as the main visual input device for our project and is essential to getting high-quality video and photographs. This camera runs at a steady 30 frames per second (fps) frame rate and has a 720p resolution, which equates to a video recording capacity of 1280x720 pixels.

High-definition image clarity, real-time 30fps video recording, and user-friendly plug-and-play capabilities are some of the Webcam 720p 30fps's standout features. It is well-suited for a variety of applications, including video conferencing, live streaming, and video recording, thanks to its high-quality lens and sensor.

Our project can record vivid graphics with adequate clarity thanks to the 720p resolution. The 30fps frame rate makes it possible for recorded films to have fluent and lifelike animation, which lessens motion blur and improves the overall watching experience.

The Webcam 720p 30fps acts as the main visual input source for our project, enabling real-time video and picture capturing. The high-definition capabilities of this camera, whether used for surveillance, remote monitoring, or interactive applications, considerably aid in the collection and analysis of visual data for our project. Its simple plug-and-play compatibility with common USB ports makes integration easier and makes it an affordable and essential part of our project's design.

### 3.1.10 Relay Module

The Relay Module is an essential part of our project since it is crucial for automating and enabling remote control of high-power electrical equipment. At its essence, a relay is an electromechanical switch that activates in response to an electrical signal. A useful option for a variety of applications, the Relay Module is a small, adaptable container that stores one or more relays.

Multiple channels (relays), input voltage compatibility, and high current-carrying capacity are frequently among a relay module's key characteristics. These modules are available in single channel, multi-channel, and solid-state relay versions among others. They can switch high current loads and are made to operate with a variety of input voltage levels, most frequently 5V or 12V.

The Relay Module is used in our project to control a variety of electrical appliances, including lights, motors, heaters, and pumps. It serves as an interface between high-voltage or high current loads and low-voltage microcontroller signals. We may open or close the circuit and regulate the linked load by energizing or de-energizing the relay using a control signal from our microcontroller.

With this skill, our project may automate procedures, use remote control, or carry out operations that are prompted by circumstances or sensor data. For instance, we may use the Relay Module to operate a pump when a water level sensor detects low water, turn on or off lights based on ambient light levels, or manage the heating element in a temperature control system. The Relay Module is a crucial part for attaining our automation and control goals because of its capacity to separate low-voltage control signals from high-voltage loads, which improves safety and dependability in our project. Its adaptability and simplicity of integration guarantee a flawless interaction with our microcontroller and other project components, enhancing the overall usefulness and success of the endeavor.

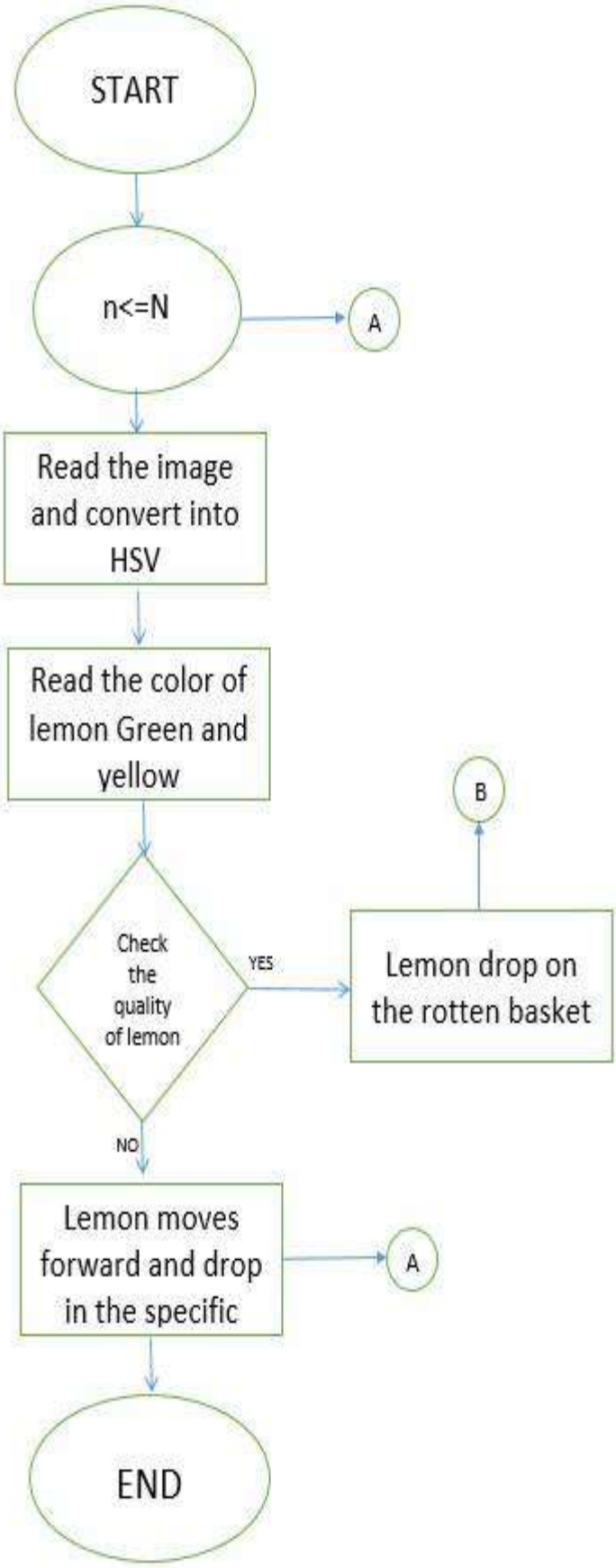
**Fig 3.9 Relay Module**

### 3.1.11 Servo Motor

A servo motor is a versatile and accurate electromechanical tool used in a variety of industries, including manufacturing, robotics, and automation. It has a closed-loop control system, which means that it constantly adjusts and maintains its location, speed, and rotational direction based on feedback from sensors. Servo motors are necessary for activities that call for accuracy and repeatability because of this feedback system, which enables them to deliver extremely accurate and responsive control. The precise angular or linear motion that servo motors are recognized for producing makes them the best choice for jobs like positioning objects, directing the action of robotic limbs, or keeping equipment oriented. To meet the needs of varied applications, they are available in a range of sizes and power levels. Servo motors are essential components of contemporary automation and control systems, whether they are used in a CNC machine to ensure precise cutting, a drone to stabilize flying, or a robotic arm to assemble items on an assembly line. They are essential components in a variety of sectors where precision and control are crucial because of their dependability, accuracy, and adaptability.


**Fig 3.10 Servo Motor**

### 3.2 Flowchart



## 3.3 Hopper Process:

The Lemon Sorting and Grading Machine project's hopper process is a systematic and regulated operation that regulates the loading and feeding of lemons into the sorting and grading system. This procedure is crucial for guaranteeing an ordered and efficient movement of lemons through the machine:

1. **3.3.1 Loading Area**
   The hopper process begins with lemons being placed in the loading area. This compartment is designed to hold a particular number of lemons, enabling for continuous processing without the need for frequent operator intervention.

