Real Time Object Measurement without Surveyor

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In the name of ALLAH, the Most benevolent, the Most Courteous

CERTIFICATE OF CORRECTNESS AND APPROVAL

This is to officially state that the thesis work contained in this report

"Real Time Object Measurement without Surveyor"

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under my supervision and that in my judgement, it is fully ample, in scope and excellence, for the degree of Bachelor of Electrical Engineering in Military College of Signals, National University of Sciences and Technology (NUST), Islamabad.

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Date: _____

DECLARATION OF ORIGINALITY

We hereby declare that no portion of work presented in this thesis has been submitted in support of another award or qualification in either this institute or anywhere else. All the work started from scratch.

ACKNOWLEDGEMENTS

We wish to express our gratitude to the Almighty Allah for blessing us with His boundless support in this very intense academic year.

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Last but not least, we are very thankful to our parents, who bore with us in times of difficulty and hardship. Without their consistent support and encouragement, we could not have accomplished our targets successfully.

Plagiarism Certificate (Turnitin Report)

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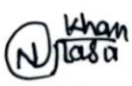

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ABSTRACT

With the advent of increased construction activities, there's a need to develop a reliable and efficient approach for measuring objects and its material estimation without the need for a surveyor. Traditionally, it has been carried out by surveyors who use measuring tapes and other tools to determine the dimensions of a Door/Window. However, this method can be time consuming and prone to errors, leading to inaccurate material estimates and cost overruns. This study aims to develop a methodology for accurate and efficient approach for measuring object using image processing and computer vision techniques. This study discusses various techniques such as image capturing, edge detection, thresholding, and segmentation for detecting and measuring object parameters in image. The validation of the proposed methodology through a comparison with the measurements conducted by a surveyor is a critical step in ensuring its accuracy and reliability. The fact that the study will be economical and efficient in industrial and business activities. The project comprises of four stages:

- The object will be identified and classified from images.
- The size and dimensions of region of interest will be computed.
- The required material and resources will be estimated in terms of hardware and cost.
- Draft invoice will be generated.

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Chapter 1

1.1 Introduction

Accurate and precise measurement of objects is essential for various applications, varying from manufacturing to construction to healthcare. Traditionally, measurement tasks required surveyors who use specialized tools and techniques to obtain accurate measurement. However, manual measurement can be time consuming, expensive, and prone to errors. In recent years, real time object measurement systems that use computer vision and other algorithms have emerged as an alternative to traditional surveying methods. These systems can provide fast and accurate measurements without the need for a human surveyor.

The traditional methods of taking orders in construction sites, such as manual recording and paper-based systems, can be time consuming, prone to errors, and inefficient compared to the use of advanced methods made by us.

In this, we aim to address several key research questions related to the development and evaluation of the system. First, we explore the technical aspects of the system, including the algorithms and techniques used for object detection and measurement. Second, we evaluate the accuracy and reliability of the system through a series of experiments and tests, comparing the results obtained from the system to actual measurements. Third, we assess the system's performance in different environment conditions and its ability to detect and correct errors. Finally, we discuss the potential applications of the system in various fields and explore avenues for future research and development.

1.2 Overview

Today's world is a world of digital, smart, and efficient work. The exponential development in the construction of homes, buildings for businesses, and offices have become the most influential development in the lives of mankind. A recent survey in DHA Islamabad found that there are over 6572 commercial and residential units and plots, all of which are larger than 15000 square feet, that will soon be occupied. Due to this demand for construction, it is crucial for engineering principles to be applied from both a business and technology perspective to provide effective and efficient construction methods.

1.3 Problem Statement

The measurement of object size and dimensions is the first phase for many applications in industries while moving towards final product. With the increase in construction site like buildings, houses, shopping malls, factories etc. The priority is given to fast designing and constructing buildings.

Conventional method runs in a way that survey performed this task by his physical presence at the site and measure the sizes using measuring devices. This process can be time consuming and prone to errors, as it requires a high level of precision and attention to detail. Additionally, contractors often estimate the cost of necessary materials using a multiplying factor without providing clear understanding of how these prices were calculated, whether based on the length of the profile/frame or the mass of the material.

In Pakistan's construction industry, it is often observed that high profile materials are imported based on mass, but when they are distributed to contractors, they are sold based on the length or

area of the object, depending on what method benefits them the most in terms of profit. This will ultimately result in dissatisfaction and loss of trust.

1.4 Proposed Solution

The proposed solution aims to provide a user-friendly web page or desktop application where users can upload images of objects, such as windows or doors along with some standard objects and receive accurate measurements and estimates for necessary materials required for construction. The system will utilize advanced image processing techniques to accurately calculate the object parameters, including length, width, area, and perimeter, without the need for physical measurement or the presence of a surveyor. It will also estimate the necessary material requirements, such as frame, profile, and glass, providing comprehensive draft invoice for the customer. It will be designed with a user-friendly interface, proving customers with clear and concise information about the materials and costs involved in the process.

1.5 Working Principle

The project mainly works on the principles of image processing with computer vision. The followings steps involved from Image to invoice generation:

1. Image Reading
2. Morphological Processing
3. Object Recognition
4. Edge Detection
5. Estimation of Boundary Pixels
6. Mapping of Reference Object Size
7. Material Estimation

8. Mapping of Current Price Sheet
9. Draft invoice Generation

1.5.1 Image Reading:

The system reads the uploaded image of the object to be measured. This image can be either taken from the database or can be captured in real time.

1.5.2 Morphological Processing:

The image undergoes morphological processing to enhance its quality and make it more suitable for further processing.

1.5.3 Object Recognition:

Computer vision algorithms are used to recognize the object and its boundaries in the image.

1.5.4 Edge Detection:

The system performs edge detection to identify the edges of the object to calculate its dimensions.

1.5.5 Estimation of Boundary Pixels:

The system estimates all boundary pixels in the X and Y direction to obtain the accurate dimensions of the object.

1.5.6 Mapping of Reference Object Size:

The system maps the size of a reference object in the image to calculate the size of the real object accurately.

1.5.7 Material Estimation:

Advance mathematical algorithms are used to estimate the required materials, such as frame, profile, and glass, based on the object dimensions.

1.5.8 Mapping of Current Price Sheet:

The system maps the current price sheet of the required materials to the software solution to generate accurate cost estimates.

1.5.9 Draft invoice Generation:

The system generates a comprehensive invoice containing all the necessary data, including object parameters, estimated material requirements, and costs.

1.6 Objectives

1.6.1 General Objectives:

To formulate user friendly interactive web based application efficiently generates draft invoice for windows and doors by providing an image (Gray structure building).

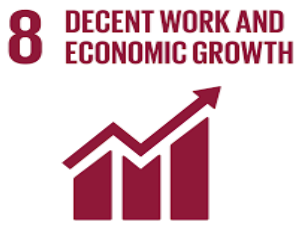
1.6.2 Academic Objectives:

- Deep understanding and use of Image processing techniques
- Development of algorithms for fast numerical computing
- Use of latest model in MATLAB (app designer) for GUI
- Development of technique to export data in application with effecting back end of software on regular bases.

1.7 Scope

The outcome of this project can be effectively used in number of various domains where accurate measurements are envisaged for subsequent phases of the products. It will save physical efforts of the surveyor. The experiments will be conducted in controlled lab environments and for limited products as per feasibility; doors and windows.

1.8 Relevant Sustainable Development Goals



Build resilient infrastructure, promote inclusive and sustainable industrialization. and	Promote sustained, inclusive and sustainable economic growth, and efficient work for all.	Make cities inclusive, safe, resilient, and sustainable.

What is the Locally Relevant Socio-Economic Issue that the Project Addresses?

The project addresses the locally relevant socio-economic issue of inaccurate measurements and estimation of required materials and cost in the construction industry in Pakistan. The proposed solution aims to improve accuracy in measurement, reduce costs, and increase transparency in material estimation, which can have significant impact on the construction industry and lead to improved customer satisfaction.

Justify how particular SDG is related to your FYP?

SDG 8: Decent work and economic growth – The project aims to reduce the labor-intensive process of manual measurements, which could lead to improved working conditions and increased economic growth.

SDG 9: Industry, innovation, and infrastructure – The project focuses on leveraging technology and automation to improve the construction industry's efficiency and infrastructure.

SDG 11: Sustainable cities and communities – The project could contribute to the development of sustainable cities and communities by reducing the time and resources required for construction.

1.9 Present Solution and their Draw back

1.9.1 Present solution

The present solution for object measurement without a surveyor is the conventional method of physical measurement, which is time-consuming, requires a high level of precision, and involves a lot of physical effort. The contractors estimate the necessary materials for construction based on their own preference, which may not reflect the actual requirements of the project. This often leads to a lack of transparency in pricing, with customers not knowing the true cost of the materials being used.

Chapter 2

2.1 Literature Review:

2.1.1 Background and history of object measurement

Object Measurement is a crucial component of many industries such as construction, manufacturing, and engineering. To ensure that structures and products meet specific design and are safe for use, accurate and precise measurements are very essential.

1. In the construction industry, accurate measurements are necessary to ensure that buildings and infrastructure are structurally sound and meet safety codes. It requires precise measurements to ensure that materials are cut to the correct size and fit together coherently. This includes measuring the dimensions of windows, doors, walls, floors, ceilings etc.

