UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF A MOBILE ROBOT VISION FOR OBJECT DETECTION AND TRACKING USING PIXY CAMERA

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Automation and Robotics) with Honours

by

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DECLARATION

I hereby, declared this report entitled “Development of Mobile Robot Vision for Detection and Tracking Using Pixy Camera” is the results of my own research except as cited in references.

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Date : 12/12/2016

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the Bachelors of Electrical Engineering Technology (Industrial Automation and Robotic) with Honors. The member of the supervisory is as follow:

……

(MR MOHD ZAIDI BIM MOHD TUMARI)

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ABSTRACT

The old school detects and track robot only use IR sensor to detect and track the object in front of it. The flaws of this type of robot are the robot cannot detect the specific object based on its color. With this limitation, an improvised robot was created with a vision sensor as its main component to detect and track the object in front of it. The development of a mobile robot vision for object detection and tracking using Pixy camera will encounter this problem. The camera will detect the color objects that have been assigned in the coded program in the Arduino. Then, the DC motor servo will actuate to find the object to make it to the center of the camera. The DC metal motor gear then will move to follow the object.

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ABSTRAK

Cara lama untuk mengesan dan trek robot hanya menggunakan sensor IR untuk mengesan dan menjejaki objek di hadapannya. Kelemahan jenis ini robot tidak boleh mengesan objek tertentu berdasarkan warnanya. Dengan batasan ini, robot yang dinaik taraf telah dicipta dengan sensor penglihatan sebagai komponen utama untuk mengesan dan menjejaki objek di hadapannya. Pembangunan visi robot mudah alih untuk mengesan objek dan pengesanan menggunakan kamera Pixy akan mengatasi masalah ini. Kamera akan mengesan objek warna yang telah diberikan dalam program ini dikodkan dalam Arduino. Kemudian, DC motor servo akan bergerak untuk mencari objek untuk membuat ia ke pusat kamera. DC gear motor logam kemudian akan bergerak untuk mengikuti objek.

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DEDICATION

To my beloved parents

To my kind lecturers

And not forgetting to all friends

For their

Love, Sacrifice, Encouragement, and Best Wishes

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Before, while and after I doing my job to complete this project, I have received many help from my supervisor, lecturers, researchers, and family members and also my fellow friends.

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CHAPTER 1
INTRODUCTION

1.1 Project Background

In the tough gets going mainstream technology nowadays, the technology has become so important in life where technological advances have reduced the gap relationship between humans and robots. It is become an advantage for the community by using the technology nowadays. A development of a mobile robot vision for object detection and tracking by using pixy camera will be a project that will facilitate the life of the community in solving daily problem as well as displaying a new dimension in the field of robotic detection and tracking.

To convey information and control the robot, this project uses the Arduino as the robot's brain. Arduino is a microcontroller consisting of a combination of integrated circuits of ATMega328 as well as there are several other electronic components. The use of the Arduino board is to provide instruction in the form of programming to the robot. With the use of the Arduino board, the robot can be controlled as well as receive instructions to complete the task given.

The main component of this project is the Pixy Camera. Pixy Camera can interfaces specifically to Arduino and other controllers. We can instruct the Pixy Camera to rapidly discover items as it is a fast vision sensor. Vision (picture) sensors are extremely helpful on the grounds because it is so adaptable. To identify for all intents and purposes anything, a Pixy Camera can sense the object with the right algorithm. The use of these cameras is to detect an object placed in front of the robot so that the robot can follow the objects placed in front of it. PixyMon is software that allows users to see what is seen by the Pixy Camera. Whether in the form of raw or

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videos that have been processed. The main aims and the importance of the use of PixyMon is that the Pixy Camera can be configure for the output port and manage color signatures. With a small USB cable, PixyMon is an application that can connect to Pixy Camera and it is running on Windows, MacOs and Linux. This mobile robot vision also using pan/tilt mechanism to detect the position of the object that is placed in front of the robot itself. Pixy Camera will be affixed to the pan/tilt mechanism and two motor servo has been placed to the pan/tilt mechanism so that the camera can detect objects in a wider angle. For the movement of the robot, two DC metal gear motor is used with motor drivers powered by Lipo battery.

1.2 Problem Statement

As we know, the old school detects and track robot only use IR sensor to detect and track the object in front of it. The flaws of this type of robot are the robot cannot detect the specific object based on its color. With this limitation, an improvised robot was created with a vision sensor as its main component to detect and track the object in front of it.