2. **3.3.2 Gravity-Assisted Feeding**
   The hopper process's core rests in its use of gravity to feed lemons farther into the machine. The hopper is usually created with an inclined or funnel-shaped structure that promotes lemons to fall down because to gravity.

3. **3.3.3 Controlled Flow**
   Mechanisms like as conveyor belts or vibrating feeders are frequently used in hoppers to ensure an equal and controlled flow of lemons. These ingredients control the circulation of lemons, reducing clumping and congestion.

4. **3.3.4 Synchronization**
   To guarantee that lemons are supplied at a pace that fits the machine's processing capability, the hopper is synced with the sorting and grading system. This synchronization helps to avoid bottlenecks and improves overall efficiency.

5. **3.3.5 Customization**
   Depending on the project needs, the hopper method may be tailored to accept a variety of lemon sizes and production quantities, making it applicable to a variety of circumstances.

In conclusion, the hopper process is an essential component of your Lemon Sorting and Grading Machine project, coordinating the regulated and orderly feeding of lemons into the sorting and grading system. Its design, synchronization, and safety measures are critical to the machine's overall efficiency and safety.

### 3.3.6 Circuit Diagram of Hopper

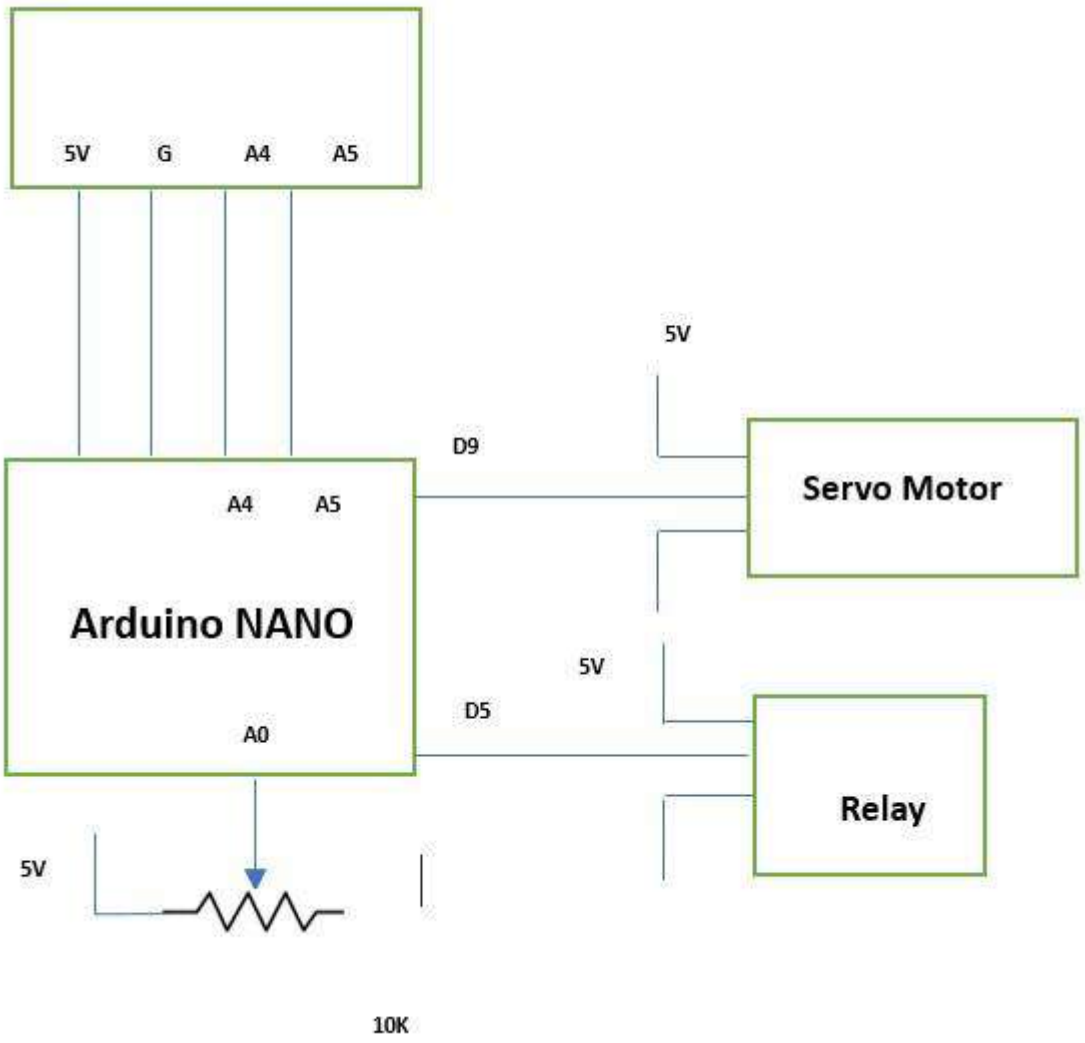



**Fig 3.11**

## 3.4 Grading Procedure (Detection of Rotting):

The lemon sorting and grading machine's grading procedure is intended to identify and separate rotting lemons from healthy lemons. This critical step guarantees that only high-quality lemons are packaged or processed further. The following is a full explanation of the rotting detecting process:

## 3.4.1 Data Collection:

The procedure starts with data gathering, which collects information about each lemon that passes through the system

## 3.4.2 Technology for Sensing:

The system captures crucial characteristics of each lemon using modern sensing technologies such as cameras and sensors. These sensors are particularly designed to detect rot or deterioration.

## 3.4.3 Algorithms for Rot Detection:

The sensor data is analyzed using rot detection methods. These algorithms examine visual clues and features of lemons to detect rot or deterioration.

## 3.4.4 Mechanism of Sorting:

The sorting mechanism of the machine is triggered based on the findings of the rot detection algorithms. It physically separates lemons that exhibit indications of decay from lemons that are healthy.

## 3.4.5 Quality Assurance:

Rotten lemons are normally removed from the sorting process and transferred to a separate disposal or processing plant, ensuring that only fresh and healthy lemons go on.

The grading procedure, which focuses on rotting detection, is critical for maintaining product quality by ensuring that only fresh lemons reach customers. It uses sophisticated sensors and algorithms to identify and separate rotting lemons from the batch in an efficient and precise manner.

**Fig 3.12**

**Fig 3.13**

## 3.5 Color sorting process

In the Lemon Sorting and Grading Machine project, the color sorting process is critical to ensure that lemons satisfy the appropriate color requirements. This technique is necessary for a variety of purposes, including product uniformity and satisfying specific market needs. It consists of many critical steps:

### 3.5.1 Color Sensing Technology

The process starts with the use of advanced color sensing technology, such as high-resolution cameras and image processing. Image processing is skilled at extracting accurate color information from each lemon that passes through the system.