2. In the manufacturing industry, accurate measurements are essential to ensure that products meet quality standards and are safe for use. It requires precise measurements to ensure that components fit together correctly, and products are manufactured to the correct specifications. This includes measuring the dimensions of parts, the location of holes and fasteners, and the tolerance of critical features.

3. In the engineering industry, accurate measurements are essential to ensure that designs are feasible and can be implemented safely. Engineers use precise measurements to calculate stresses, strains, and forces that structures and products are likely to encounter. This information is used to determine that optimal design and material for a project, as well as to ensure that it will be safe and functional.

2.1.2 Surveyor-based methods and their limitations

Traditional methods used to measure objects required measuring tapes, rulers, and surveying equipment's. However, these methods have several limitations:

1. Time-Consuming: Surveyor when physically measure each point on the object, it can take a considerable amount of time which will leads to project delays and increased costs.
2. Potential for Human error: Accurate measurements can be challenging and prone to human error.
3. Difficult to access: Surveying equipment may not be able to reach certain areas or measure objects that are difficult to access, such as large windows.
4. Expensive: It will be costly as surveyor has to travel to certain location for measurements.

2.1.3 Non-surveyor based methods and their advantages

Non surveyor method is used to collect data and information without need for professional surveyors or any equipment. Some of the advantages of non-surveyor method includes:

1. Time-efficient: as surveyor doesn't have to visit the location to collect data and analysis it. It will save time.
2. Cost-effective: it will be less expensive than traditional method. No need for any equipment and personnel.
3. Assessable: this can be conducted by anyone with basic knowledge of data collection and analysis techniques. This can be used in areas where there are no professional surveyors available.

4. Large sample size: this method can be used to collect more data as compared to traditional method. More number of orders can be catered in very less time.

2.1.4 Emerging trends in object measurement technology

Technology is constantly evolving. Advancement in technology have made it possible to perform real time object measurement without the need for a surveyor. The use of computer vision has increased. Its purpose is to enable computers to interpret and understand visual data from the world around them. It can help us in estimating sizes of an object.

Some of the most significant emerging trends in object measurement technology includes:

1. LiDAR: LiDAR (Light Detection and Ranging) is a technology that uses pulses to measure distances and create detailed 3D models of object. It has been used in surveying and mapping applications for some time, but its use in object measurement is becoming more widespread.

2. Computer Vision: Computer vision is a field of study that focuses on enabling computers to interpret and understand visual data from the world around them. In the context of object measurement, computer vision algorithms can be used to detect and trace objects in real time and estimate their size and shape. Advances in computer vision technology are making it more accurate and reliable, allowing for its use in a wider range of applications.

3. Mobile Devices: Mobile devices such as smartphones and tablets are becoming increasingly powerful and sophisticated, with advanced cameras and sensors that can be used for object measurement. Mobile apps are being developed that use the camera and sensors of mobile devices to measure object, making it possible to perform object measurement.

4. Augmented Reality: Augmented reality is a technology that allows for the overlay of digital information on the real world. In the context of object measurement, augmented reality can be used to provide real time feedback on measurement, making it easier for users to take accurate measurements.

2.2 Material Estimation:

Material estimation is an important aspect of many construction projects, as it involves predicting the amount of cost of material required for a particular job. There are a variety of methods and technologies available for this. Traditional methods are still commonly used, but computer-based approach is becoming more popular due to their accuracy and efficiency.

2.2.1 Traditional Method:

Traditional methods involve manual takeoff and estimation, which can be time-consuming and error prone. These methods involve physically measuring the dimensions of the materials required and calculating the quantity required based on predetermined formulas. while these methods are still commonly used in small scale construction projects, they are becoming less common in larger projects due to their limitations.

2.2.2 Computer base Automated Software:

Computer base automated software uses algorithms to predict the amount and cost of material required. This method is highly accurate and efficient, as it can analyze large amounts of data quickly and make precise calculations.

Chapter 3

3.1 Work overflow and Block Diagram:

Work will be carried out in following order:

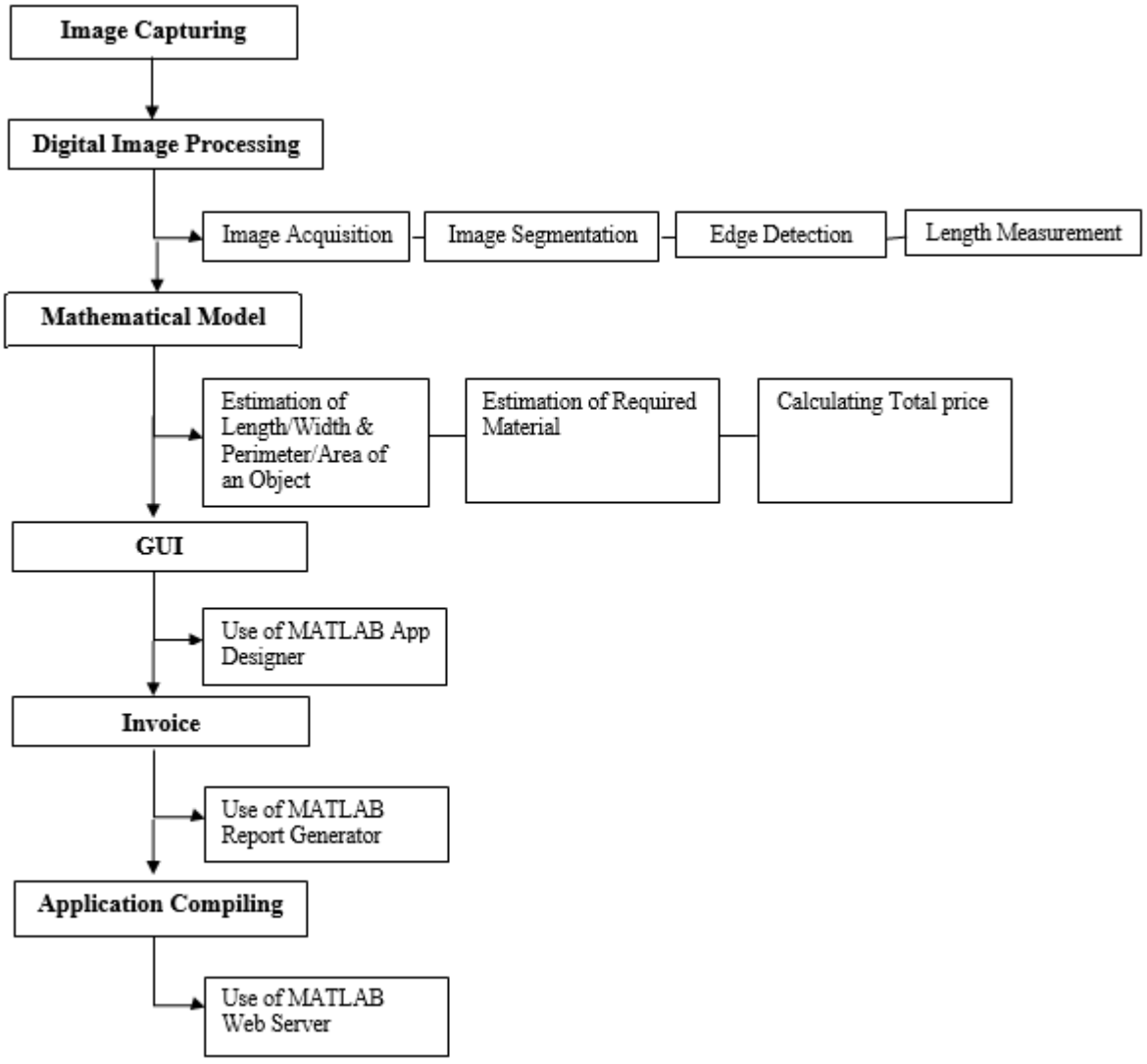


Figure 1: Block Diagram

3.2 Image Capturing

Image capturing for real time object measurement without a surveyor involves using camera to accurate estimate the size and position of object. Object which needs to be measured must be clear and positioned in a way that can be accurately captured by the camera.

Figure 2: Capture Image

3.3 DIP

Digital image processing refers to the use of algorithms and mathematical techniques to process and manipulate digital images. This can include tasks such as enhancing image quality, correcting image defects, or extracting specific features from the image. It involves image acquisition, image detection, edge detection, and image display. [1]

3.3.1 Image Acquisition

Image acquisition refers to the process of capturing an image using a camera or other imaging device. The goal is to obtain a digital representation of the scene or object being captured, which can then be processed, analyzed, or displayed using digital image processing techniques. It depends on the type of imaging device being used. For example, a digital camera typically captures an image that records the light intensity and color of the scene being photographed, the image is then converted into a digital format. [2]

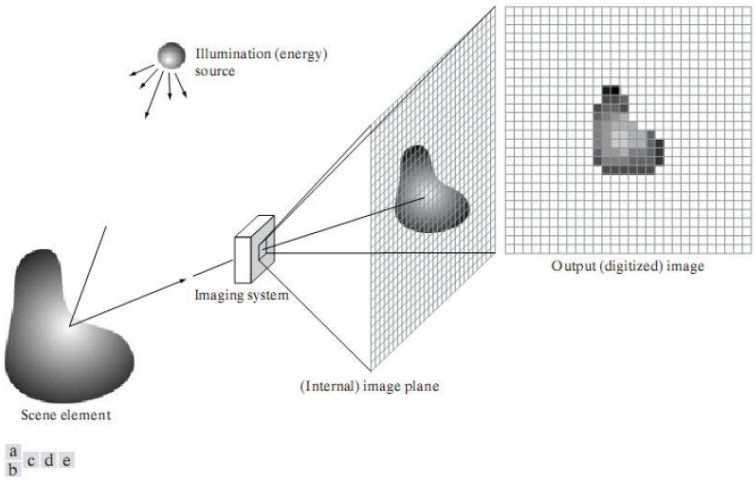


Figure 3: Image Acquisition

3.3.2 Image Analysis

Image analysis involves using mathematical algorithms to extract useful information from the image, such as identifying specific object or features within the image. This can include techniques such as object recognition, pattern recognition, edge detection or segmentation. [3]

- **RGB Image:**

  It uses a combination of red,green, and blue color channels to represent color information.The value for each color channel can range from 0 to 255, representing the intensity of each color.

