An Embedded Real-Time Object Detection and Measurement of its Size

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Abstract— **In these days, real-time object detection and dimensioning of objects is an important issue from many areas of industry. This is a vital topic of computer vision problems. This study presents an enhanced technique for detecting objects and computing their measurements in real time from video streams. We suggested an object measurement technique for real-time video by utilizing OpenCV libraries and includes the canny edge detection, dilation, and erosion algorithms. The suggested technique comprises of four stages: (1) identifying an object to be measured by using canny edge detection algorithm, (2) using morphological operators includes dilation and erosion algorithm to close gaps between edges, (3) find and sort contours, (4) measuring the dimensions of objects. In the implementation of the proposed technique, we designed a system that used OpenCV software library, Raspberry Pi 3 and Raspberry Camera. The proposed technique was nearly achieved 98% success in determines the size of the objects.**

Index Terms— **Object Detection, Object Dimension Measurement, Computer Vision, OpenCV, Raspberry pi 3, Canny Edge Detection.**

I. INTRODUCTION

Real-time object detection and measurement systems are very vital tasks in the industrial process. Object detection is often used in product quality stages in the industry. The proposed system can be applied to an industrial quality control system. Likewise, it can be utilized for various industrial systems or for security purposes. Generally, it is identifying objects in public area and measure dimensions of each of them.

The competence of the proposed system has been confirmed through utilizing real videos that taken from a Raspberry Pi camera. The execution of this procedure has a high computation rate and it is dependent on the resolution of frames. The achievement of identifying objects and separate these objects from the background is perfect [1-4].

To calculate the size of each object, firstly we need to determine the reference object. After that, the dimensions of the reference objects will be used to calculate the size of other objects. We calibrate the camera according to the reference object. The reference object always is the left-most object in the image. Also, to calibrate your pixels per metric variable, the reference object can be utilized and from there, calculate the size of other objects in all frames [5]. Completely computational procedures are assessed through a raspbian operating system using a raspberry pi 3 running with a frequency of 1.3 GHz [6-10]. Every processes utilize the libraries of OpenCV [11].

We have found various papers attached to a measurement system. Each measurement applications are utilized for various purposes. A movable outdoor distance measurement system was proposed and 90% precision were obtained [12]. The distance was measured by utilizing through utilizing S3C2410. For this purpose, a temperature reparation module was used to improve the accuracy [13]. An ultrasonic distance measurement system was proposed for embedding distance measurement [14]. The sizes of objects in an image are estimated by using computer vision methods [15].

II. TTIME OBJECT -HE PROPOSED METHODOLOGY FOR REAL DETECTION AND MEASUREMENTS

The system consists of two parts which are object detection and object measurement. In the first part, raspberry pi camera used to achieve the frames. In the second part, computer vision module will be applied to the captured frames to determine the objects, then, we will measure each object. The detected object of the current frame immediately will be processed to extract dimensions of objects.

In the proposed system, firstly, we need to preprocess our image. The camera will capture a frame and the frame will convert to grayscale to increase quickness and accuracy. Objects are detected via canny edge detector algorithm. It is used to detect only one object or multiple objects. By the help of canny edge detector, the converted image will be processed. The canny edge algorithm scans the entire image. After that, execute dilation and erosion algorithm to close holes among edges in the edge frame [16-18]. Figure 1, shows that the flow chart for the recommended system.

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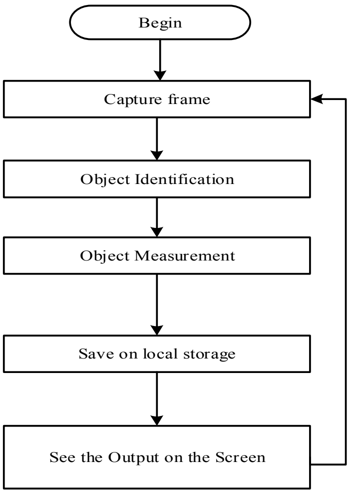

Figure 1. Flowchart for proposed method

Figure 2, shows the input frame that used for canny edge detection. First stage in canny edge detector algorithm is delete the noise in the frames by applying a Gaussian filter. The frame after converting to gray scale and apply Gaussian filter is appeared in Figure 3.