### 3.5.2 Color Classification Algorithms

After acquiring the color data, it is put into advanced color classification algorithms. These algorithms are set up to classify lemons based on predetermined color criteria. Lemons, for example, might be categorized according to their hue, such as yellow and green.

### 3.5.3 Sorting Mechanism

The sorting mechanism of the machine is activated based on the findings of the color categorization algorithms. It physically divides lemons into distinct bins or conveyor lanes, each of which is labeled with a different color group.

### 3.5.4 Quality Control

Quality control techniques are frequently incorporated into the color sorting process to ensure that lemons within the same color group satisfy extra quality standards. This can involve identifying and removing lemons with physical flaws or abnormalities.

### 3.5.5 Flexibility and Customization

The system may provide users with the ability to alter color standards to fit individual market demands or client preferences.

**Fig 3.14**

## 3.6 Circuit Diagram

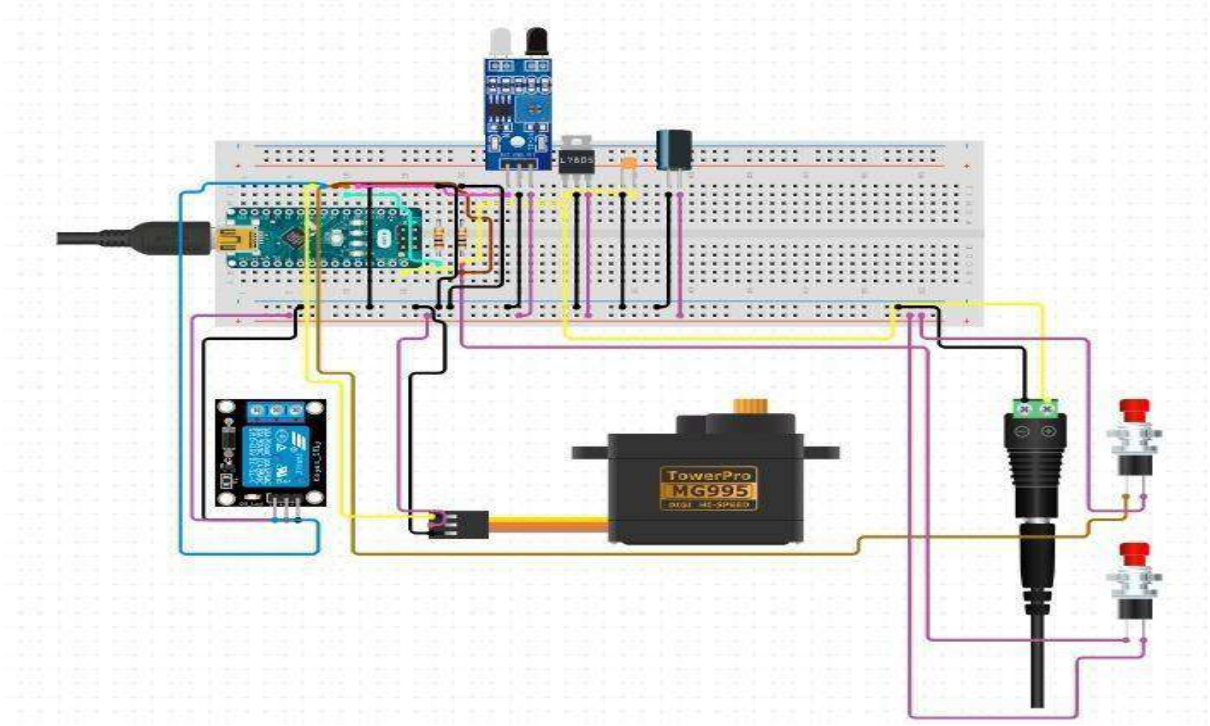



**Fig 3.15**

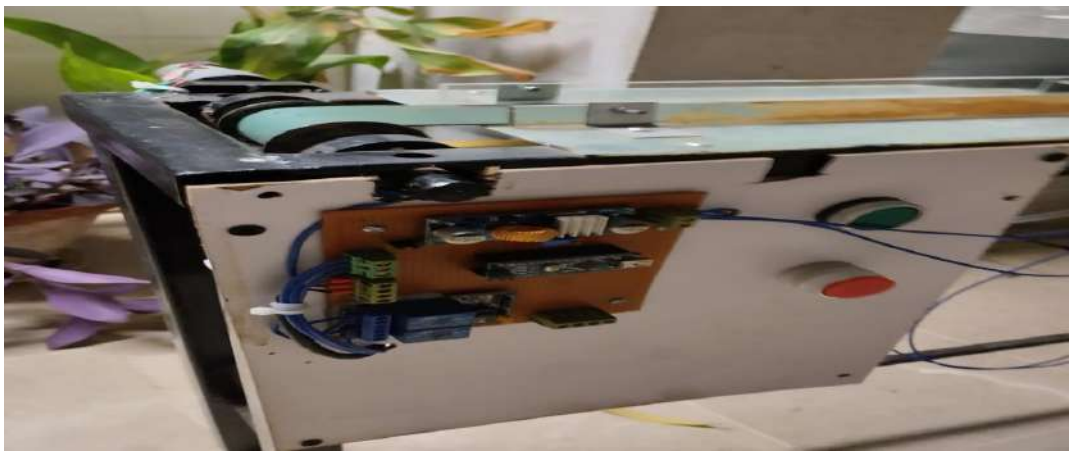


**Fig 3.16**

### 3.7 Size sorting process

The size sorting process is a critical component of the Lemon Sorting and Grading Machine project, and it is used to categorize lemons depending on their measurements. This component of the project is critical since it allows for the packing and distribution of lemons of consistent size, satisfying market expectations and increasing customer satisfaction. Several critical factors are involved in the size sorting process:

### 3.7.1 Size Measurement Technology

To measure the size of the lemons, we placed a rod mechanism that can drop the lemons based on the size of each lemon that passes through it.

### 3.7.2 Size categorization Algorithms

Size measurement data is then submitted to size categorization algorithms. These algorithms are intended to classify lemons into predetermined size categories “small,” “medium,” or “large,” according to size standards.

### 3.7.3 Sorting Mechanism

The machine’s sorting mechanism then comes into action. This mechanical component effectively sorts lemons into multiple bins, each of which is labeled with a different size class.

### 3.7.4 Quality Control

In addition to size sorting, the system may include quality control techniques. This guarantees that lemons of the same size fulfill other quality standards, such as the lack of faults or blemishes.