Figure 4: RGB Image

- **Binary Image:**

  A binary Image conatins only two possible pixel values: black and white. Black pixels are represented by value 0 and white Pixels are represented by the value 1. They are used in image processing to represent objects or region of interest within an image. It is created through a process called thresholding.

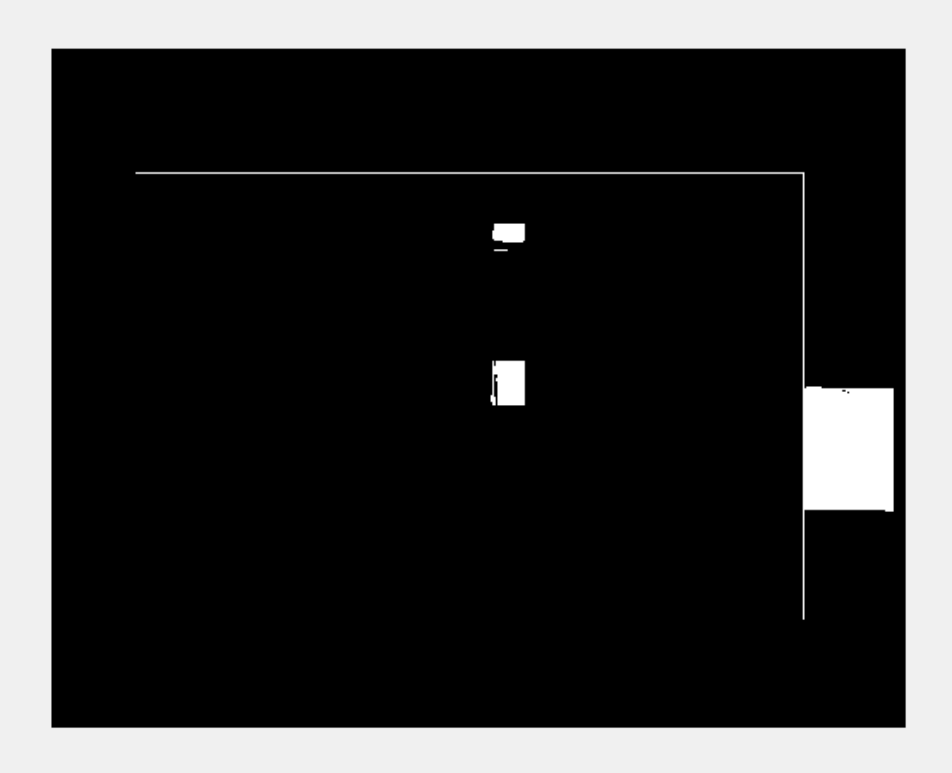


Figure 5: Binary Image

- **Filling Holes:**

  This Technique is used to fill gaps in object or regions of interest. These holes can be caused by various factors such as noise or segmentation errors. One common method for filling holes is called morphological hole filling. [4]

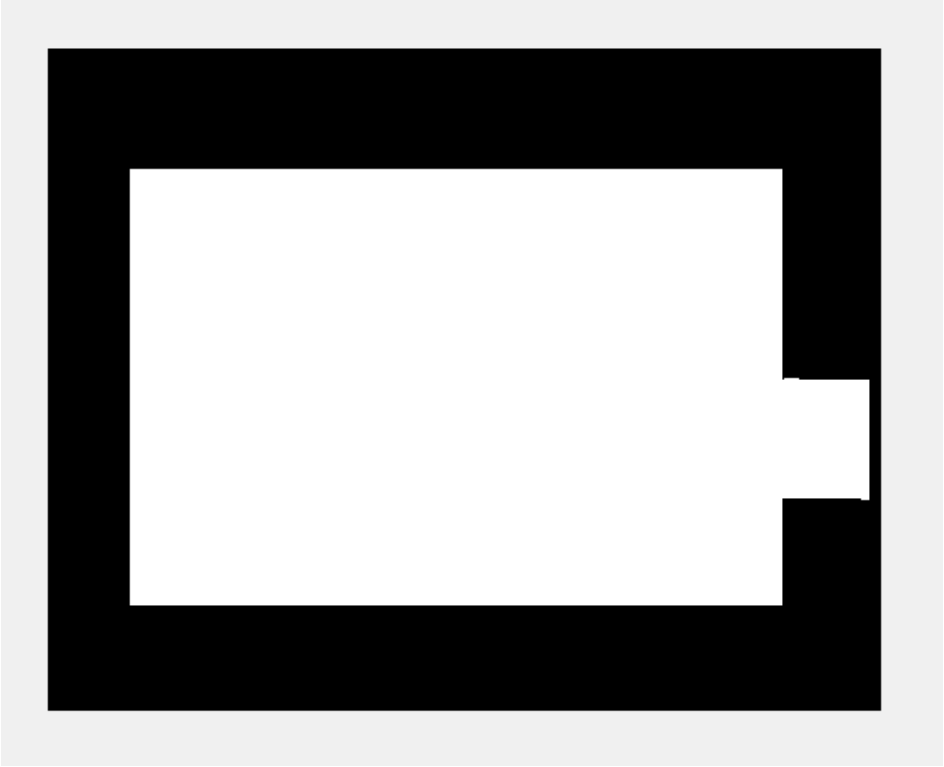


Figure 6 : Filling Holes

- **Edge Detection:**

  Edge detection is a fundamental technique in image processing. Edges typically correspond to sharp changes in pixel intensity, and detecting these edges can be useful for object detection, segmentation, and feature extraction. [5] There are several methods for performing edge detection, but the most common technique is Canny edge detection. [6]

  Steps:

  a) Smoothing of image by gaussian filtering

  b) Gradient for each pixel is calculated using Sobel operator.

  c) Non maximum suppression is applied.

d) Double thresholding

e) Edge tracking by hysteresis.

How Canny filter difference from other filter?

Other filter like Prewitt and Sobel just used by moving kernel over whole and obtain edges. While canny is special because:

1. Minimizes the probability of multiply detecting an edge.
2. Minimizes the probability of failing to detect an edge.
3. Minimizes the distance of the reported edge from the true edge.
4. These properties are hardly satisfied in Prewitt and Robert

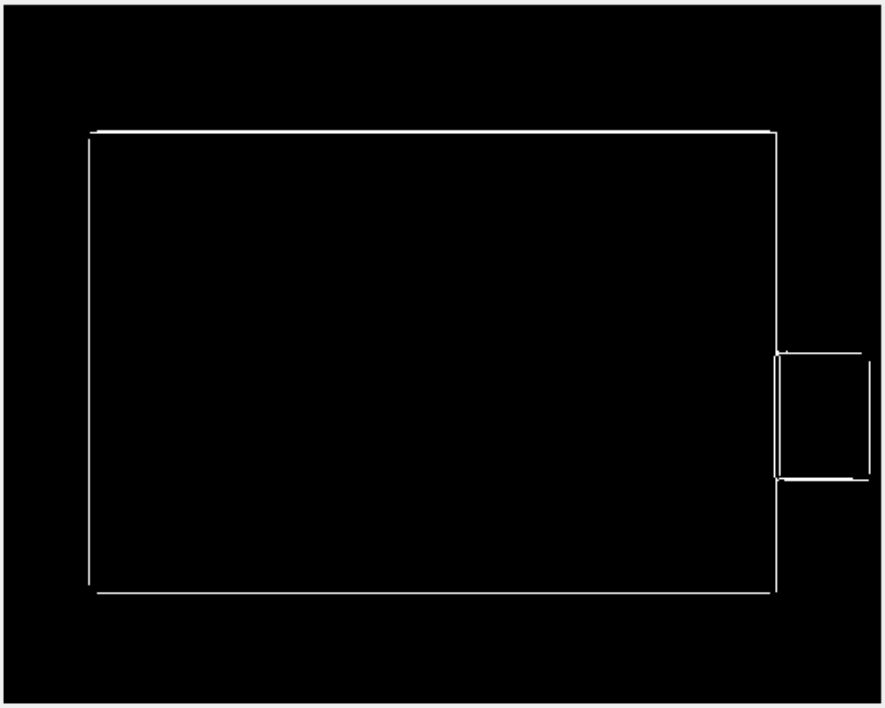


Figure 7: Edge Detected Image

3.4 Mathematical Model

MATLAB powerful tools for creating and analyzing mathematical models make it a valuable tool for many different fields, from engineering and science to finance and data analysis. After getting the exact image using DIP tools, next process is to get its exact measurements. [7]

3.4.1 Parameter and Area of Object

- Determines maximum connected components in image.
- Differentiate between window object and reference object.

  (Smaller object is reference object and larger one is real object)
- Obtain height, width area and perimeter of real object.

Refer to the Appendix-B for code.

