Ryerson University

**Department of Electrical, Computer, & Biomedical Engineering**
Faculty of Engineering & Architectural Science

| | |
|---|---|
| **Course Title:** | Intro to Computer Vision |
| **Course Number:** | CPS 843 |
| **Semester/Year (e.g.F2016)** | F2023 |

| | |
|---|---|
| **Instructor:** | Dr. Guanghui (Richard) Wang |

| | |
|---|---|
| *Assignment/Lab Number:* | Project |
| *Assignment/Lab Title:* | Detection of objects and finding their dimensions project |

| | |
|---|---|
| *Submission Date:* | 11/20/2023 |
| *Due Date:* | 11/20/2023 |

| Student LAST Name | Student FIRST Name | Student Number | Section | Signature* |
|---|---|---|---|---|
| Butt | Ibrahim | 500967416 | 1 | I.B |
| Siraj | Muhammad Ahmed | 500855878 | 1 | M.A.S |
| Kanagarajah | Akash | 500966409 | 1 | A.K |

*By signing above you attest that you have contributed to this written lab report and confirm that all work you have contributed to this lab report is your own work. Any suspicion of copying or plagiarism in this work will result in an investigation of Academic Misconduct and may result in a "0" on the work, an "F" in the course, or possibly more severe penalties, as well as a Disciplinary Notice on your academic record under the Student Code of Academic Conduct, which can be found online at: http://www.ryerson.ca/senate/current/pol60.pdf

# Table of Contents

1) Project title, group number, group members and the role of each member. .....2

2) A brief introduction to the problem and the chosen algorithm(s) or model(s) for the project. .....3

3) A description of the project's objectives. .....3

4) The experimental methodology, including datasets, evaluation metrics, and other relevant aspects. ...3

5) The current status of your project. .....7

6) A timeline outlining your projected milestones leading to project completion and submission .....8

## 1) Project title, group number, group members and the role of each member.

**Title:** Object dimensions parameters calculations based on its shape

**Ibrahim Butt: Data Scientist - Focus on Dataset Collection and Preprocessing**

- Dataset Collection: Responsible for gathering and curating a comprehensive dataset that includes a wide range of object shapes. This dataset should cover various geometries and should be extensive enough to train the machine learning model effectively.
- Data Preprocessing: Involves cleaning the data, handling missing values, and performing any necessary transformations to make the data suitable for training the model.
- Data Augmentation: Implement techniques to augment the dataset, especially for custom-defined shapes, to ensure robustness in the model.
- Initial Data Analysis: Conduct preliminary analysis to understand the characteristics of the data, which will guide the model development process.

**Ahmed Siraj: Machine Learning Engineer - Focus on Model Development and Training**

- Model Selection: Choose appropriate machine learning algorithms for both shape recognition and dimension measurement tasks.
- Model Development: Develop and code the machine learning models, ensuring they are well-suited to the task at hand.
- Model Training and Validation: Train the models using the prepared dataset, fine-tune hyperparameters, and validate the model's performance to ensure accuracy and reliability.
- Integration of Shape Recognition and Dimension Measurement: Ensure seamless integration of the two phases of the model for efficient and accurate processing.

**Akash Kanagarajah: Application Developer and Tester - Focus on Implementation and Testing**

- Application Development: Develop an application or interface that utilizes the machine learning model. This could involve creating a user interface for data input (like images of objects) and output (displaying the recognized shape and its dimensions).
- Testing and Quality Assurance: Rigorously test the application in various scenarios to ensure its reliability and accuracy. This includes testing for different shapes, sizes, and in different environmental conditions.
- Feedback Loop Integration: Implement a system for collecting feedback on the model's performance, which can be used for continuous improvement.

- Documentation and Reporting: Prepare comprehensive documentation on the application's usage and maintain reports on the testing outcomes and model performance.

## 2) A brief introduction to the problem and the chosen algorithm(s) or model(s) for the project.

**Introduction to the Problem**
The project at hand addresses a critical challenge in the realm of automated object recognition and measurement, which finds significant applications in various industries such as medical diagnostics and electronics manufacturing. The core objective is to develop a system capable of accurately identifying the shapes of objects and subsequently determining their dimensions based on their classified shape. This process is not only pivotal in quality control and diagnostic procedures but also in enhancing the efficiency and accuracy of automated systems in these sectors.

