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Object Tracking by PID Control and Image Processing On Embedded System

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Abstract: *In this study, object tracking and object capturing application were realized according to the data obtained using image processing techniques and pid speed control was implemented to object catch. Image processing software and DC motor speed control program were programmed on the Raspberry pi 3 card in python language. The red and round properties of the object are defined to image processing and OpenCV library is used. The object tracking was realized and its position was determined with the result of filtering operations on image processing. According to the obtained position information, the object is caught by the robot.*

Keywords: *Object tracking, Image processing, PID control, Raspberry Pi*

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I. Introduction

Nowadays, development of the technology and with the start of the realization of the industrial revolution 4.0, human control disappears in the control process Instead robot systems are arising very fast as respond faster and more accurately. [1] In order for the control process to take place correctly, the data entered into the system must be fast and accurate. Industrial sensors used in this process have limitations in functioning as supervisory bodies. By using image processing methods in obtaining the data entered in the system, the measurements are provided in a more comprehensive and more precise manner. The use of image processing technique instead of using the sensor in particular is a great advantage in process for the object. Some of the advantages of the image processing are the ability to analyze and recognize the perceived image. As a result of applications in image processing, fast, low error rate, stable measurements have been determined. [2]

Embedded systems are developing rapidly today. It can perform image processing applications in its own ability and can make complex structures simpler. Embedded systems have input and output ports and can perform control operations such as PID. [3]

1.1 Raspberry Pi 3 Model A

Embedded cards are easy to use, low cost, accessible and practical moreover operating system can be installed. These features have increased the use of embedded cards in both industry and academia. The Raspberry Pi 3 Model is the 3rd version of the raspberry cards that went on sale in 2016. The embedded card has an ARMv8 CPU A 1.2GHz 64-bit quad-core processor. Raspberry 3 card used in this study has 1GB Ram, 40 GPIO pin, 4 USB port, Full HDMI port, Ethernet port, 3.5mm audio jack, camera and display interface, micro SD card slot and 3D graphics kernel. [4]

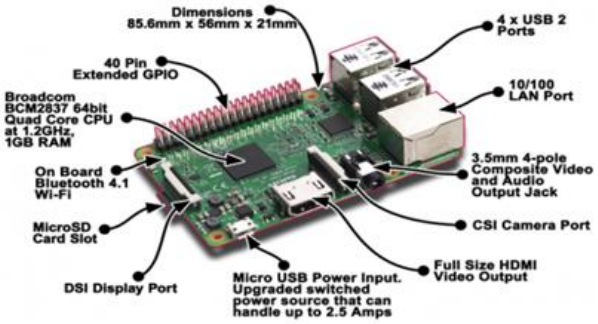

Figure 1: Raspberry Pi 3 Hardware

1.2 Open CV Libraries

OpenCV, developed by intel company, has been developed with programming in C, C ++, C #, Python and java languages, which contains many image processing algorithms on it and can work on Mac, Windows, Linux, etc. platforms. In this work, the OpenCV 3.0 version is programmed with the Python language on the Raspberry Pi 3 development board. [5]