### 3.7.5 Customization

The system may provide possibilities for customers to change size criteria to match unique market preferences or packaging requirements.

Size sorting is critical for aiding effective packaging and distribution procedures. It improves product presentation and customer satisfaction by ensuring that lemons are categorized by size, complying with industry norms and consumer expectations.

**Fig 3.17**

## Block Diagram

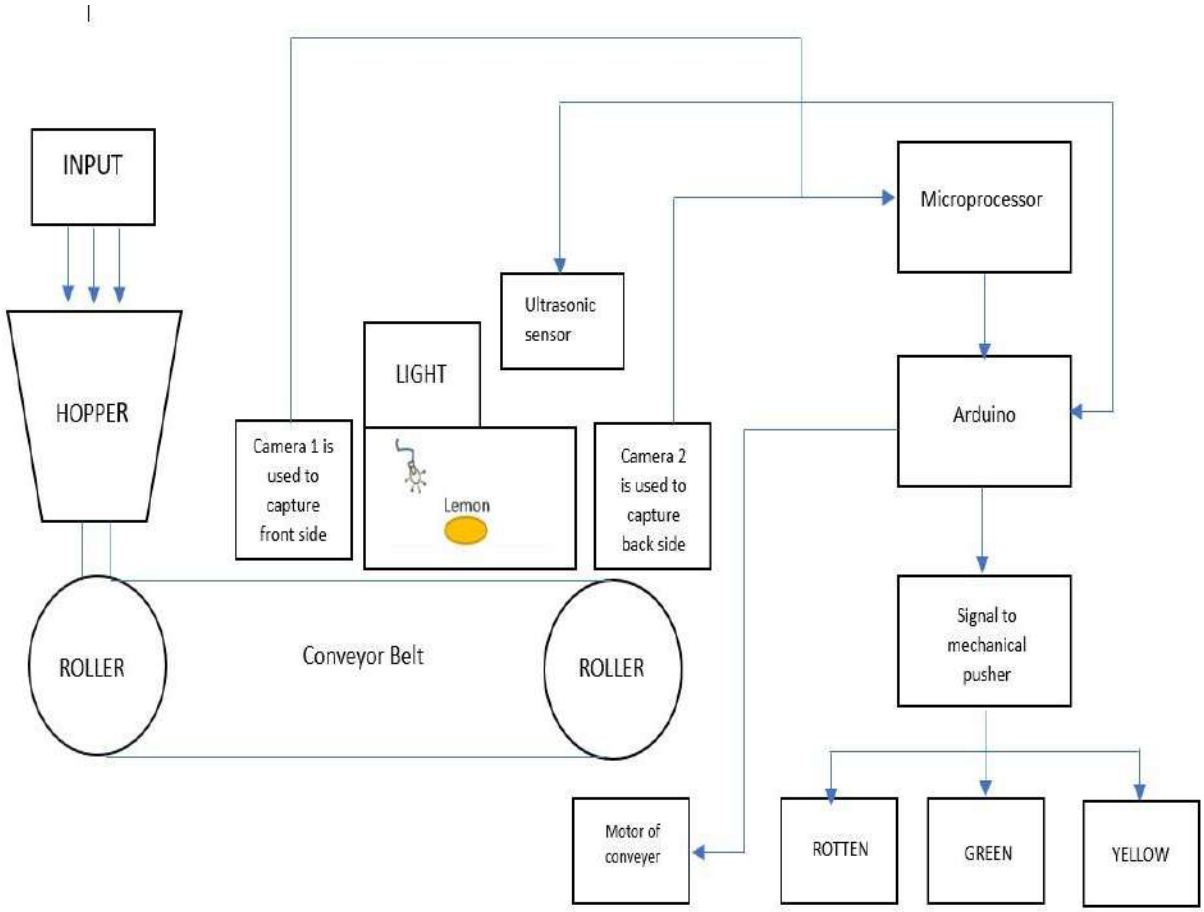



**Fig 3.18**

# Chapter 4

# EXPERIMENTAL RESULTS AND DISCUSSION/

# SIMULATION AND RESULTS

## 4.1 Environmental Impact

## 4.2 4.1.1 Reduced Food Waste

Reducing food waste is one of the most major environmental benefits of a Lemon Sorting Machine. The machine guarantees that only high-quality lemons are picked for market distribution by quickly sorting and classifying lemons based on quality parameters. This reduces food waste by decreasing the disposal of defective or broken lemons.

### 4.1.2 Resource Optimization

Lemon sorting machines help with resource optimization by ensuring that lemons that satisfy certain quality criteria are packaged and sold. This minimizes the entire resource footprint of producing, transporting, and disposing of unsold fruits.

### 4.1.3 Energy Efficiency

Many new lemon sorting machines are built with energy-efficient components and technology. Lowering energy use means lowering greenhouse gas emissions and leaving a smaller carbon footprint.

### 4.1.4 Reduced Chemical Use

Effective sorting methods can reduce the requirement for chemical treatments or coatings on lemons to improve their appearance or shelf life. This can result in less chemical use and the related environmental advantages.

### 4.1.5 Sustainable Agriculture

Lemon sorting machines contribute to sustainable agriculture by encouraging the development and sale of high-quality crops. This encourages farmers to implement strategies that increase fruit quality, such as reducing pesticide usage and improving growing techniques.

### 4.1.6 Economic advantages

While not directly related to the environment, the economic advantages of decreased food waste and improved product quality can indirectly benefit the environment by lowering pollution.

## 4.2 Software

### 4.2.1 Anaconda

The Python distribution Anaconda, which is widely used, is essential to the field of image processing. For researchers, developers, and engineers working on image-related tasks, this software package offers a comprehensive ecosystem for managing libraries, dependencies, and environments.

Anaconda offers a number of significant advantages in the field of image processing. The conda package manager, which makes it easier to install and manage Python libraries, is one of its major features. Anaconda's conda makes it simple to establish isolated environments suited to the particular needs of an image processing project, which frequently requires specific libraries and dependencies. This guarantees reproducibility and that various projects can have their own unique environments with the precise versions of libraries needed, preventing conflicts. Several libraries in the Anaconda ecosystem are necessary for image processing. For numerical operations and scientific computing, NumPy and SciPy are essential, and OpenCV is a potent package for computer vision jobs. An essential tool for image analysis and manipulation, OpenCV offers functions for picture loading, modification, feature extraction, and more. Additionally, scikit-image, which is based on NumPy and SciPy, provides an intuitive, highlevel interface for a variety of image processing functions, making it usable by both novices and specialists. The Pillow library is a well-liked option for fundamental image handling operations like reading, writing, and format conversion and is effortlessly integrated into Anaconda.