## 3) A description of the project's objectives.

Pioneering an automated system for object recognition and measurement, this project draws inspiration from modern iPhones' augmented reality-based measuring apps. Our approach simplifies the process significantly: users only need to upload an image, eliminating reliance on AR. The system we designed identifies various object shapes within these images and accurately determines their dimensions. The capability we discuss holds transformative potential for sectors such as medical diagnostics and electronics manufacturing, which necessitate precise measurement processes. With a clear objective to amplify efficiency and accuracy in quality control and diagnostics beyond existing technological boundaries, this project aims for high adaptability: an ability to recognize--and measure—a broad spectrum of specifically defined shapes; it further pursues scalability at its core. The system, upon detecting these shapes, will meticulously calculate their dimensions by leveraging advanced machine learning models; this innovative approach promises a more accessible and user-friendly alternative to AR-based measuring tools. It aims to make advanced measurement technology readily available to a broader audience.

## 4) The experimental methodology, including datasets, evaluation metrics, and other relevant aspects.

**Experimentation strategy:**

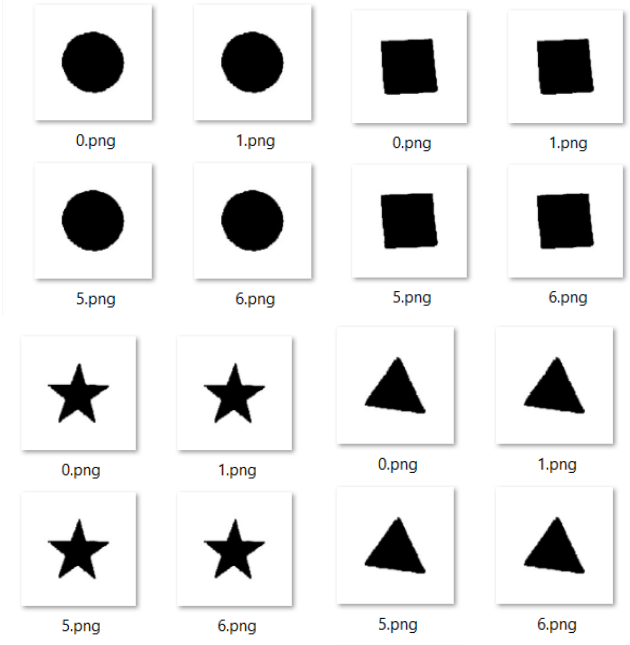
The process is divided into two steps. The first step is the recognition of object shapes and classifying them into different categories. The second step is finding different dimensions of the objects based on their classification. For example, if the object is circular, then dimensions of interest would be radius, diameter etc. and if it’s rectangular then length and width of its sides are required. The more advanced, flexible and scalable version of this application would be to register other specifically defined shapes which

are fed into the machine learning model for training and their specific dimension parameters are also defined. When that shape is detected then the algorithm looks for its class and whichever class it belongs to, the dimension parameters would be calculated.

**Dataset collection:**

The simple shapes were used to develop the algorithm which can detect different shapes and based on the shape, the dimensions will be calculated.