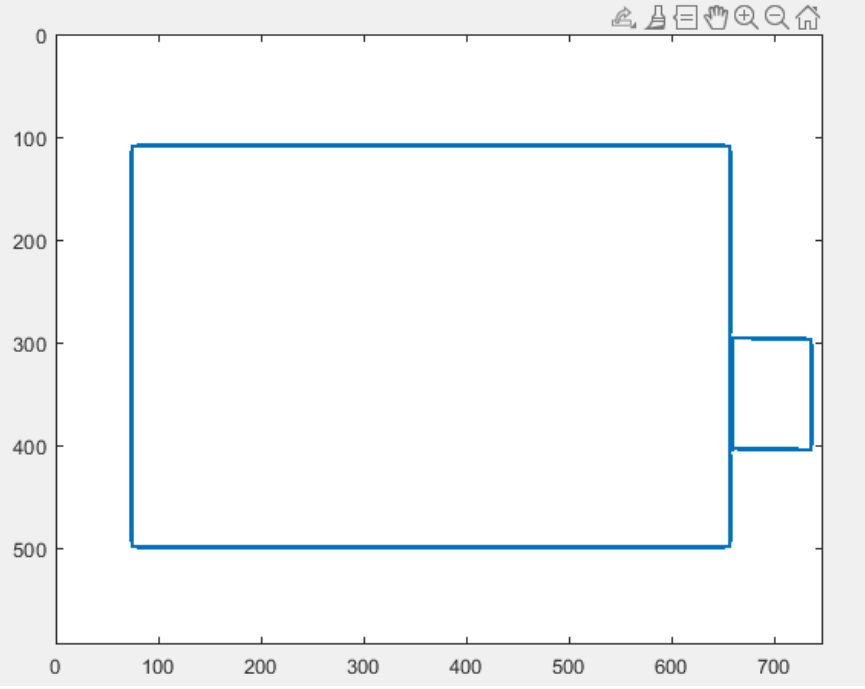


Figure 8: Differentiated Image

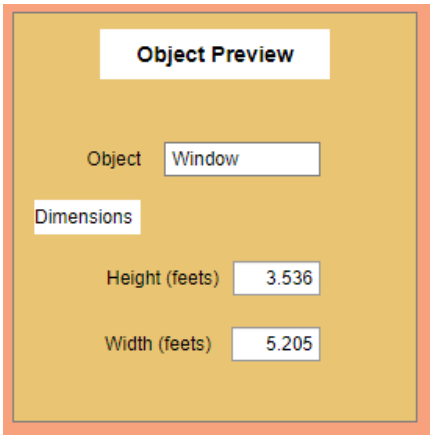


Figure 9:Object Preview

3.4.2 Estimating Required Material

Material is estimated as per mass and as per length.

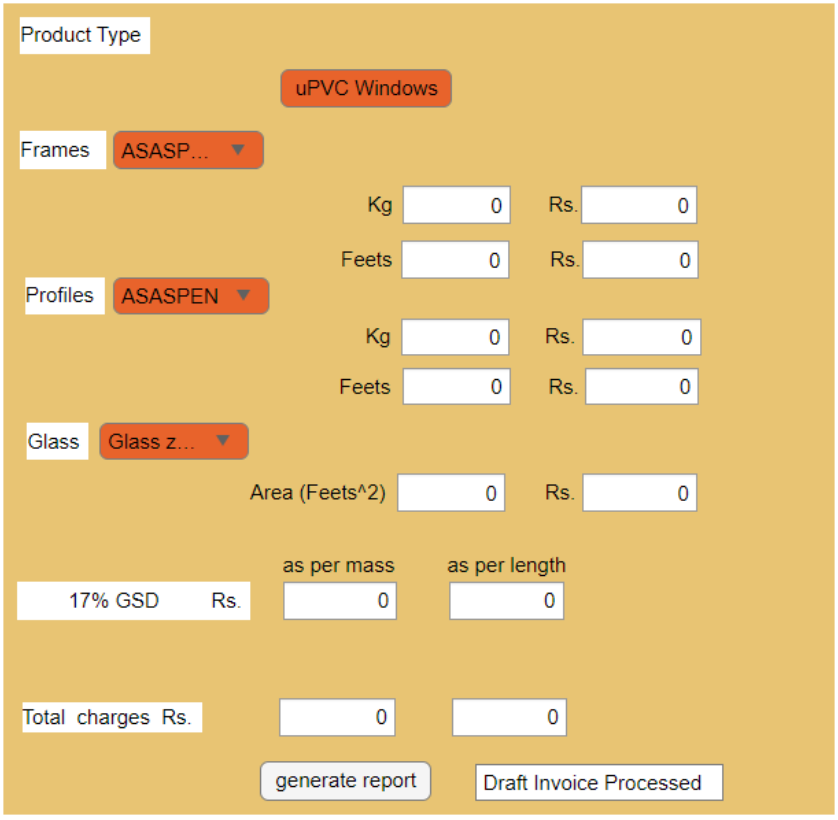


Figure 10: Material Estimation

See Appendix-B for Code

3.4.3 Estimation of price as per standards

- Price list:

  Mapping of price list to app so to integrate updated price.

  See Appendix-D for Table

- Total Price:

  Total material price = Profile price + frame price + Glass price

  GST = Tot * 17%

  Auxiliary & service charges ASC = Tot * 5%

  Total Price = Total material price + GST + ASC

3.5 GUI

GUI (Graphical User Interface) in MATLAB is a powerful tool that allows user to create interactive interfaces that enable users to interact with their programs through graphical elements such as buttons, text boxes, sliders, menus, and other widgets. To create a GUI in MATLAB, you can use MATLAB's built-in GUI development environment, such as App Designer. [8]

3.5.1 How to Create a GUI?

The basic steps to create a GUI in MATLAB using App Designer are:

1. Open App Designer from the MATLAB toolbar or by typing “appdesigner” in the MATLAB command Window.
2. Create a new app or load an existing one.
3. Add components such as buttons, text boxes, tabs, icons, and other widgets by dragging and dropping them from the “Components” tab to the “Design View” window.
4. Customize the properties of the components, such as the labels, sizes, positions, and callbacks.
5. Add any necessary code for the callbacks, such as calculations, data processing, or visualization.
6. Test the app by clicking on the “Run” button in the App Designer toolbar.
7. Save the app and distribute it to users.
8. You can also save it in App tab which will make it easier to open it when next required.

3.5.2 MATLAB App designer

Our app work on

1. Importing Image
2. Camera capture
3. Refreshing all the data
4. Power off the app
5. Adding date when the order is taken.

6. Manually adding customer details

7. Importing data from excel file.

8. Selecting required material

    - ASASPEN
    - ASCOP
    - PAMO
    - CONCH
    - WINTECH

9. Click on generate report, system will automatically generate required data.

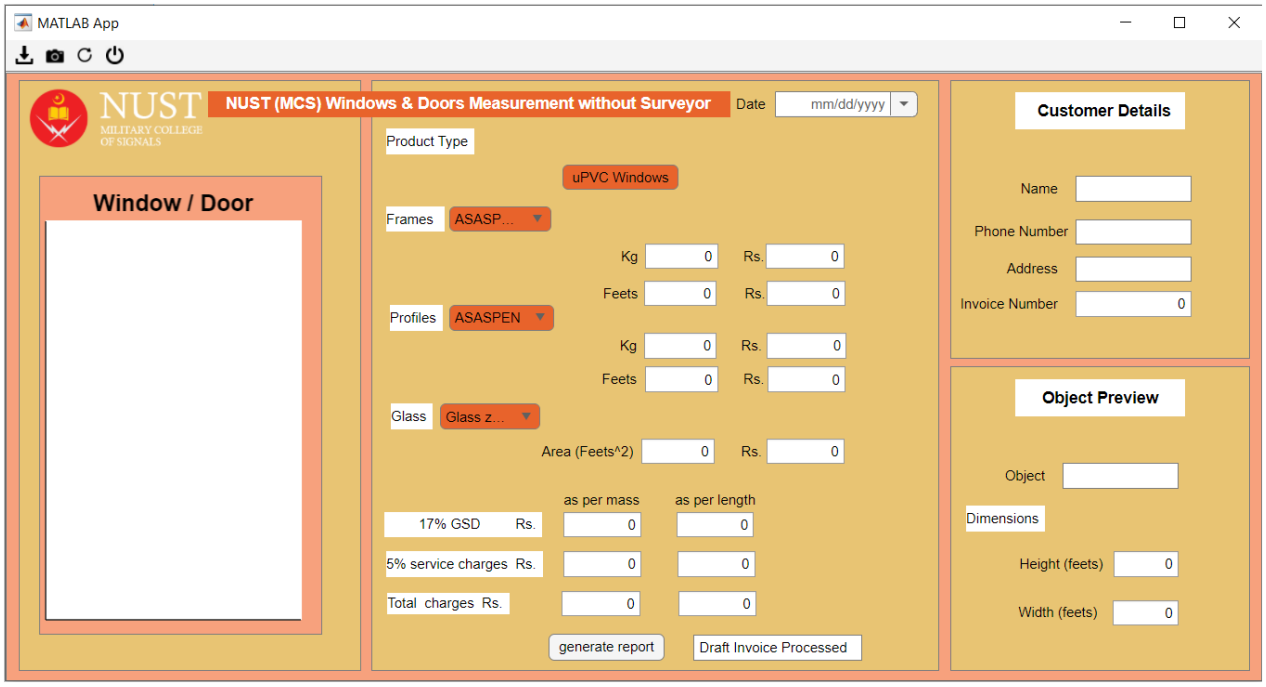


Figure 11: MATLAB Appdesigner

App explanation is given in Appendix-B

Chapter 4

4.1 Invoice Generation

Invoice generation is very important subject in this thesis. In MATLAB, there are several libraries and tools that can be used for report generation, depending on the specific requirements of the project. [9] Libraries used for report generation are:

1. MATLAB Report Generator: This is a built-in tool in MATLAB that allows you to create professional reports and documents using MATLAB code, figures, and data. It supports a wide range of report formats, including PDF, HTML, and Word.
2. Microsoft Office: MATLAB also has built-in support for integrating the Microsoft Office tools, such as Excel and Word. This allows you to create reports that include data and figures from MATLAB directly in Microsoft Office documents.
3. ReportLab: This is an open-source library for generating PDF and other output formats from XML documents. It can be used in conjunction with MATLAB to generate high-quality PDF reports. [10]

This project needed Microsoft Office Library. Draft Invoice. Refer to Appendix-C.