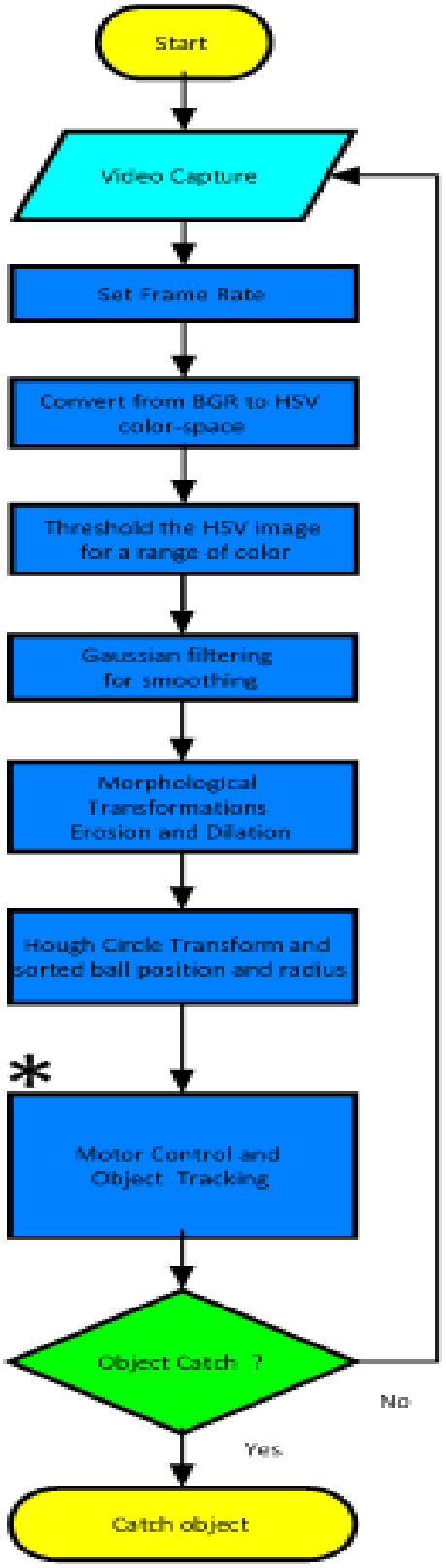

Figure2.0: Image Processing Diagram

II. Object Tracking and ımage Processing

2.1 İmage Processing

Many physical features of the object to be tracked can be found. In this study, the object was made according to the feature of being round and red color. Image iscaptured with Logitech C270 webcam and is processed in image processing algorithm on Raspberry pi 3 card. According to the object tracking information, the DC motors on the robot are controlled and the object is continuously tracked. Image processing algorithm with OpenCV appears in the figure.

Image processing algorithm with Open CV appears in the diagram. According to the algorithm, the frame value of the camera is setted. Conversion from RGB color space to HSV color space is achieved and the reference color threshold value is determined. Parasitic images are blocked by morphological filtering. Round object is detected and their position is determined. [6]

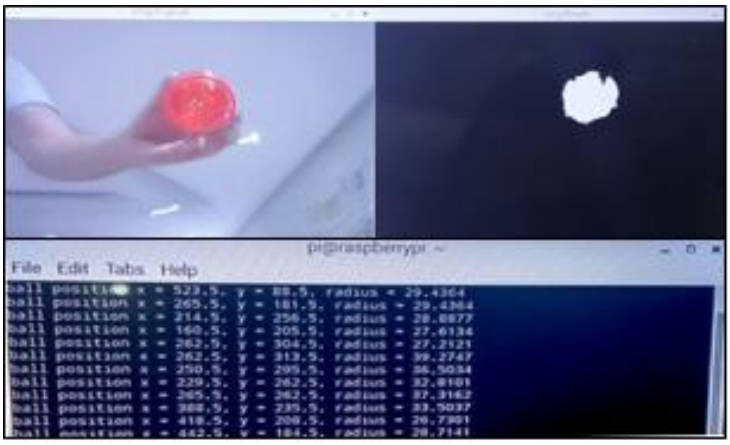

Figure2.1 : Red Ball Coordinate

2.2 PIDDC Motor Control

PID consists of proportional, integral and derivative controls. Due to its simple form, the industry is widely used. Pid accepts the difference between the desired value and the reference value within the process as an error. It controls the process input to minimize the error value. [7]

The radius value measured by the camera is compared with the reference value. In this study, the speed of DC motors is used more efficiently by PID control in the robot to object catch in addition; the PID continuously controls the speed by adjusting the speed according to the changing distance in the moving objects.

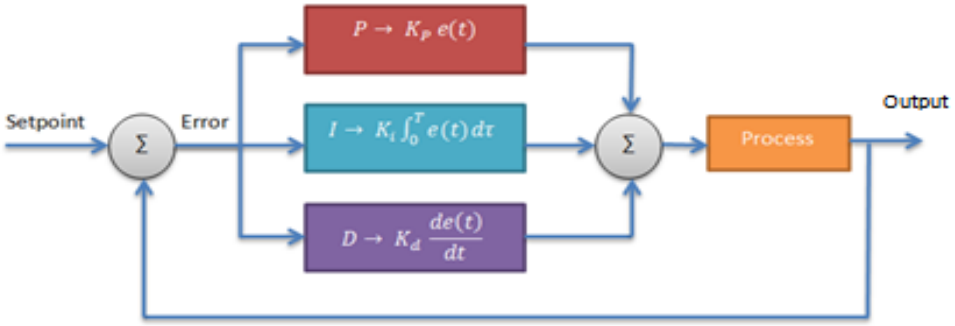

Figure2.2: *Motor Control and Object TrackingDiagram

III. Object Tracking And Capturing

Object tracking is realized by the camera located on the robot. A pan tilt mechanism is used to perform the cameras follow-up action. Pan tilt mechanism is controlled by servo motors. The rotation angles of the servo motors are made according to the coordinate values determined by image processing.