The interactive web-based environment Jupyter Notebook, which is part of Anaconda, is very useful for image processing processes. It enables users to produce papers with live code, equations, illustrations, and explanatory text. This is especially helpful for image processing since it allows for the breakdown of difficult jobs into simple steps with supporting illustrations and explanations, improving the clarity and transparency of image processing pipelines. Deep learning, an area that has transformed image processing, is flexible with Anaconda. Installing frameworks like TensorFlow, Keras, and PyTorch—all of which are easily accessible in the Anaconda repository—allows users to quickly set up deep learning settings. These frameworks make it possible to create and use neural networks for projects like picture production, object identification, and classification. Additionally, Anaconda's GPU acceleration support via libraries like CUDA and cuDNN greatly accelerates image processing workloads, particularly in applications like image segmentation and pattern recognition. In conclusion, Anaconda is a crucial tool for experts in image processing. The development and deployment of image processing projects are made simpler by its package management, ability to create isolated environments, and vast library ecosystem. Anaconda is a leader in the field of image processing because it enables academics and engineers to solve a variety of image processing problems

quickly and effectively. It does this by supporting Jupyter Notebook, deep learning frameworks, and GPU acceleration.

### 4.2.2 Arduino IDE

A crucial component of open-source hardware and electronics prototyping is the user-friendly software platform known as the Arduino Integrated Development Environment (IDE). It is intended to make the process of uploading code to Arduino microcontroller boards simpler, making it usable by both novices and specialists.

The Arduino IDE's primary feature is a practical code editor with syntax highlighting, autocomplete, and error checking capabilities. The Arduino programming language, which is a condensed version of C/C++, is supported by this environment. It's a great alternative for individuals new to programming and electronics because the syntax is friendly and simple to understand. This ease of use, along with a sizable user base and thorough documentation, has boosted Arduino's acceptance in classrooms and among enthusiasts.

The Arduino IDE's adaptability with a variety of Arduino devices is one of its unique advantages. The IDE offers a uniform programming interface regardless of whether you're working with the traditional Arduino Uno, the more potent Arduino Mega, or any of the various Arduino versions designed for particular uses. This implies that you may program numerous Arduino boards without having to become familiar with diverse software environments.

The uploading of code to the microcontroller is also made simpler by the Arduino IDE. You may compile your code, translate it into a format that the Arduino board recognizes, then upload it to the board through a USB connection all with the push of a single button. The entry barriers are lowered for those who may lack considerable embedded programming skills thanks to this simplified method.

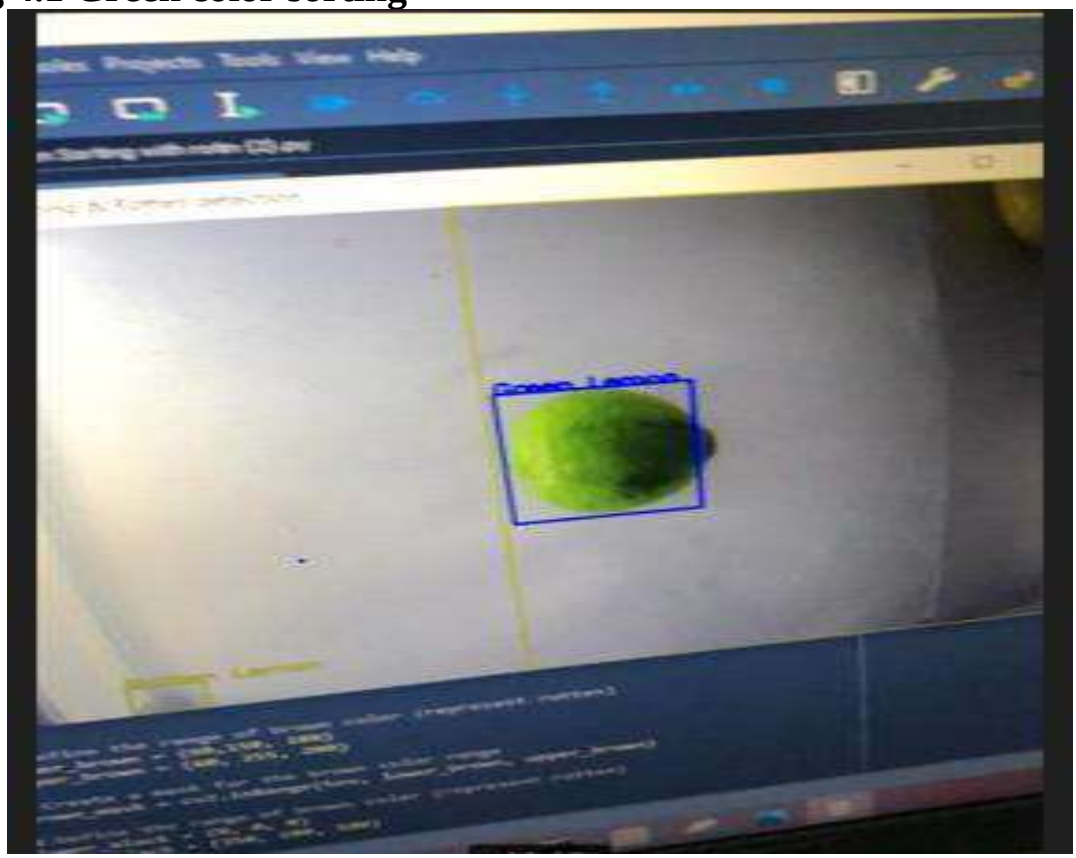
The Arduino IDE also provides a robust library environment. A wide collection of pre-written code snippets and libraries are available to users, making it easier to complete routine tasks like controlling LEDs and sensors or interacting with displays and motors. Prototyping is sped up by this library assistance, which also frees users to concentrate on the particular features of their ideas.

The Arduino IDE has developed to include new features and tools as technology has advanced. For instance, it now enables comprehensive serial monitoring and debugging, both of which are crucial for diagnosing and perfecting applications. In order to accommodate more experienced users that demand specialized capabilities, the IDE can also be expanded with plugins and thirdparty tools.

In conclusion, the Arduino IDE is a flexible and user-friendly platform that has been instrumental in democratizing embedded programming and electronics prototyping. It is a fantastic option for both new and experienced electronics enthusiasts due to its simplicity, interoperability with a variety of hardware, and comprehensive library support. The Arduino IDE is still a useful resource for anyone wishing to realize their electronic ideas thanks to ongoing improvements and a strong community.

