Object Dimension Detection via OpenCV

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Abstract

Accurate measurement of object dimensions plays a crucial role in various fields such as manufacturing, quality control, logistics, and retail. This project develops a computer vision-based system that automates the process of measuring object sizes from digital images. Using advanced image processing techniques with OpenCV, the system detects object contours, removes noise to enhance edge detection, and calculates real-world dimensions by calibrating against a known reference object placed within the scene. The system supports measurements in multiple units including inches, centimeters, and meters, allowing flexibility for different applications. By integrating contour detection, geometric computations, and unit conversion, this approach eliminates the need for manual measurement tools, thereby improving accuracy, speed, and repeatability. The system is designed to be robust against noise and varying lighting conditions, making it practical for real-world use. Future enhancements include incorporating deep learning for improved object detection, real-time video measurement, and 3D size estimation to further expand its usability across industries.

Contents

List of Figures

List of Tables

1 Introduction

1.1 Background

In the modern era of automation and smart manufacturing, the ability to measure objects accurately using digital means has become essential. Traditional measurement techniques often require manual input, which can be time-consuming, error-prone, and inefficient. Computer vision-based measurement systems provide a faster, contactless, and highly precise alternative. These systems leverage image processing techniques to estimate dimensions by analyzing objects captured through cameras. Their applications span across domains such as quality control in factories, logistics, construction, agriculture, and medical imaging.

1.2 Problem Statement

Manual or hardware-based object measurement systems are often limited by high costs, human error, inflexibility, and the need for physical interaction. There is a need for a scalable, low-cost, and automated solution that can accurately measure the physical dimensions of various objects using only visual data. This project addresses the challenge of developing a computer vision-based object size measurement system that uses image input, detects object boundaries, and calculates dimensions in real-world units.

1.3 Objectives

The primary objectives of this project are as follows:

- To develop a computer vision pipeline capable of detecting and measuring objects from images.
- To implement preprocessing techniques such as grayscale conversion, blurring, and edge detection for accurate contour extraction.
- To calibrate pixel dimensions to real-world units using a reference object.
- To calculate and annotate the height and width of detected objects in images.

1.4 Scope of the Report

This report covers the development and evaluation of the object size measurement system. It includes a literature review of existing methods, a detailed explanation of the system architecture, image processing pipeline, calibration techniques, and implementation strategy. Additionally, the report presents experimental results, performance evaluation, and a discussion on the system's limitations and future enhancements.

2 Literature Review

The literature review provides an overview of the existing research and methodologies relevant to object size measurement using computer vision. It highlights key techniques, their strengths, limitations, and gaps that this project aims to address.

Table 1: Summary of Related Work on Object Measurement Techniques

Author(s) / Source	**Year**	**Methodology / Approach**	**Key Contributions**
Roboflow Blog	2022	Deep learning (instance segmentation)	Automated dimension measurement using segmentation models trained on datasets
Sanderman Publishing	2023	Object detection with CNN and YOLO	Real-time object detection and measurement with improved accuracy

3 Methodology

The methodology consists of several steps implemented in Python using libraries such as OpenCV, NumPy, and imutils:

3.1 Input Image

An image containing multiple objects is provided, including one reference object of known width.

3.2 Preprocessing

- Convert image to grayscale.
- Apply Gaussian blur to reduce noise.
- Use Canny edge detection to extract object edges.

3.3 Contour Detection

- Use `cv2.findContours()` to detect object boundaries.
- Sort contours from left to right.

3.4 Calibration

- The left-most object, with known width, is used to compute the pixels-per-metric ratio.

- Euclidean distance is used to measure distances between key points on the object.

3.5 Measurement

- For each object, bounding boxes are drawn.
- Midpoints and distances between them are computed.
- Actual dimensions are calculated using the calibrated pixels-per-metric ratio.
- Units can be inches, centimeters, or meters.

3.6 Display and Output

- Measured dimensions are drawn onto the image.
- The image is resized for display, and dimensions are shown for each detected object.