**Snapshot of sample data set:**



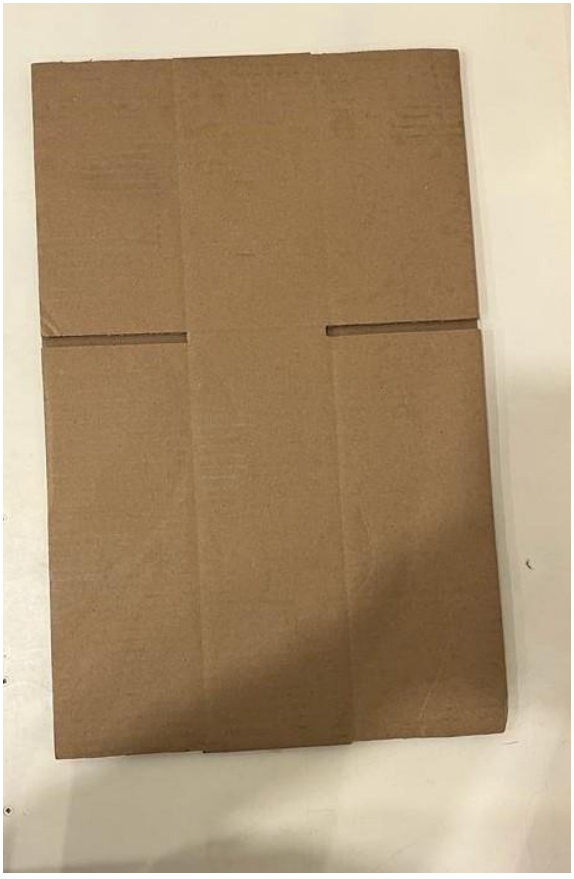

Algorithm accuracy with this sample dataset:

```
Found 44 images belonging to 4 classes.
Epoch 1/10
2/2 [==============================] - 1s 42ms/step - loss: 2.6476 - accuracy: 0.2727
Epoch 2/10
2/2 [==============================] - 0s 87ms/step - loss: 4.3546 - accuracy: 0.3182
Epoch 3/10
2/2 [==============================] - 0s 44ms/step - loss: 1.0285 - accuracy: 0.7727
Epoch 4/10
2/2 [==============================] - 0s 88ms/step - loss: 1.7787 - accuracy: 0.5682
Epoch 5/10
2/2 [==============================] - 0s 43ms/step - loss: 1.4673 - accuracy: 0.4773
Epoch 6/10
2/2 [==============================] - 0s 85ms/step - loss: 0.6673 - accuracy: 0.5909
Epoch 7/10
2/2 [==============================] - 0s 90ms/step - loss: 0.6914 - accuracy: 0.5909
Epoch 8/10
2/2 [==============================] - 0s 101ms/step - loss: 0.5664 - accuracy: 0.6818
Epoch 9/10
2/2 [==============================] - 0s 43ms/step - loss: 0.3631 - accuracy: 0.9545
Epoch 10/10
2/2 [==============================] - 0s 94ms/step - loss: 0.3774 - accuracy: 0.9091
```

**Dimension calculations of shapes:**

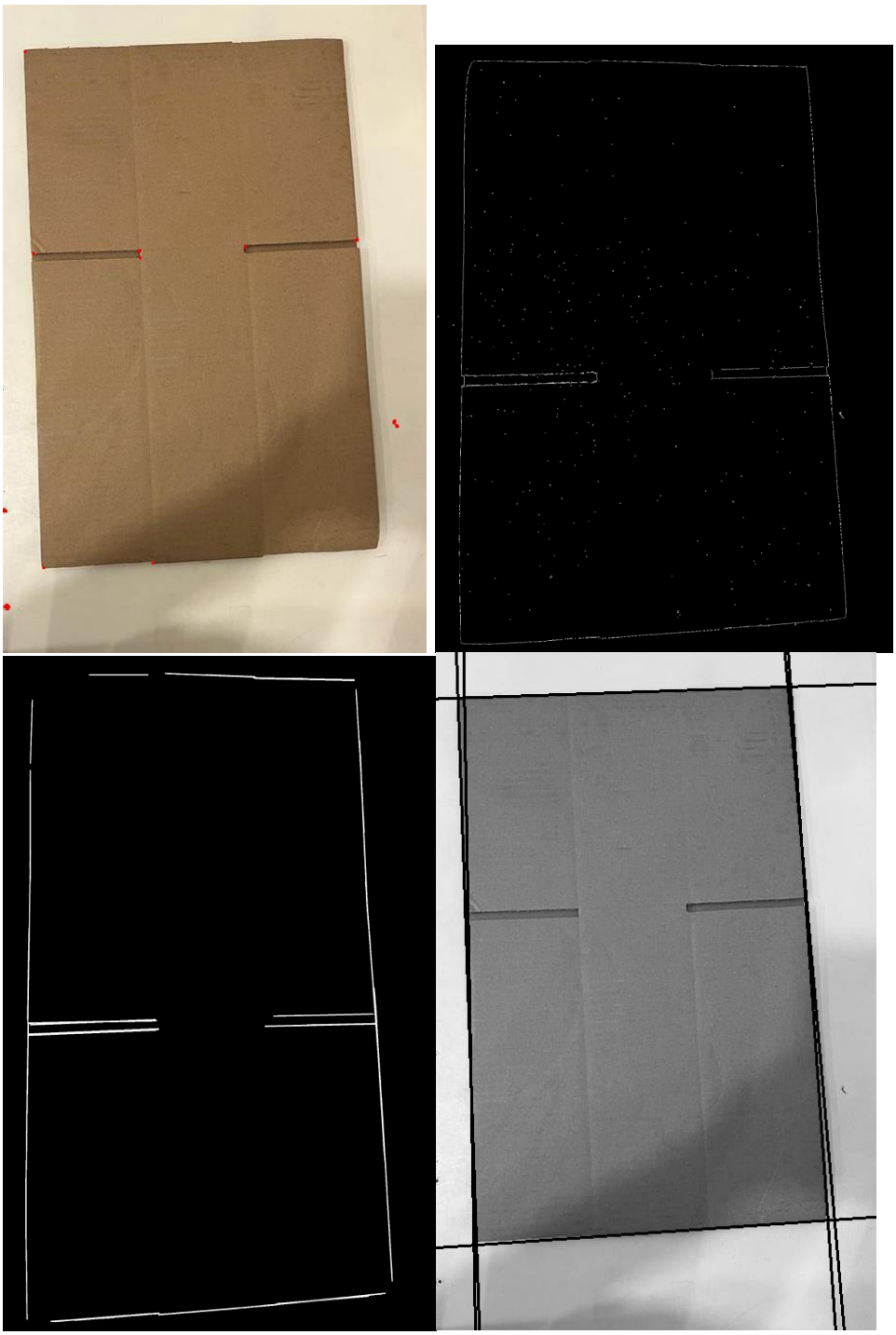
In parallel, we are creating an algorithm which uses edge detection techniques to identify the boundaries of the shapes then the dimensions would be calculated.