### 4.3 Results

## Fig 4.1 Green color sorting



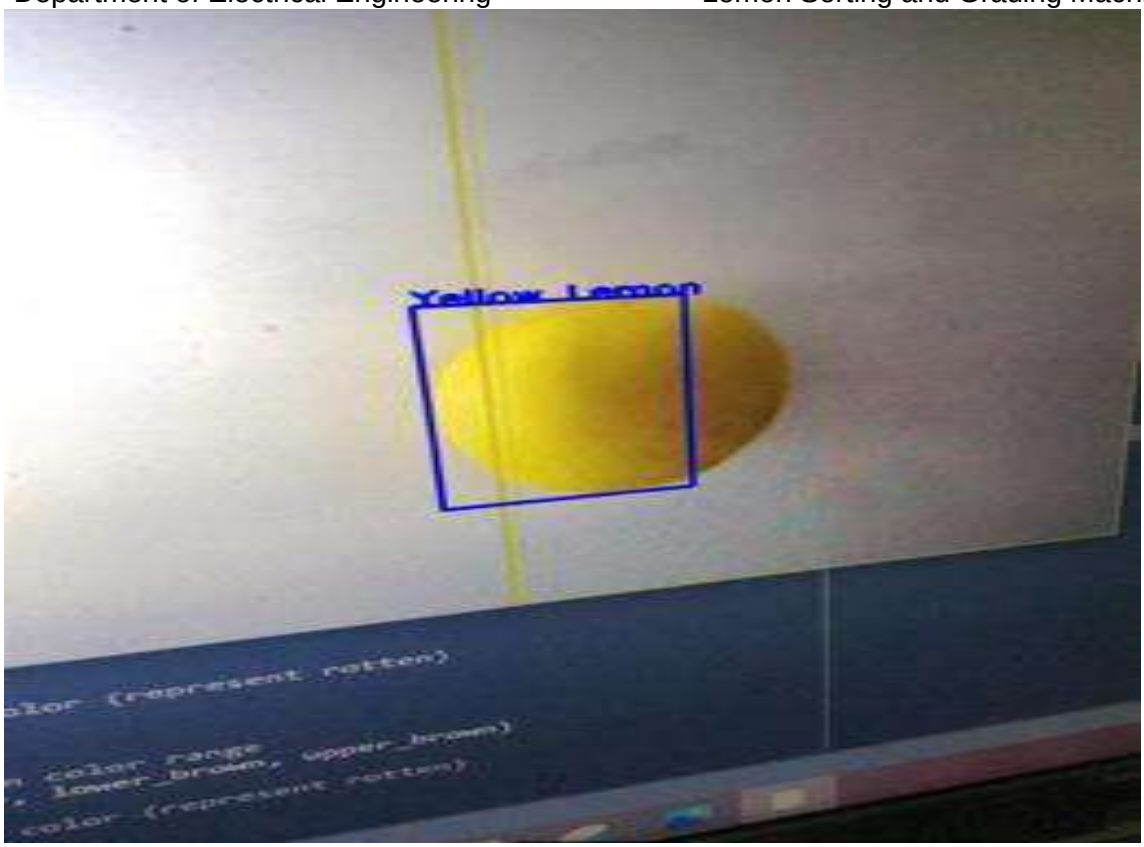
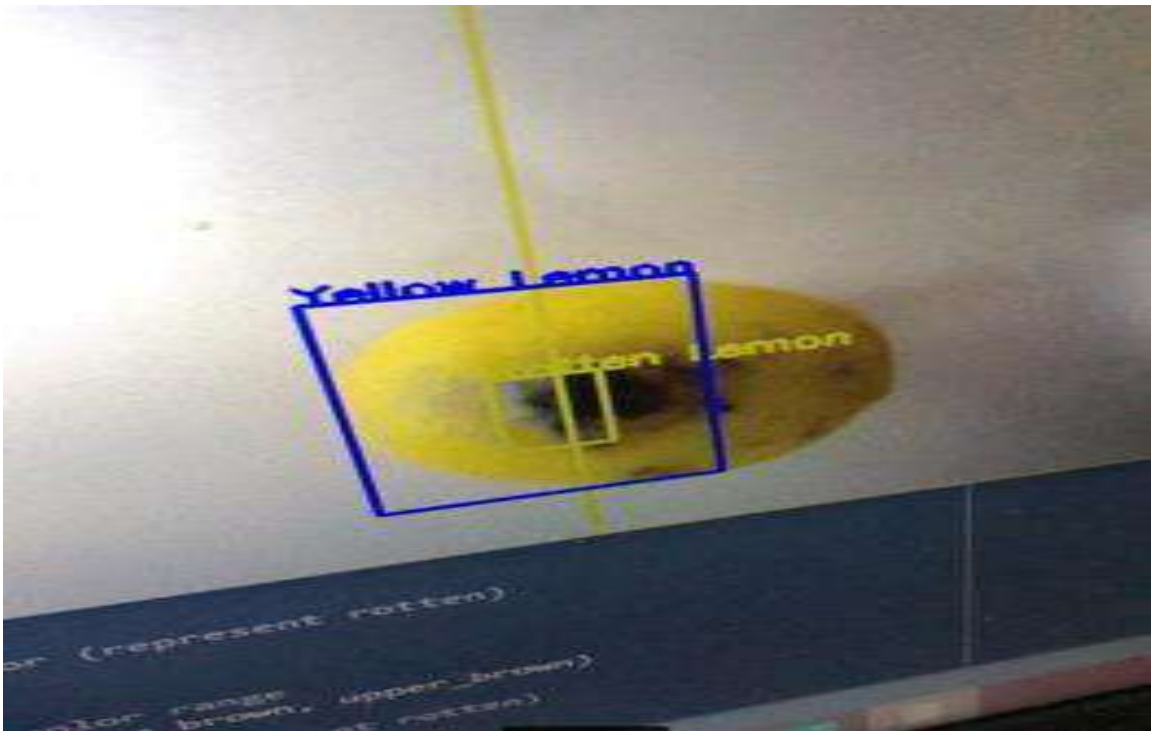