Figure 2. Input frame

Figure 3. Grayscale and Smoothed input frame

In the compute gradient stage, we detect the edge gradient and direction for each pixel. For the define the gradient at every pixel of smoothened frame, Sobel operator utilized.

A complete scan of frame will be done afterward receiving gradient magnitude and direction, to eliminate any undesirable pixels which might not establish the edge. In this stage, just local maxima must be considered as edges through applying Non-maximum suppression. Non-maximum suppression exchanges the smoothed edges in the frame of the gradient magnitudes to sharp edges. Non-maximum suppression is carried out to keep every local maximum in the gradient picture, and removing the whole thing else. Figure 4, shows that the frame after apply non-maximum suppression.

Figure 4. Input frame apply non-maximum suppression

The final stage of canny edge detector algorithm is hysteresis thresholding. This stage selects which are every edges are surely edges and which aren't edges. The two threshold values are empirically selected and their definition will upon on the content of a given frame. This is achieved via choosing big and small threshold values. If Edge pixels stronger than the big threshold, it is marked such as sturdy. Strong edges will be measured as the last edges. Also, edge pixel will be suppressed If an edge pixels weaker than the small threshold, and it is marked as weak edge if an edge pixel among the big and small thresholds.

To obtain the better result and more accurate object detection, the canny edge detection procedure has been improved with some Morphological operations [19]. These procedures are commonly a combination of nonlinear procedures performed relatively on the preparation of pixels without changing their numeral values. erosion and dilation are the keys for morphological operations.

In this study, a morphological process is performed such as a mixture of dilation and erosion. The opening is the initial procedure in which erosion is followed through dilation. Closing is the second operation in which dilation is followed through erosion. As a mixture of these processes we are capable to acquire superior determination for discovery edges in-depth frame. Figure 5 shows that the frame after applying erosion and dilation operation.

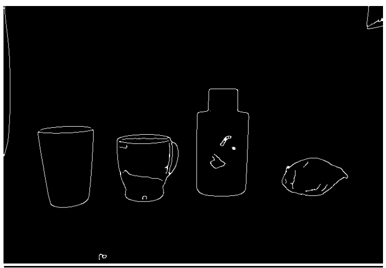

Figure 5. Input frame after apply dilation & erosion operation

To briefly summarize object measurement, after edge detection and close any gaps between edges, we detect contours by using an OpenCV function that is cv2.findContours to find the shapes of the objects in the edge map. We arrange contours from left to right. The reference object in the frame is permanently the left one. By depending to the reference object, we calibrate the camera and set the value of parameter. Next, we scan every contours, begin looping above every individual contours. After that, the rectangle around objects will be drawn in green. So, the points of the bounding box rectangle will draw in a small purple rounds. After that, we can get midpoints because the bounding box is ordered. Finally, we calculate pixels Per Metric variable through dependence on reference object. The height-distance in pixels will put on hD (height) variable and width distance will put on wD (width) variable. Then, we calculated the Euclidean distance among sets of center points.

III. RESULTS EXPERIMENTAL

We proposed the system to measure objects in a real time video and pictures. We prepared a few experimental setups to test the correctness of the proposed method. The implement the proposed system has made by the help of Python language. Figure 6. show that the setup of the prepared system. Except the hardware formation, the software's required has installed.

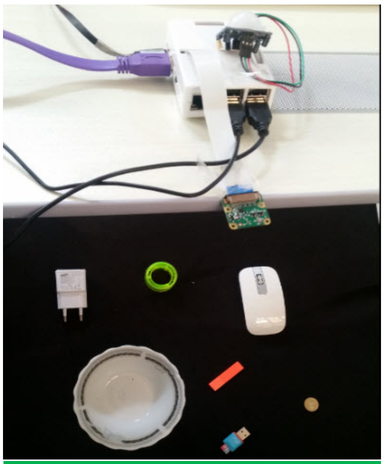

Figure 6. Setup of proposed system

For the experiment the camera has been effectively capturing the pictures. The proposed system applies four operations such as record frames, find edges, find objects, and measure size for each objects. When we run the application, the output screen displays on the PC screen as appear in Figure 7.