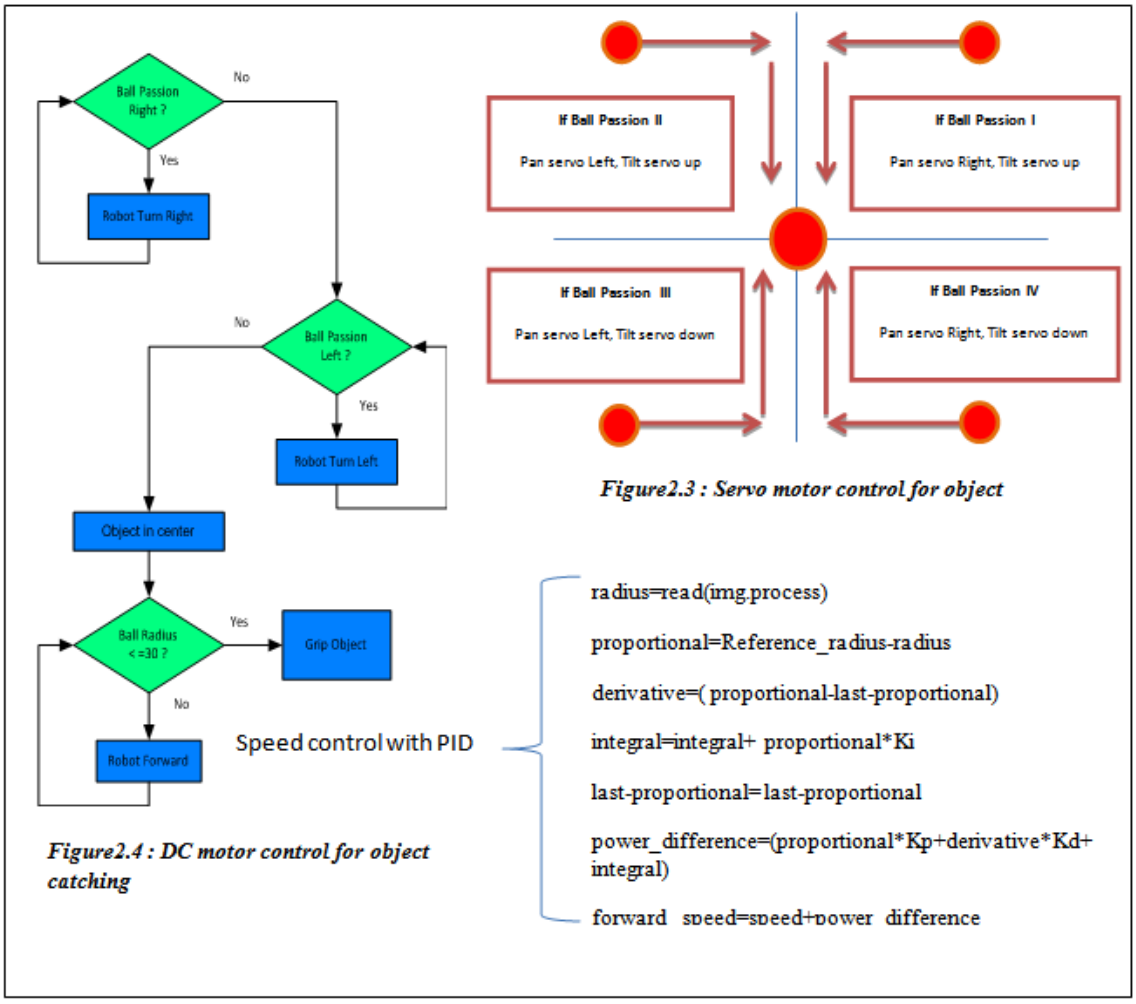

Figure2.3 : Servo motor control for object

Figure2.4 : DC motor control for object catching

In the catch of the object, the object radius gauge is the input value. The radius value measured by object tracking is compared with reference radius. Radius difference is considered an error. Speed and direction control of DC motor is performed by PID control according to the calculated error share and the coordinates of the object. These operations continue until the object is captured. [8,9,10]

IV. Results

In the study, red ball object is detected and followed by image processing methods. Fixed or mobile object was caught by robot arm. Ambient light has a significant effect on image processing. For this reason, constant illumination of the environment with power led has increased the stability of the image processing and removed the effect of light and dark environment. As a result of the study, the use of image processing techniques instead of sensors in object detection is made it possible to detect many features that sensors cannot measure. This study is could combined with artificial intelligence systems to determine the objects around and forms the basis of decision-making systems.

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