**Sample data:**



**Edge detection output:**

Sobel, Laplacian, Harris corner, and Gaussian edge detection techniques are used to highlight the boundaries of the shapes like cardboard, phone, capacitor etc. The next step is to identify the coordinates of the corners and using the Euclidean formula, the distance between different coordinates would be calculated and after scaling, the dimensions of sides (length, width) would be calculated.



**Applications:**

In the medical industry, the detection of lesions or any other damaged part in the body can be easily identified and based on the size or dimensions, it can be categorized for analysis. This model can be used by chip manufacturers for validation of different components integrated together on one board. The camera could be placed on top of

the conveyer belt and it can capture the chip board components shapes and dimensions and compare it with the standard values. This way any component whose physical orientation like shape or size gets altered in the manufacturing phase due to any process can be detected. For example, some capacitors get burned due to excessive heat in the fabrication process and thus their shape and size changed.

## 5) The current status of your project.

**What's done:**

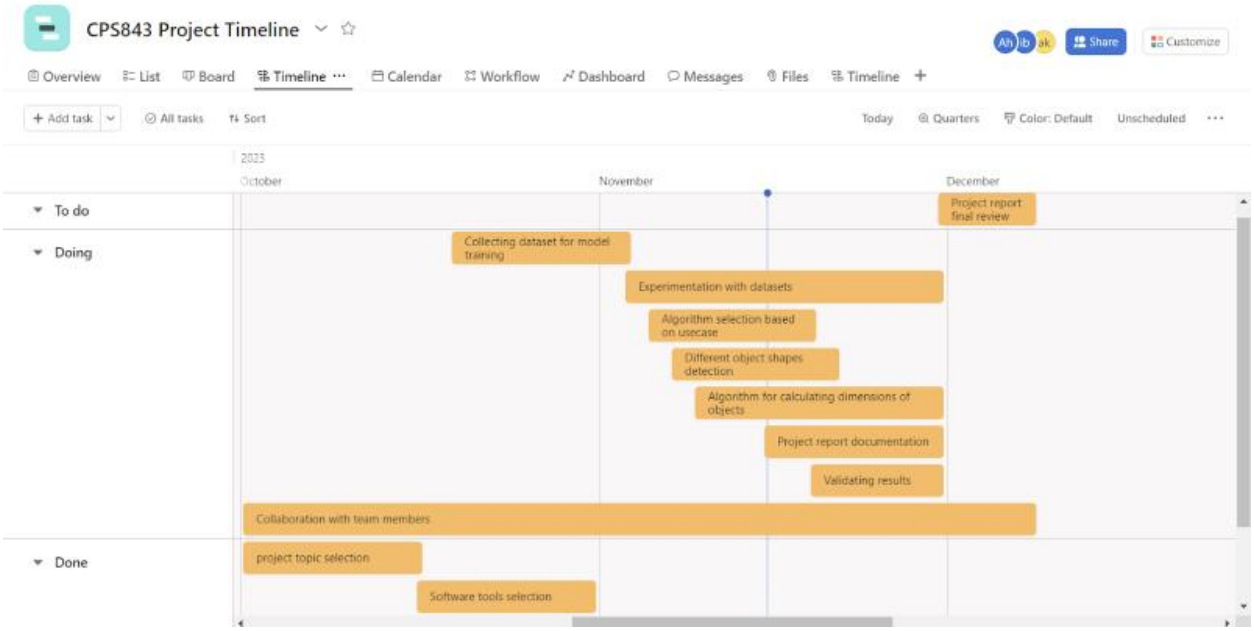
The shape detection model is developed, and the accuracy is tested by employing a test dataset. On the other hand, the edge detection method is used, and the algorithm is developed to identify the boundaries of the shapes.

**What's Underway:**

We are currently working on the model for detecting shapes to improve the accuracy of it. For the dimension calculations, different techniques are being used to get the coordinates of the corners of the shape and once it is identified, the dimensions can be easily calculated.

## 6) A timeline outlining your projected milestones leading to project completion and submission

**Project Timeline:**




**Project Board:**