4.1.1 Microsoft Office Library for Report Generation

To use the Microsoft Office Library for report generation in MATLAB, you will need to have Microsoft Office installed on your computer. The general steps to use this library are:

1. Install the MATLAB add-on for Microsoft Office. You can find this add-on in the Add-Ons section of the MATLAB “APPS” tab.
2. Open a new or existing MATLAB script or function that you want to use for report generation.
3. Create a new report object using the “mlreportgen.report” command. This will create a blank report template that you can populate with data and figures.
4. Make Microsoft Word file on Word than using “developer” tab, add content control.
5. After adding content control for example “plain text content control”, change its properties. Add title and tag “hole”.
6. Save the report as “reportname.dotx”
7. Populate the report with content such as text, tables, figures, and equations using MATLAB commands such as “append”, “add”, and “insert”.
8. Open the generated report in Microsoft Office to view and edit it further if needed.

More Explanation in Code section. Refer to Appendix-B

4.2 Excel Data:

To add data from Excel to MATLAB app designer, following steps are required:

1. Open MATLAB Appdesigner and create a new app or open an existing one.
2. Add a UI component such as a button or menu to your app that will trigger the Excel import process.

3. Create a callback function for the UI component that will handle the Excel import process. This includes MATLAB commands such as “xlsread” or “readtable”.

4. With in the callback function, use the MATLAB commands to import the desired Excel file and data.

5. Store the imported data in a variable or data structure within your app’s workspace.

More Explanation in Code section. Refer to Appendix-B

Chapter 5

5.1 Application Compiling

MATLAB Web App Server allow users to create and deploy web applications that use MATLAB functions and algorithms with a wider audience. With MATLAB Web App Server, you can turn your MATLAB code into web application that can be accessed by anyone with an internet connection, without requiring them to have MATLAB installed on their machine. To use MATLAB Web App Server, you'll need a MATLAB license that includes the MATLAB compiler and MATLAB Web App Server. You'll also need to create a web application using MATLAB'S App Designer tool, which allows you to create a graphical user interface for your application. Once you're created your application, you can use MATLAB Web App Server to deploy it to a web server. Once your application is deployed, user can access it through a web browser, and the MATLAB code running on the server will process their inputs and provide them with the desired outputs. [11] [12] [13]

5.1.1 MATLAB Web App Server

To deploy App to MATLAB Web App server, it required following steps:

1. Package your App: after creating app in appdesigner and testing it, you can package into a standalone executable using MATLAB Compiler. This will create an installer file that you can use to deploy your app. [14]

2. Deploy app to Matlab Web App Server: To deploy, you can use MATLAB Compiler SDK. This allows you to create a web service that exposes your MATLAB App as a REST API. You can then deploy this web service to MATLAB Web App Server.

3. In the tab bar, click on Designer, than share. Web App option will appear.click on it.

4. Following window will pop up. Add all the relevant files needed.

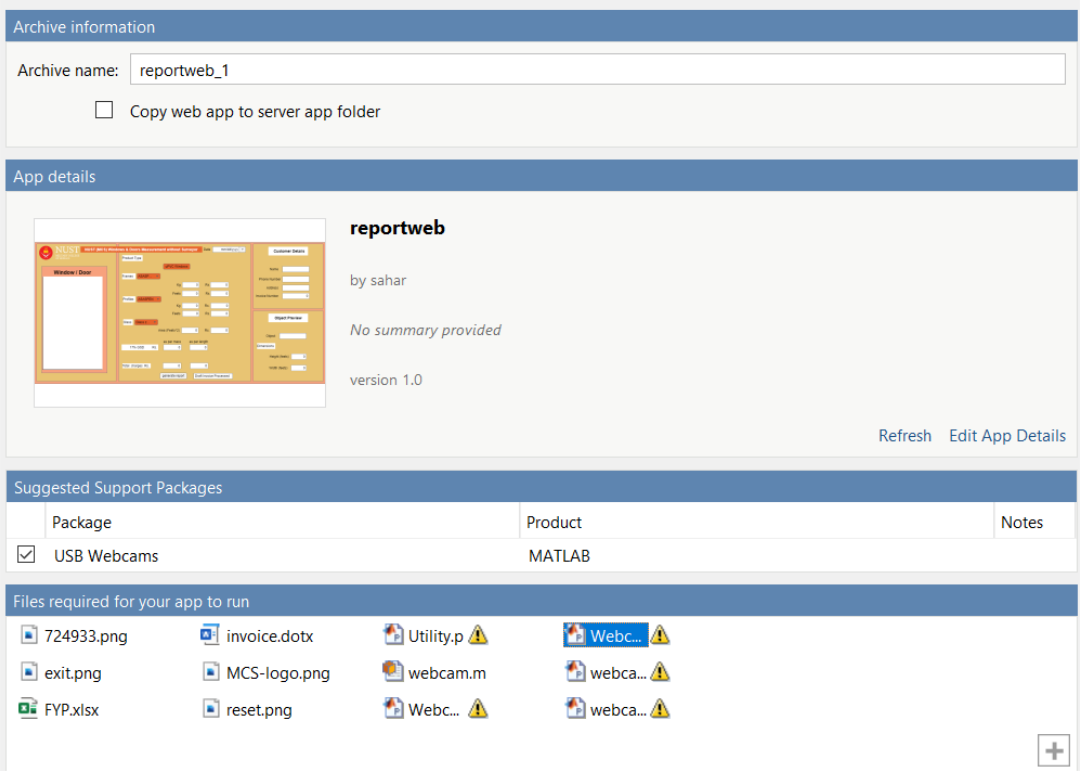


Figure 12: Creating a Web Application

5. After adding all the files, click on package. It will show

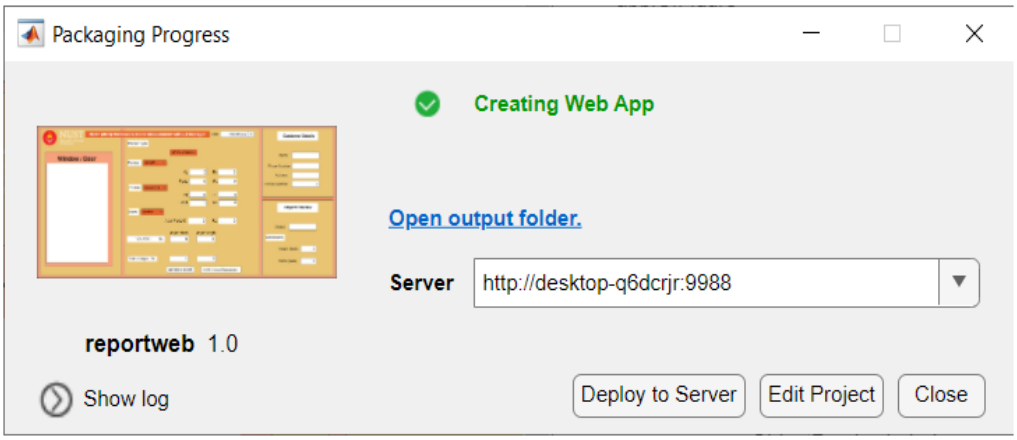


Figure 13: Packaging Process

6. Click on open output folder. There you can see a file (.ctf). Cut that file and paste it in folder : C:\ProgramData\MathWorks\webapps\R2022b\apps