1.3 Objectives

i. To develop a mobile robot with a vision sensor.
ii. To design a mechanical structure, electronic circuit and control for mobile robot vision.
iii. To implement the pixy camera to detect and track the object.

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1.4 Work Scope

i. Mechanical scope:

Mechanism that will be used to make this robot is by using two DC metal gears motor and two servo motor that attach to pan/tilt mechanism.

ii. Electronic scope:

A circuit will be design to connect between the Arduino, Pixy Camera, motor driver, DC motor, and servo motor.

iii. Software scope:

The programming software to make this robot is by Using Arduino IDE and PixyMon.

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CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

For a better project, ideas from previous inventors and researchers were required to obtain a variety of ideas. By reading and refinement of other researchers and inventors, a variety of ideas will appear and you can take the ideas featured in their research, such as the mechanical design, electrical circuit design and product design to develop this mobile robot vision. This literature review should be a stepping stone to understand the idea of developing this mobile robot vision. A comparison and discussion from previous inventors and researchers for this mobile robot vision will be summarized in details in this chapter.

2.2 Previous Project Work

2.2.1 Microcontroller

Nowadays, there are so many ways to develop this mobile vision robot. As stated by Yusuf (2014) for constructing and programing of hardware the Arduino can be used as it is an open-source platform utilized for it. Data can be send to most gadgets, and even through the web to command the specific electronic gadget. To program the board,it utilizes a hardware called Arduino UNO circuit board and software program as example Simplified C++. In these current, Arduino are utilized a great deal as a part of microcontroller programing in addition to other things because of its easy to understand or

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simple to utilize setting, an Arduinoare also similar to other microcontroller as it is a circuit board with chips that can be customized to do the various numbers of errands, the information had been send from the computer system to the Arduino microcontroller lastly to the particular circuit or machine with numerous circuits so as to execute the particular order or instructions. The information can be read by Arduino from information devices, for example, sensors, radio wire, trimmer (potentiometer) and can likewise send information to yield devices, for example, LED, LCD Screen, Speakers, and a DC metal gear motor. Figure 2.1 shows label Arduino Board.