**Fig 4.2 Yellow Color Sorting**




**4.3 Rotten Lemon Sorting**

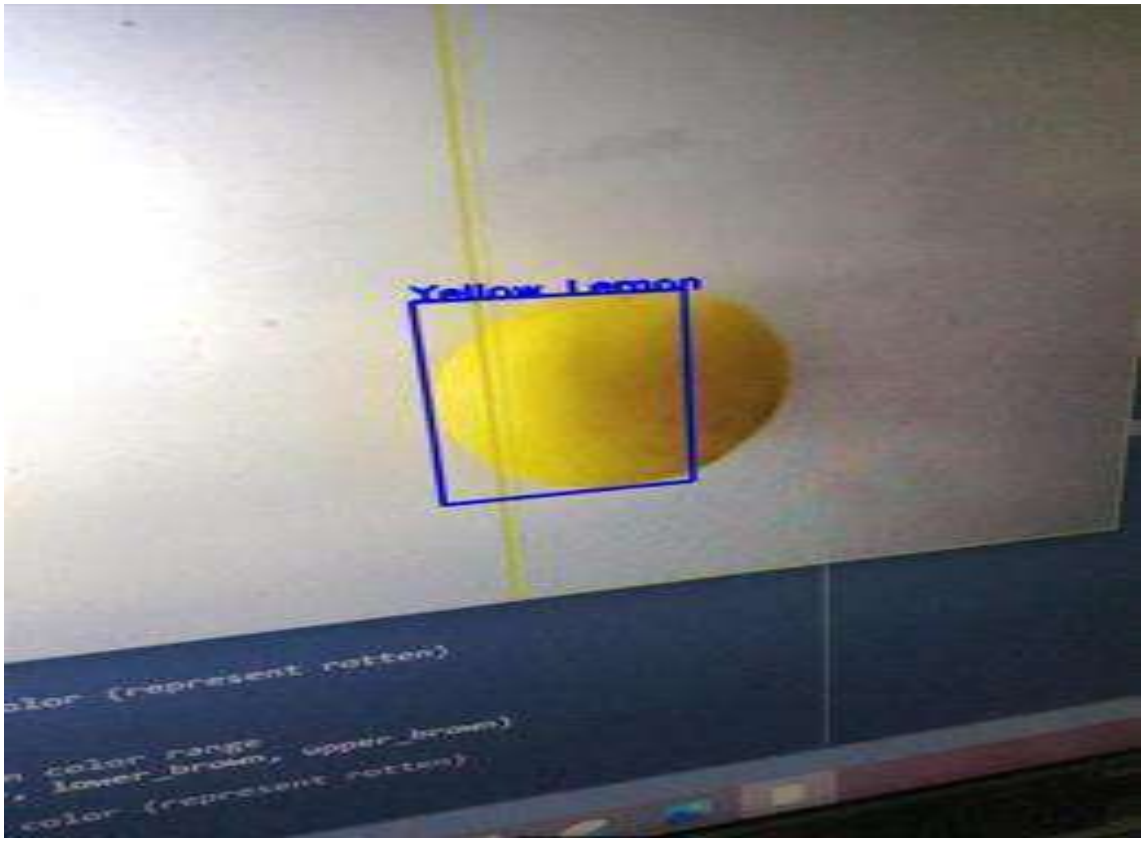
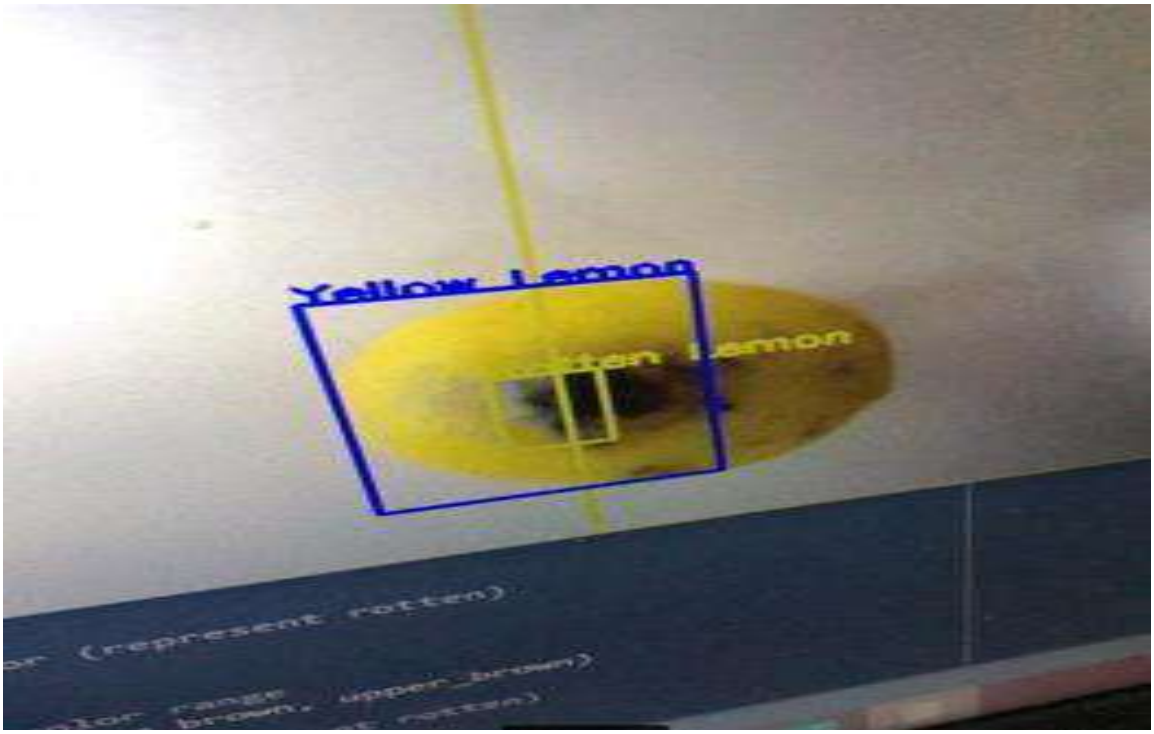



**Fig 4.2 Yellow Color Sorting**




**4.3 Rotten Lemon Sorting**

# Chapter 5

# CONCLUSION AND FUTURE WORK

Salient features of Lemon Sorting and Grading Machine are as under.

## 5.1 High Precision Sorting

The Lemon Sorting and Grading Machine project is notable for its outstanding precision in lemon sorting. It uses cutting-edge technology to systematically categorize lemons based on factors like as size, color, and quality. This accuracy guarantees that only the best and most marketable lemons pass through the sorting process, improving total product quality.

## 5.2 Cost-Effective Solution with Financial Benefits

This project contributes to lower operational expenditures while improving financial sustainability and profitability for agricultural and food processing firms by providing a costeffective solution for fruit processing and sorting.

## 5.3 Stability

A Lemon Sorting and Grading Machine project's stability is critical for its effective deployment and long-term operation. Several elements influence project stability:

### 5.3.1 Quality Components

It is critical to employ high-quality sensors, cameras, conveyors, and sorting systems. Investing in dependable components decreases the likelihood of problems and assures consistent performance.

### 5.3.2 Regular maintenance

A proactive maintenance plan is essential for project stability. Regular inspections, cleaning, and replacement of worn-out parts can help to avoid unexpected downtime and keep operations stable.

### 5.3.3 Quality Assurance

Stringent quality control techniques implemented during the production and assembly phases guarantee that each machine fulfills the necessary quality and performance criteria, boosting project stability.