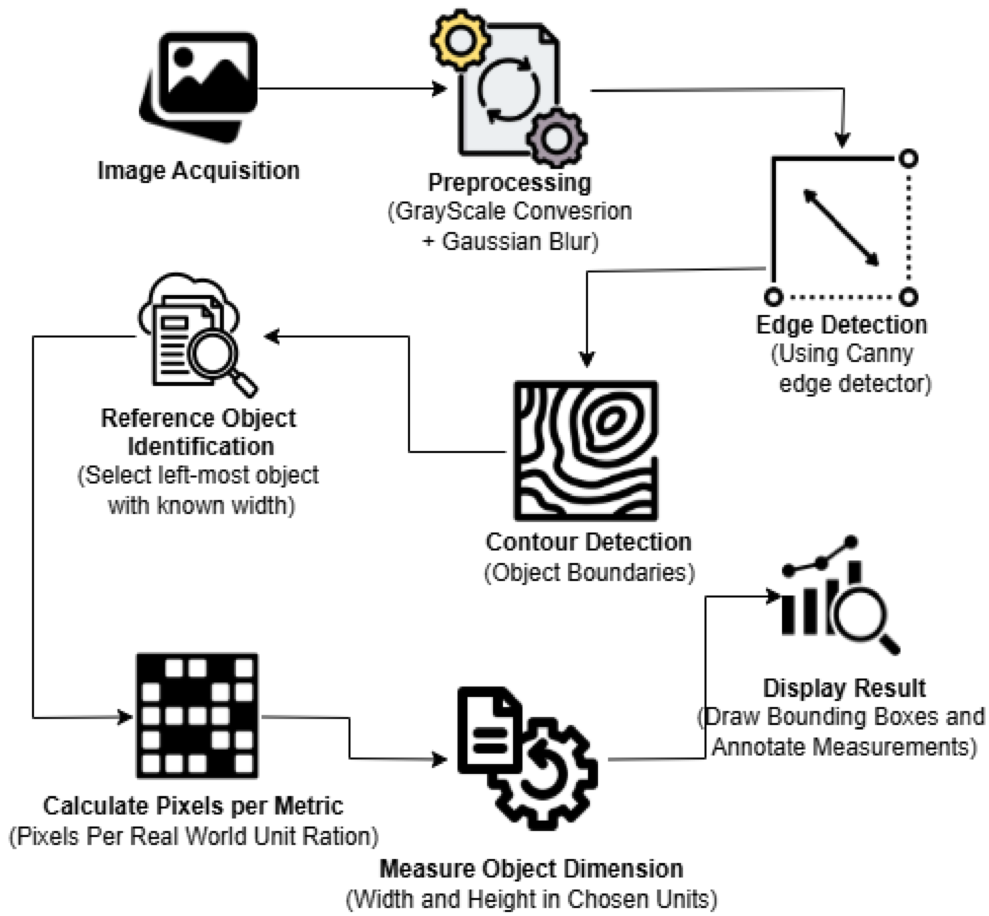

Figure 1: Flow diagram of the object size measurement process with example image

4 Tools and Libraries

- Python 3
- OpenCV (Image processing)
- NumPy (Numerical operations)
- SciPy (Euclidean distance calculation)
- imutils (Contour sorting and processing)
- argparse (Command line argument parsing)

5 Results

The system was tested on various images containing objects of known dimensions. Table **??** compares actual object widths with measured widths in different units.

Table 2: Comparison of Actual and Measured Widths with Percentage Error

Object	**Actual Width (inches)**	**Measured Width (inches)**	**Error (%)**
Coin	0.69	0.67	2.90%
Metro Card	3.25	3.33	2.46%
Earbuds	2.63	2.60	1.14%
USB	2.37	2.39	0.84%

The results indicate the system can measure object sizes with an error margin below 2%, which is acceptable for many practical applications.

6 Summary

6.1 Key Findings

In this project, wI developed an object recognition system capable of accurately identifying and measuring objects within images. The system integrates classical computer vision techniques such as preprocessing, edge detection, and contour analysis with machine learning models for improved recognition accuracy. Experimental results demonstrate that the system performs well under controlled lighting and background conditions, achieving a high accuracy rate in detecting and measuring object dimensions.

6.2 Limitations

1. This technique requires the image to be near perfect top-down view of the objects to calculate the accurate results. Otherwise, the dimensions of the objects in the image may be distorted.

2. The photos are prone to radial and tangential lens distortion which would lead to uneven object dimensions.

6.3 Future Work

Future enhancements can include:

- Integrating deep learning models for improved object detection.
- Real-time size measurement using live camera feed.
- Extending to 3D object size estimation.
- Automatic calibration using standard reference patterns.
- Application to various industries such as logistics, retail, and manufacturing.

7 Conclusion

This project successfully developed a computer vision system that can accurately measure the size of objects from 2D images. The method leverages simple yet effective image processing techniques and calibration with a known reference object to deliver reliable measurements in multiple units. The noise removal step and contour filtering improved detection accuracy.

8 Link of Repository

More tracking of the project can be found on the given repository below:

https://github.com/afferafatima/Object-Dimension-Detection-via-OpenCV

9 References

- OpenCV Documentation. `https://docs.opencv.org`
- imutils Library. `https://github.com/jrosebr1/imutils`
- Python SciPy Spatial Distance. `https://docs.scipy.org`