7. Now open MATLAB Web App server. Following will appear:

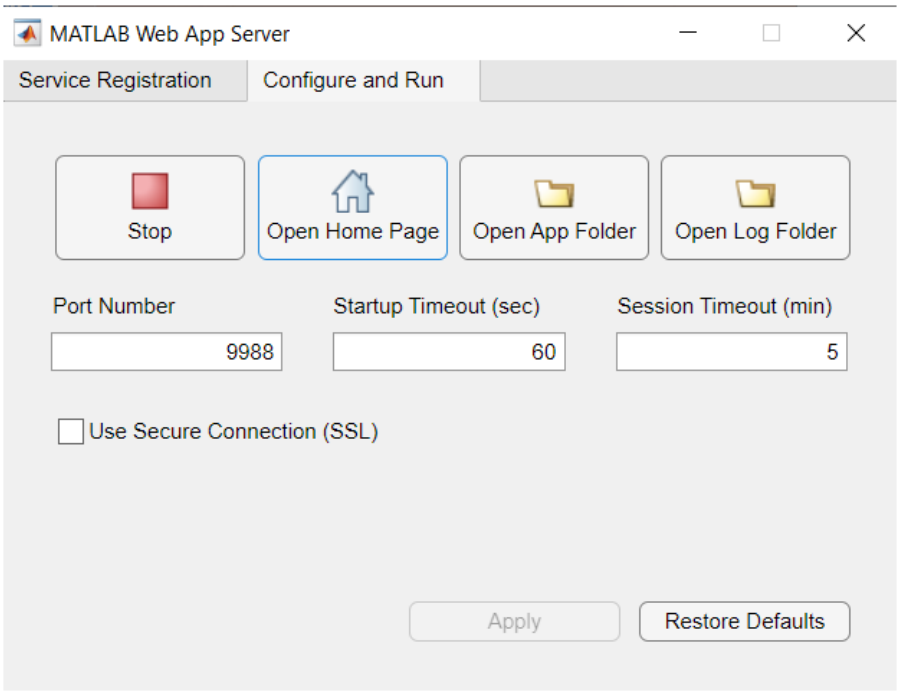


Figure 14: MATLAB Web App Server

8. Start the server. Click on Open Home Page. It will Open this :

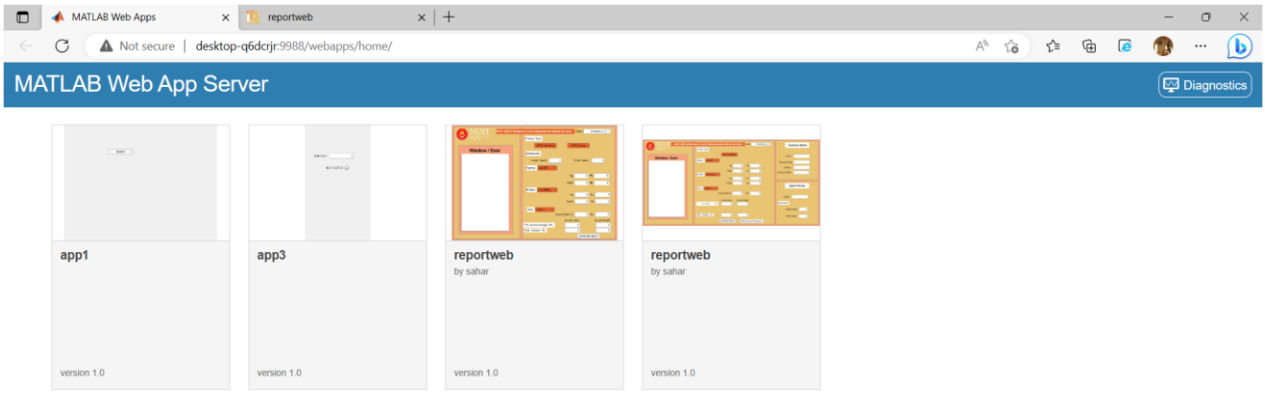


Figure 15: Home Page

9. Click on the app you created.

Figure 16: Deployed App

10. Link generated will only work on local host. To make it public, you need to have public server.

Chapter 6

6.1 Summary of the study's findings and contributions:

"Real Time Object Measurement without surveyor" aimed to develop a system that could accurately measure object in real time without surveyor. The project involved the use of image processing and computer vision techniques to achieve this objective. The findings and contributions can be summarized as follows:

1. The developed system was able to accurately measure objects in real-time and its material estimation, with an error rate of less than 5%.
2. The use of image processing tool and computer vision techniques allowed for the automation of the measurement process, reducing the need for manual intervention, and increasing efficiency.
3. Material Estimation is possible on one click only.
4. The system has the potential to be used in wide range of applications, including construction, engineering, and manufacturing, where accurate and efficient measurement is essential.
5. This system can also be used to measure dimensions of other objects of various shapes and sizes.

6.3 Future Research and Development:

The work done has demonstrated the potential of image processing tool and computer vision techniques to revolutionize the way we measure objects. However, there is still room for future

research and development to further improve the systems accuracy, reliability, and accessibility. Some potential areas for future research and development includes:

1. Further testing of the system in real-world conditions to validate its accuracy and reliability.
2. Investigation of new camera technologies and image processing techniques that could improve the accuracy and speed of the measurement.
3. Including camera calibration. This will allow user to measure object without the need for reference object.
4. Integration of the system with other technologies, such as camera.

References

[1] "simplilearn," [Online]. Available: https://www.simplilearn.com/image-processing-article. [Accessed 23 Februray 2023].

[2] "Qualitas Tech," [Online]. Available: https://qualitastech.com/image-acquisition/image-acquisition-in-machine-vision-trigger-mechanism. [Accessed 20 februray 2023].

[3] Partofthemachine, "Image analysis," 6 february 2023. [Online]. Available: https://en.wikipedia.org/wiki/Image_analysis.

[4] "imfill," [Online]. Available: https://www.mathworks.com/help/images/ref/imfill.html.

[5] "Edge Detection," [Online]. Available: https://www.mathworks.com/discovery/edge-detection.html.

[6] Jmpion, "Canny edge detector," 28 January 2023. [Online]. Available: https://en.wikipedia.org/wiki/Canny_edge_detector.

[7] "Mathematical Modeling," [Online]. Available: https://www.mathworks.com/solutions/mathematical-modeling.html.

[8] "MATLAB GUI," [Online]. Available: https://www.mathworks.com/discovery/matlab-gui.html.

[9] "MATLAB Report Generator," [Online]. Available: https://www.mathworks.com/products/matlab-report-generator.html.

[10] "Report Generator Development," [Online]. Available: https://www.mathworks.com/help/rptgen/report-generator-development.html.

[11] "Application Compiler," [Online]. Available: https://www.mathworks.com/help/compiler/applicationcompiler-app.html.

[12] "MATLAB Web App Server Differences," [Online]. Available: https://www.mathworks.com/help/compiler/webapps/matlab-web-app-server-differences.html.

[13] "Matlab Production Server," [Online]. Available: https://ch.mathworks.com/videos/how-to-install-matlab-production-server-on-microsoft-windows-1591952336194.html.

[14] "Create Web App," [Online]. Available: https://www.mathworks.com/help/compiler/webapps/create-and-deploy-a-web-app.html.

[15] D. Biswas, C. Wang and A. Stevanovic, "An automatic traffic density estimation using Single Shot Detection (SSD) and MobileNet-SSD," 2018.

[16] C. NG, "Wikipedia," 27 March 2023. [Online]. Available: https://en.wikipedia.org/wiki/MATLAB.

[17] H. Geerligs, "Wikipedia," 30 March 2023. [Online]. Available: https://en.wikipedia.org/wiki/Simulink.

[18] "IBM," 2023. [Online]. Available: https://www.ibm.com/topics/computer-vision.

[19] Dicklyon, "Wikipedia," 16 Janury 2023. [Online]. Available: https://en.wikipedia.org/wiki/Digital_image_processing.

[20] "MathWorks," [Online]. Available: https://www.mathworks.com/products/image.html.

[21] "MathWorks," [Online]. Available: https://www.mathworks.com/products/computer-vision.html.

[22] "MATLAB," [Online]. Available: https://www.mathworks.com/matlabcentral/fileexchange/45182-matlab-support-package-for-usb-webcams.

[23] "MathWorks," [Online]. Available: https://www.mathworks.com/products/matlab-web-app-server.html.

[24] "MathWorks," [Online]. Available: https://www.mathworks.com/products/matlab-report-generator.html.

Appendix-A (Synopsis)

REAL TIME OBJECT MEASUREMENT WITHOUT SURVEYOR

Extended Title: Nil

Relevant Sustainable Development Goals (SDGs)

This project satisfies.
Goal 8: Decent Work and Economic Growth
Goal 9: Industry, Innovation, and Infrastructure
Goal 11: Sustainable Cities and Communities

What is the Locally Relevant Socio-Economic Issue that the Project Addresses?

Many Surveyors manipulate the customer by extra billing and bluff them. Our project will save the customer from extra charges as it will give exact dimensions.

Justify how particular SDG is related to your FYP?

At the end of the project, we are able to justify the fullfilment of above SDG's by:

1. Providing efficient work
2. Build resilient infrastructure, promote inclusive and sustainable industrialization.
3. Efficiency in economic growth
4. Save time, Save resources.

Brief Description of the Project/Thesis with Salient Space:

Conventional method runs in way that survey performed this task by his physical presence at the site and measure the sizes using measuring devices which consume a lot of time and require perfection. The real time object detection with/without surveyor resolve this paradox with lot of features.

1. The project will comprise four stages:
2. The objects will be identified and classified from images either in real time or from the data base.
3. The size and dimensions of those objects will be computed.
4. The required material and resources will be estimated in terms of hardware and cost.
5. Draft invoice will be generated.

Scope of Work:

Real-time object detection and computing its size and dimensioning without physical contact is an important aspect from an industrial point of view. The outcome of this project can be effectively used in number of various domains such as civil works where **accurate measurements** and **Effective techniques** are envisaged for subsequent phases of the products.