## 4. 5.4 Arduino Code for Hopper

```
#include <Servo.h>

#include <LiquidCrystal_I2C.h>

#include <Wire.h>


#define variable A0

LiquidCrystal_I2C lcd(0x27, 16, 2);

Servo myservo;  // create servo object to control a servo


int pos = 0;    // variable to store the servo position


void setup() {
Serial.begin(9600);
lcd.init();   lcd.backlight();
lcd.clear();   lcd.setCursor(0,
0);   lcd.print("Hopper");
  myservo.attach(9);  // attaches the servo on pin 9 to the servo object


}


void loop() {

  int timedelay = map(analogRead(variable), 0, 1023, 0, 255);

  for (pos = 0; pos <= 180; pos += 1) { // goes from 0 degrees to 180 degrees

    // in steps of 1 degree     myservo.write(pos);             // tell servo to go to
position in variable 'pos'     delay(15);                    // waits 15 ms for the servo to
reach the position   }
}
```

## 5.5 Arduino Nano Code

```
/*

Arduino Nano

Syed Muhammad Shariq

*/


#include <Servo.h> const int StartPin =2;  // Holding
Switch INPUT const int StopPin = 2;   // Holding
Switch INPUT
const int Inching = 3;


const int IRSensorPin = 5;  // IR Sensor INPUT

const int SensorSpare = 6;  // IR Sensor INPUT


const int ConveyourPin = 11;  // Conveyour Relay const int
Relay2 = 12;        // Conveyour Relay

const int ServoPin = 9;       // Servo Motor Pin


int Yellow = 130; int
Green = 170;

int Rejected = 150;


Servo Sorter;  // create servo object to control a servo

int tick = 0;


bool ON = LOW;

bool OFF = HIGH;


void setup() {    Serial.begin(9600);

  Sorter.attach(ServoPin);
```

```
 Sorter.write(Rejected);


 pinMode(StartPin, INPUT_PULLUP);  pinMode(StopPin,
INPUT_PULLUP);  pinMode(Inching, INPUT_PULLUP);
 pinMode(IRSensorPin, INPUT);


 pinMode(ConveyourPin, OUTPUT);  digitalWrite(ConveyourPin,
OFF);

 Serial.println("System OK");

}


void loop() {


 if (digitalRead(StartPin) == LOW) {
digitalWrite(ConveyourPin, ON);  while
(digitalRead(StartPin) == LOW) { if
(digitalRead(IRSensorPin) == LOW && tick == 0) {
digitalWrite(ConveyourPin, OFF);
      delay(100);
Serial.println("Check");

      tick = 1;
delay(250);      }
else {
      if (Serial.available() > 0) {          String Data
= Serial.readStringUntil('&')             if (Data ==
"Green") {           Sorter.write(Green);
digitalWrite(ConveyourPin, ON);
         delay(500);

         tick = 0;

        } else if (Data == "Yellow") {
Sorter.write(Yellow);           digitalWrite(ConveyourPin,
ON);
         delay(500);

         tick = 0;

        } else if (Data == "Reject") {
Sorter.write(Rejected);           digitalWrite(ConveyourPin,
ON);
```

```
        delay(500);
tick = 0;
        } else {
         Serial.println("Error");
tick = 0;
        }
       }
     }
   }
}
 else {
   if (digitalRead(Inching) == LOW) {
     digitalWrite(ConveyourPin, ON);
   } else {
     digitalWrite(ConveyourPin, OFF);
   }
 } }
```

## 5.6 Image Processing Code

Lemon Sorting Code (Hamdard University)

# Start Date: 10-01-2023.

Company: REX ENGINEERING SOLUTIONS

import cv2

Import numpy as np

Load the video capture object

cap cv2.VideoCapture (0) You can change the camera port here (e.gi aspect_ratiouser = 2.6

This variable is used to find contour in o

shape

contoursize - 2500

Size of Contour

while True:

ret, image cap.read()

Convert the frame to HSV color space hav cv2.cvtColor(image, cv2.COLOR_BGR2HSV)

Define the range of green color lower green (35, 43, 46)

upper green (77, 255, 255)

Create a mask for the green color range green_mask = cv2.inRange (hsv, lower green, upper green)

# Define the range of yellow color lower yellow (20, 100, 100)

upper yellow = (30, 255, 255)

Create a mask for the yellow color range yellow_mask = cv2.inRange (hsv, lower yellow, upper_yellow)

+ Combine the two masks combined_mask = cv2.bitwise or (green_mask, yellow_mask)

Define the range of brown color (represent rotting) lower_brown = (40,150, 80) upper_brown = (60, 255, 200)

# Create a mask for the brown color range

brown_mask = cv2.inRange (hsv, lower brown, upper_brown)

# Define the range of brown color (represent rotting)

lower black = (0, 0, 0)

upper black = (350, 100, 100)

• Create a mask for the brown color range black_mask cv2.inRange (hsv, lower black, upper_black)

+ Combine the two masks

rotting mask= cv2.bitwise or (brown mask, black_mask)

Lemon Sorting Code (Hamdard University)

# Start Date: 10-01-2023.

Author: Muhammad Taha.

Company: REX ENGINEERING SOLUTIONS

import cv2

Import numpy as np

Load the video capture object

cap cv2.VideoCapture (0) You can change the camera port here (e.gi aspect_ratiouser = 2.6

This variable is used to find contour in o

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while True:

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Convert the frame to HSV color space hav cv2.cvtColor(image, cv2.COLOR_BGR2HSV)

Define the range of green color lower green (35, 43, 46)

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Create a mask for the green color range green_mask = cv2.inRange (hsv, lower green, upper green)

# Define the range of yellow color lower yellow (20, 100, 100)

upper yellow = (30, 255, 255)

Create a mask for the yellow color range yellow_mask = cv2.inRange (hsv, lower yellow, upper_yellow)

+ Combine the two masks combined_mask = cv2.bitwise or (green_mask, yellow_mask)

Define the range of brown color (represent rotting) lower_brown = (40,150, 80) upper_brown = (60, 255, 200)

# Create a mask for the brown color range

brown_mask = cv2.inRange (hsv, lower brown, upper_brown)

# Define the range of brown color (represent rotting)

lower black = (0, 0, 0)

upper black = (350, 100, 100)

• Create a mask for the brown color range black_mask cv2.inRange (hsv, lower black, upper_black)

+ Combine the two masks

```
rotting mask= cv2.bitwise or (brown mask, black_mask)

# Draw the bounding box around the contour


cv2.rectangle (image, (x, y), (x+w, y + h), (255, 0, 0), 2)

# Print a label for the rotting lemon  cv2.putText (image, "Green Lemon", (x, y),
cv2.FONT_HERSHEY SIMPLEX,


0.5, (255, 0, 0), 2)


print ("Green")


# Show the image with the rotting lemons highlighted  cv2.imshow("Lemon
Sorting & Rotting detection", image)


#Break the loop if the 'q' key is pressed if cv2.waitKey (1) & 0xFF ord ('q'): break


# Release the video capture object cap.release()


# Close all the windows cv2.destroyAllWindows ()
```

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