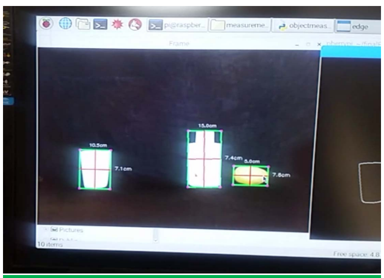

Figure 7. Display output on the screen

Figure 8, illustrates the object detection and measurements. The size of each object in the frame which are calculated.

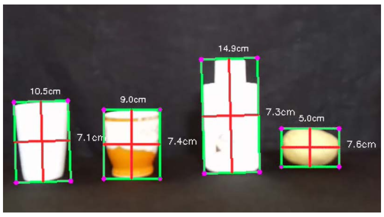

Figure 8. Calculate the size of objects

In the first experiment we measured size of objects such as white glasses, orange cup, bottle, potatoes. Table I, shows the accuracy of proposed object measurement system for these objects. Abbreviations in the table are as follows; AM-H: Actual Measure-Height, PM-H: Proposed Measure-Height, AM-W: Actual Measure-Width, PM-W: Proposed Measure-Width.

TABLE I. ACCURACY OBJECT MEASUREMENT FOR ONE FRAME

Name of objects	AM-H (cm)	PM-H (cm)	AM-W (cm)	PM-W (cm)	Accuracy (%)
White glasses	10.0	10.5	6.8	7.1	% 95.45
Orange cup	8.5	9.0	7.5	7.4	% 97.56
Bottle	15.2	14.9	7.4	7.3	**% 98.23**
Potatoes	4.8	5.0	7.4	7.6	% 96.82

Nevertheless, not every results are perfect, since this is due to the seeing angle and lens deformation. By calibrate the camera and set good width parameter, accuracy will be increase.

In the second experiment, we set the camera above the objects. Figure 9, shows that the results of the object detection and measurement for another objects. And the Table II, demonstrations the accuracy values among actual measure and system measure.

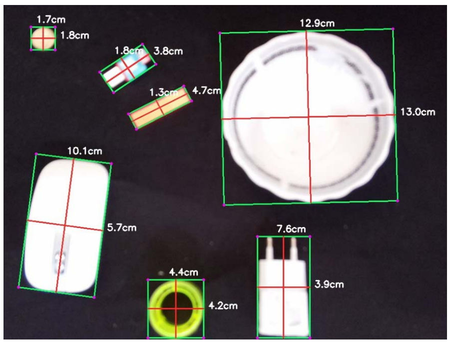

Figure 9. Experimental result when camera above the objects

TABLE II. ACCURACY OBJECT MEASUREMENT WHEN CAMERA ABOVE THE OBJECTS

Name of objects	AM-H (cm)	PM-H (cm)	AM-W (cm)	PM-W (cm)	Accuracy (%)
Turk kurus	1.7	1.7	1.7	1.8	% 97.14
Mouse	10.0	10.1	5.2	5.7	% 96.20
Card reader	3.8	3.8	1.7	1.8	% 98.21
Peace of paper	4.6	4.7	1.2	1.3	% 96.66
tray	12.6	12.9	12.6	13.0	% 97.29
Charger	7.6	7.6	3.7	3.9	**% 98.26**
plaster	4.4	4.4	4.4	4.2	% 97.72

The result for error column displays very low errors. The error rate is especially smaller when camera above the objects.

IV. CONCLUSION

In this study, an powerful real time object measurement method is proposed for industrial systems. In the offered system, Computer Vision used to detect and measure objects. The system can detect and measure objects in a real time video. After the object has been detected by using canny edge detector, the size is obtained for each object by using OpenCV functions. We enhanced the canny edge detector algorithm through utilizing Morphological operations. This procedure benefits to eliminate extra noises. Furthermore, whereas eliminating the extra noises it likewise smoothens the shape and keeps the outline and size of each object. Thus, the outlines of the different objects in the scene were kept.

The proposed technique works very fast and five frames can be processed pending one second. Raspberry Pi 3 used to implement the systems since it has very great features and low cost embedded equipment platform.

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