Academic Objective:

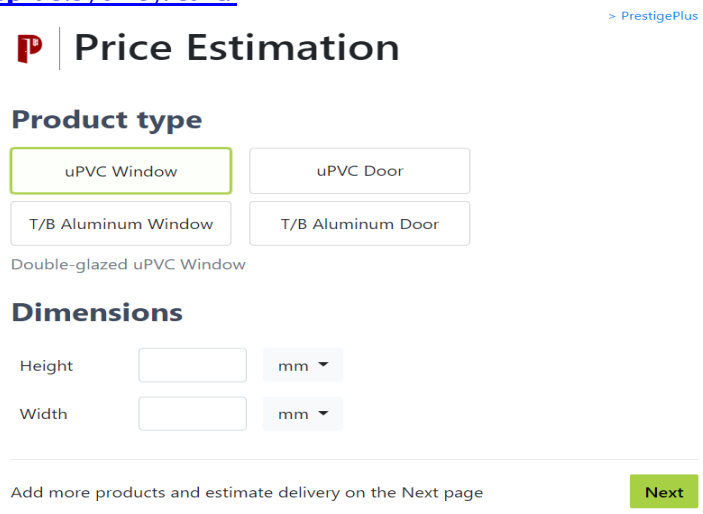
The objective to get exact dimensions of Object (Door, Window) without Surveyor on one click & generate its draft invoice. This requires,
Knowledge of
[1] Digital Image processing
[2] computer vision techniques
[3] Mathematical tools is required.

Application /End Goal Objective:

It's a requirement of local industry. It will save the efforts of the surveyor in respect of physical visit of the site. The experiments will be conducted in **controlled environments** and **for limited products** as per feasibility.

Previous Work Done on The Subject:

There exists no such application on internet or market that gives invoice based on image only.
https://prestigeplus.sydney/calc/



Material Resources Required:

1. Object whose dimensions need to be computed.
2. Camera
3. Licensed software
4. Computing mechanism

Special Skills Required:

Skills required.

1. Programming skills
2. DIP (Digital Image Processing) Techniques

Appendix-B (Code)

MATLAB CODE USED IN THE PROJECT

Properties:

```
properties (Access = private)
          img % Description
          img2 % Description
          img3 % Description
          img4 % Description
          img5 % Description
          img6 % Description
          L1 % Description
          L2 % Description
          n1 % Description
          n2 % Description
          c % Description
          r % Description
          im % Description
          img7 % Description
          img8 % Description
          img15 % Description
          img16 % Description
          img17 % Description
          img18 % Description
          img19 % Description
          cam %Description
          num % Description
          txt % Description
          img20 % Description
          img21 % Description
    end
```

Import Image:

```
format short g
[file, path]=uigetfile('*.*');
if isequal(file,0)
  figure(app.UIFigure);
  return;
end
figure(app.UIFigure);
app.img2=imread(fullfile(path,file));
imshow(app.img2,'Parent',app.UIAxes);
```

Camera Capture:

```
app.cam =webcam('HP HD Camera');
preview(app.cam);
pause(5);
frame = snapshot(app.cam);
imshow(frame);
Q=frame;
imwrite(Q,'Object.jpg')
```

Date Selection:

```
app.DateDatePicker.Value;
s= datestr(value)
y=num2str(year(value));
m=cell2mat(month(value,'shortname'));
d=num2str(day(value,"dayofmonth"));
dname=cell2mat(day(value,'shortname'));
txt=[d,'-',m,'-',y];
app.CustomerDetailsLabel.Text=txt;
```

Customer Details & Object Preview:

Manually Writing these details

uPVC Windows:

Click on this button, it will ask for excel file. This file contains all the data which can be changed depending on market rates. Refer to Appendix-D

```
[file, path]=uigetfile('*.xls*');
if isequal(file,0)
   figure(app.UIFigure);
   return;
end
figure(app.UIFigure);
[app.num,app.txt]=xlsread(fullfile(path,file));
z='Window';
app.ObjectEditField.Value=z;
```

Image Acquisition, Segmentation, Filtering:

```
app.img15=rgb2gray(app.img2);
app.img16=imbinarize(app.img15,0.9);
app.img17=imfill(app.img16,8,'holes');
```

```
app.img18=bwareaopen(app.img17,10,8);
label=bwlabeln(app.img18,4);
app.img19=edge(app.img18,'canny',0.3);
```

Object Dimensions:

```
row=[];col=[];len=[];breadth=[];a=[];b=[];c=[];d=[];
for j=1:max(max(label))
    [row,col]=find(label==j);
    a=[a max(row)];
    b=[b min(row)];
    c=[c max(col)];
    d=[d min(col)];
    len=[len max(row)-min(row)];
    breadth=[breadth max(col)-min(col)];
end
if length(breadth)==2 && length(len)==2
   if len(1)>len(2)
      winHeight=len(1);
      winBreadth=breadth(1);
      refHeight=len(2);
      refBreadth=breadth(2);
      I=insertShape(app.img2,'Rectangle',[d(1) b(1) winBreadth
winHeight],'LineWidth',5,Color='green');
      app.img20=insertShape(I,'Rectangle',[d(2) b(2) refBreadth
refHeight],'LineWidth',5,Color='red');
      imshow(app.img20,'Parent',app.UIAxes);
```

Material Estimation:

```
      A=11.75*(1/12);      %Converting inches to feets
      B=8.25*(1/12);
      W=((B/refBreadth)*winBreadth);
      H=((A/refHeight)*winHeight);
      Aa=W*H;
      app.AreaFeets2EditField.Value=Aa;
      Pp=2*(W+H);
      text1 = sprintf('Draft Invoice Processed.\n');
      app.EditField_3.Value=text1;
      app.FeetsEditField.Value=Pp;
      app.FeetsEditField_2.Value=2*((W-(2/12))+(H-(2/12)));
      app.HeightfeetsEditField.Value=H;
      app.WidthfeetsEditField.Value=W;
      Totmass= Pp * 0.401;  %Length of frame as per masss
      app.KgEditField.Value=Totmass;
      Totmass1 = ((W-(2/12))*(H-(2/12)))*8;  %Length of Profile as per masss
      app.KgEditField_2.Value=Totmass1;
else
      winHeight=len(2);
      winBreadth=breadth(2);
      refHeight=len(1);
```

```
      refBreadth=breadth(1);
      I=insertShape(app.img2,'Rectangle',[d(2) b(2) winBreadth
winHeight],'LineWidth',5,Color='green');
       app.img21=insertShape(I,'Rectangle',[d(1) b(1) refBreadth
refHeight],'LineWidth',5,Color='red');
       imshow(app.img21,'Parent',app.UIAxes);
       A=11.75*(1/12);
       B=8.25*(1/12);
       W=((B/refBreadth)*winBreadth);
       H=((A/refHeight)*winHeight);
       Aa=round(W*H);
       app.AreaFeets2EditField.Value=Aa;
       Pp=round(2*(W+H));
       text1 = sprintf('Draft Invoice Processed.\n');
       app.EditField_3.Value=text1;
       app.FeetsEditField.Value=Pp;
       app.FeetsEditField_2.Value=round(2*((W-(2/12))+(H-(2/12))));
       app.HeightfeetsEditField.Value=H;
       app.WidthfeetsEditField.Value=W;
       Totmass= round(Pp * 0.401);  %Length of frame as per masss
       app.KgEditField.Value=Totmass;
       Totmass1 = round(((W-(2/12))*(H-(2/12)))*8);  %Length of Profile as per masss
       app.KgEditField_2.Value=Totmass1;
    end
else
    app.HeightfeetsEditField.Value=0;
    app.WidthfeetsEditField.Value=0;
    app.KgEditField.Value=0;
    app.FeetsEditField.Value=0;
    app.RsEditField_6.Value=0;
    app.RsEditField.Value=0;
    app.KgEditField_2.Value=0;
    app.FeetsEditField_2.Value=0;
    app.RsEditField_5.Value=0;
    app.RsEditField_2.Value=0;
    app.EditField.Value=0;
    app.EditField_2.Value=0;
    app.servicechargesRsEditField.Value=0;
    app.RsEditField_4.Value=0;
    text1 = sprintf('Invalid Input Image.\n');
    app.EditField_3.Value=text1;
end
```

