CHAPTER 5
MEASURING DIAMETER OF REAL OBJECTS THROUGH MARKER CALIBRATION

Suriati Sadimon and Muhamad Musadiq Muhamad Aizudin

5.1 INTRODUCTION

The growth of computer technologies has provided a platform for enhancing image processing techniques, specifically aimed at measuring an object's diameter using a camera. With the improvement of technology in computer vision (CV) and deep learning over the years, researchers have been trying to simplify human tasks by enabling machines to understand our world through cameras. Nowadays, CV can successfully perform tasks such as handwriting recognition, object classification, and measuring an object's distance through a camera

When dealing with three-dimensional objects in the real world, CV faces inherent limitations. Humans have two eyes, which enable us to perceive the depth of objects and locate them naturally. In contrast, most computer vision applications rely on a single camera to capture and interpret the environment using only the X- and Y-axes. The absence of the third dimension, the Z-axis, which conveys depth between objects, significantly limits the performance of these systems. An image captured by a digital camera provides some sense of object locations within a scene and the relative positions of objects. However,

without depth information, it is difficult to draw accurate conclusions about object locations and linear measurements.

The CV algorithms struggle to determine depth in the third dimension, whereas humans can perceive it effortlessly. Depth provides critical information for achieving precise results. For instance, to accurately represent a scene, a CV algorithm must identify which objects are closer to the camera and which are farther away. To transform how people interact with technology in the near future, depth sensing must be combined with two-dimensional imaging to capture the complete information of the real world.

Marker calibration serves as a foundational method in the realm of image measurement. By employing specific markers—distinctive patterns or shapes placed within the scene of interest—users can establish reference points that facilitate accurate dimensional analysis. These markers enable the system to determine spatial relationships and measurements by providing a known scale and orientation. In the context of diameter measurement, marker calibration allows for precise calculations by correlating the physical dimensions of the markers to their representations in the captured images. This process not only simplifies measurement tasks but also improves the overall accuracy and reliability of the data collected, making it an essential technique for any project involving dimensional analysis through image processing.

5.2 UNDERSTANDING THE BASICS

This section presents the image processing techniques and related works on methods to calibrate a single camera with markers to detect the depth of an object.

5.2.1 Image Processing Pipeline

Image processing is a process of manipulating images through several steps, as shown in Figure 5.1, to achieve the desired result. (Bhurke et al., 2015). Image acquisition is the process of obtaining images, which

can be a still image, a series of images, or video, to be used as input. It can be performed by capturing photos using cameras or importing existing images from devices. After that, image pre-processing will be performed on the acquired image. Image pre-processing is an operation of altering the nature of the image captured by converting the image into a greyscale image to differentiate the depth, applying blur, and filtering to reduce the noise in the image. Then, edge detection is applied to enhance the visual clarity of an image by highlighting its borders.

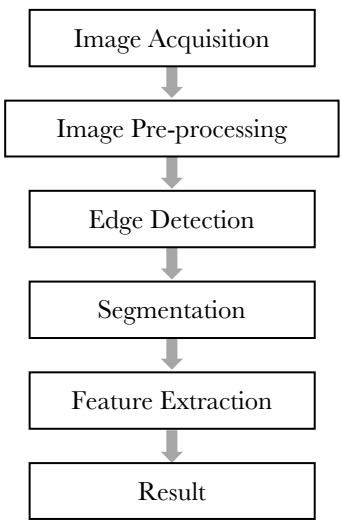

Figure 5.1 Image processing pipeline

Image segmentation is the process of partitioning a digital image into multiple segments where every pixel in the image is given its own label according to some characteristics and is grouped. To extract information from the image, the process of feature extraction is applied to represent the important data of an image captured.

5.2.2 Image Segmentation

Image segmentation involves partitioning a digital image into multiple regions to create a simplified representation that is easier to analyse by converting it into something meaningful (Pal & Pal, 1993). Image