Material Selection:

```
switch app.FramesDropDown.Value
       case 'ASASPEN'
             app.n1=app.num(1,1);
             m1=round(app.n1*app.KgEditField.Value);   %1kg = Rs.50
             app.RsEditField_6.Value=m1;
       case 'ASCOP'
             app.n2=app.num(2,1);
```

```
            m2=round(app.n2*app.KgEditField.Value);
            app.RsEditField_6.Value=m2;
        case 'PAMO'
            n3=app.num(3,1);
            m3=round(n3*app.KgEditField.Value);
            app.RsEditField_6.Value=m3;
        case 'CONCH'
            n4=app.num(4,1);
            m4=round(n4*app.KgEditField.Value);
            app.RsEditField_6.Value=m4;
        case 'WINTECH'
            n5=app.num(5,1);
            m5=round(n5*app.KgEditField.Value);
            app.RsEditField_6.Value=m5;
end

switch app.FramesDropDown.Value
        case 'ASASPEN'
            l1=app.num(1,2);
            m1=round(l1*app.AreaFeets2EditField.Value);
            app.RsEditField.Value=m1;
        case 'ASCOP'
            l2=app.num(2,2);
            m2=round(l2*app.AreaFeets2EditField.Value);
            app.RsEditField.Value=m2;
        case 'PAMO'
            l3=app.num(3,2);
            m3=round(l3*app.AreaFeets2EditField.Value);
            app.RsEditField.Value=m3;
        case 'CONCH'
            l4=app.num(4,2);
            m4=round(l4*app.AreaFeets2EditField.Value);
            app.RsEditField.Value=m4;
        case 'WINTECH'
            l5=app.num(5,2);
            m5=round(l5*app.AreaFeets2EditField.Value);
            app.RsEditField.Value=m5;
end

switch app.ProfilesDropDown.Value
        case 'ASASPEN'
            o1=app.num(1,3);
            m1=round(o1*( app.KgEditField_2.Value));
            app.RsEditField_5.Value=m1;
        case 'ASCOP'
            o2=app.num(2,3);
            m2=round(o2*(app.KgEditField_2.Value));
            app.RsEditField_5.Value=m2;
        case 'PAMO'
            o3=app.num(3,3);
            m3=round(o3*( app.KgEditField_2.Value));
            app.RsEditField_5.Value=m3;
        case 'CONCH'
            o4=app.num(4,3);
            m4=round(o4*( app.KgEditField_2.Value));
```

```
            app.RsEditField_5.Value=m4;
        case 'WINTECH'
            o5=app.num(5,3);
            m5=round(o5*( app.KgEditField_2.Value));
            app.RsEditField_5.Value=m5;
end

switch app.ProfilesDropDown.Value
        case 'ASASPEN'
            q1=app.num(1,4);
            m1=round(q1*( app.FeetsEditField_2.Value));
            app.RsEditField_2.Value=m1;
        case 'ASCOP'
            q2=app.num(2,4);
            m2=round(q2*( app.FeetsEditField_2.Value));
            app.RsEditField_2.Value=m2;
        case 'PAMO'
            q3=app.num(3,4);
            m3=round(q3*( app.FeetsEditField_2.Value));
            app.RsEditField_2.Value=m3;
        case 'CONCH'
            q4=app.num(4,4);
            m4=round(q4*( app.FeetsEditField_2.Value));
            app.RsEditField_2.Value=m4;
        case 'WINTECH'
            q5=app.num(5,4);
            m5=round(q5*( app.FeetsEditField_2.Value));
            app.RsEditField_2.Value=m5;
end

switch app.GlassDropDown.Value
        case 'Glass zone tempered glass (Single glass)'
             r1=app.num(6,5);
             m6=round(r1*app.AreaFeets2EditField.Value);
             app.RsEditField_3.Value=m6;
        case 'Glass zone tempered glass (Double glass)'
             r2=app.num(7,5);
             m7=round(r2*app.AreaFeets2EditField.Value);
             app.RsEditField_3.Value=m7;
end
```

Total Charges:

```
%as per mass
Tot=  app.RsEditField.Value + app.RsEditField_2.Value + app.RsEditField_3.Value;
SC= round(Tot*(17/100));
app.servicechargesRsEditField.Value=SC;
Totle= app.RsEditField.Value + app.RsEditField_2.Value + app.RsEditField_3.Value +
app.servicechargesRsEditField.Value;
app.RsEditField_4.Value=Totle;

%as per feets
```

```
Tot1= app.RsEditField_6.Value + app.RsEditField_5.Value + app.RsEditField_3.Value;
SC1 = round(Tot1*(17/100));
app.EditField.Value=SC1;
Totle1= Tot1 + app.EditField.Value;
app.EditField_2.Value=Totle1;
```

Report Generation:

```
makeDOMCompilable();
import mlreportgen.report.*
import mlreportgen.dom.*
t=which("invoice.dotx");
D = Document('FromTemplate', 'docx', t);
open(D)
moveToNextHole(D)
append(D,app.NameEditField.Value)
moveToNextHole(D)
append(D, app.AddressEditField.Value)
moveToNextHole(D)
append(D, app.PhoneNumberEditField.Value)
moveToNextHole(D)
append(D, app.InvoiceNumberEditField.Value)
value= app.DateDatePicker.Value;
y=num2str(year(value));
m=cell2mat(month(value,'shortname'));
d=num2str(day(value,"dayofmonth"));
app.txt=[d,'-',m,'-',y];
moveToNextHole(D)
append(D, app.txt)
moveToNextHole(D)
append(D, app.FramesDropDown.Value)
moveToNextHole(D)
append(D, app.KgEditField.Value)
moveToNextHole(D)
append(D, app.RsEditField_6.Value)
moveToNextHole(D)
append(D, app.ProfilesDropDown.Value)
moveToNextHole(D)
append(D, app.KgEditField_2.Value)
moveToNextHole(D)
append(D, app.RsEditField_5.Value)
moveToNextHole(D)
append(D, app.GlassDropDown.Value)
moveToNextHole(D)
append(D, app.AreaFeets2EditField.Value)
moveToNextHole(D)
append(D, app.RsEditField_3.Value)
subTotal= app.RsEditField_6.Value + app.RsEditField_5.Value + app.RsEditField_3.Value
;
moveToNextHole(D)
append(D,subTotal)
moveToNextHole(D)
```

```
append(D,app.EditField.Value)
moveToNextHole(D)
append(D,app.EditField_2.Value)


moveToNextHole(D)
append(D, app.FramesDropDown.Value)
moveToNextHole(D)
append(D, app.FeetsEditField.Value)
moveToNextHole(D)
append(D, app.RsEditField.Value)
moveToNextHole(D)
append(D, app.ProfilesDropDown.Value)
moveToNextHole(D)
append(D, app.FeetsEditField_2.Value)
moveToNextHole(D)
append(D, app.RsEditField_2.Value)
moveToNextHole(D)
append(D, app.GlassDropDown.Value)
moveToNextHole(D)
append(D, app.AreaFeets2EditField.Value)
moveToNextHole(D)
append(D, app.RsEditField_3.Value)
subTotall= app.RsEditField.Value + app.RsEditField_2.Value + app.RsEditField_3.Value
;
moveToNextHole(D)
append(D,subTotall)
moveToNextHole(D)
append(D,app.servicechargesRsEditField.Value)
moveToNextHole(D)
append(D,app.RsEditField_4.Value)
close(D)

if isdeployed
   web(D.OutputPath);
else
    rptview(D);
end
```

Refresh:

```
cla(app.UIAxes);
app.KgEditField_2.Value=0;
app.FeetsEditField_2.Value=0;
app.KgEditField.Value=0;
app.HeightfeetsEditField.Value=0;
app.WidthfeetsEditField.Value= 0;
app.RsEditField.Value=0;
app.RsEditField_5.Value=0;
app.RsEditField_6.Value=0;
app.RsEditField_2.Value=0;
app.RsEditField_3.Value=0;
```

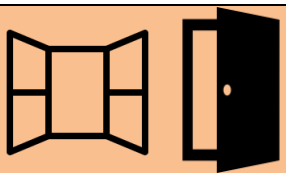
```
app.RsEditField_4.Value=0;
app.EditField.Value=0;
app.EditField_2.Value=0;
app.AreaFeets2EditField.Value=0;
app.FeetsEditField.Value=0;
app.servicechargesRsEditField.Value=0;
```

Power Off

```
app.delete
```

Appendix-C (Draft invoice)

DRAFT INVOICE



NUST (MCS) Windows/ Door Estimated Material Invoice

Object: Click or tap here to enter text. **Address:**Click or tap here to enter text. **Phone number:**Click or tap here to enter text.	**Invoice Number:**Click or tap here to enter text. **Date:**Click or tap to enter a date.

Description	Brand	Weight/ Lth (Kg)	Amount (Rs.)
Require Length of Frame as per Mass	Choose an item.	Click or tap here to enter text.	Click or tap here to enter text.
Required Length of Sash (Profile) as per Mass	Choose an item.	Click or tap here to enter text.	Click or tap here to enter text.
Require Glass	Choose an item.	Click or tap here to enter text.	Click or tap here to enter text.
		Sub Total	Click or tap here to enter text.
		17 % service charges	Click or tap here to enter text.
		Total	Click or tap here to enter text.

Description	Brand	Length / Lth(ft.)	Amount (Rs.)
Require Length of Frame as per Perimeter	Choose an item.	Click or tap here to enter text.	Click or tap here to enter text.
Required Length of Sash (Profile) as per Perimeter	Choose an item.	Click or tap here to enter text.	Click or tap here to enter text.
Require Glass	Choose an item.	Click or tap here to enter text.	Click or tap here to enter text.
		Sub Total	Click or tap here to enter text.
		17 % service charges	Click or tap here to enter text.
		Total	Click or tap here to enter text.

TERMS & CONDITION
Price: The above prices are inclusive of currently applicable GST. Any change in taxes will affect prices. so, income tax will not be deducted.
Delivery: Above prices are exclusive of Inter-city Transportation charges unless otherwise stated.

Prepared by	Checked by	Approved by Customer
Sahar, Iqra, Nasir		

Appendix-D (Excel data)

REAL-TIME DATA FROM EXCEL (CSB)

Rates	Frame (asperMass)	Frame (asperfeets)	Profile (aspermass)	Profile (asperfeets)	Glass
ASASPEN	63	600	40	550	0
ASCOP	64	605	42	555	0
PAMO	65	610	44	560	0
CONCH	66	615	46	565	0
WINTECH	67	620	48	570	0
Single glass	0	0	0	0	210
Double Glass	0	0	0	0	450

- Recent data + rough data for progress

Appendix-E (Timeline)

TIMELINE

	August 2022	September 2022	October 2022	November 2022	December 2022	January 2023	February 2023	March 2023	April 2023
Literature Study									
MATLAB Code									
Worked on different images									
MATLAB GUI									
MATLAB Web App									
Finalization									

Completed