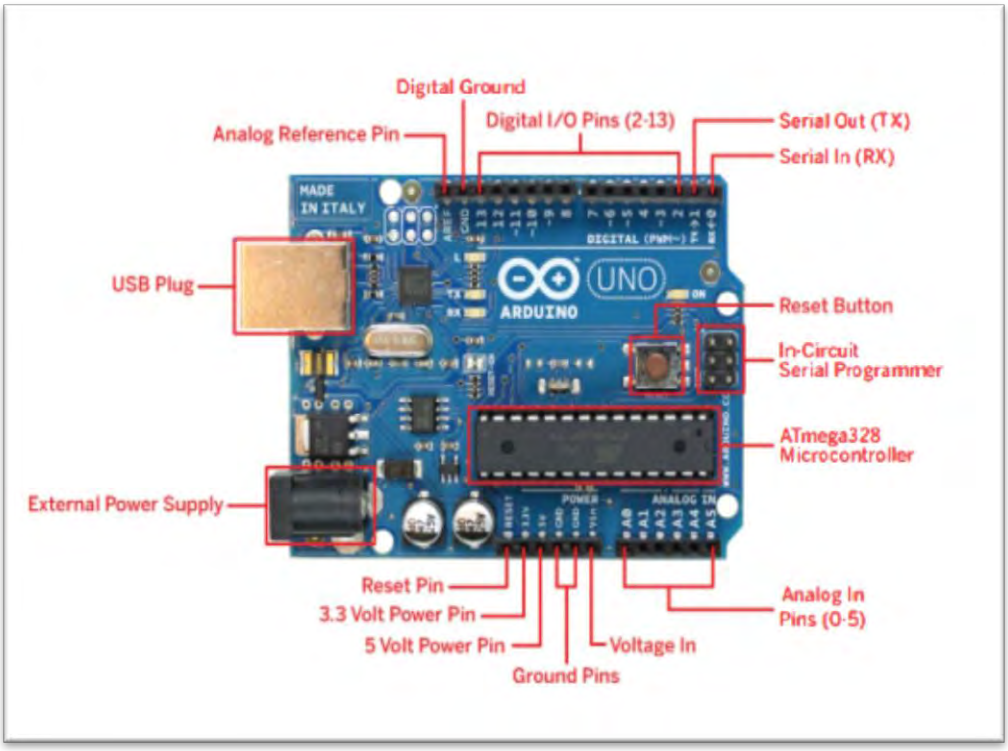

Figure 2. 1 Labeled Arduino Board

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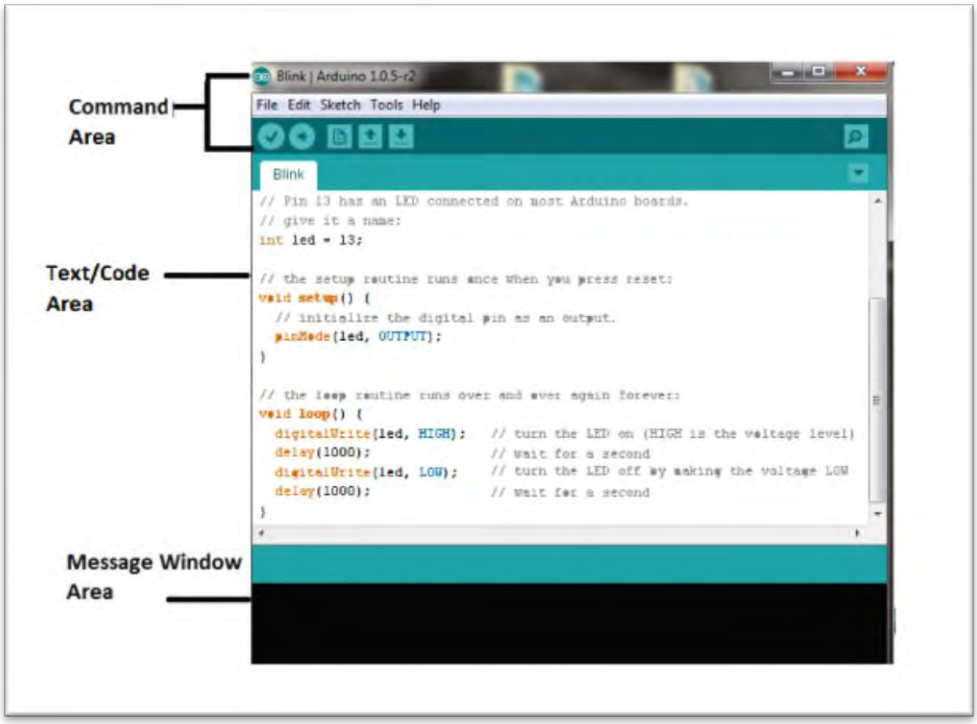

Figure 2. 2 Labelled IDE

.

Based on Ahmad (2014) Arduino is an open-source physical computing stage based on a straightforward microcontroller board and an improvement domain that executes the processing language. It was initially implied for specialists and originators make electronic models. They would have the capacity to make these outlines effectively with a little information about programming and gadgets without diving too deep into it. Electronic prototyping was generally just connected with designing and architects. Arduino can be utilized to create intuitive articles, taking in inputs to control outputs. Ventures finished with Arduino can be remain solitary or it can speak with a software that running on a computer. Furthermore, so many interesting projects can be found that had been used on the Arduino. To add functionality to the Arduino board, many shields (separate boards that can be connected) are created to be used with the Arduino.

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2.2.2 Vision Sensor

This mobile robot requires a vision sensor as a major component in this project. According to Vans et al., (2014) an algorithm for a self-sufficient way following of a versatile robot to track straight and bended ways followed in the environment. The calculation utilizes a fuzzy rationale based methodology for way following with the goal that the mobile robot can copied the way of human driving. The technique joins a fuzzy directing controller, which guiding angle of the mobile robot for way following can be controlled, plus the fuzzy velocity controller which controls the forward straight speed of the portable robot for safe way following. The inputs to the fuzzy framework are given by the vision arrangement of the mobile robot. To catch pictures of the way forward of the portable robot and the vision framework decides the horizontal counterbalance, heading mistake and curvature of the way a camera is utilized. Vision System for image data is acquired using a low cost USB camera (webcam) mounted on the mobile robot. A notebook computer running MATLAB is connected to the CMOS camera.

Utilizing the extraneous parameters that had been found, the pictures of path taken was anticipated from picture coordinates of the pixel to the ground plane. The projection on ground plane yet later changed over to meters as it in millimeters at first. A specimen picture of the way taken amid tests is appeared in the Figure 2.2. The pixel coordinates of the midpoint of the way was extricated from the picture and these coordinates were anticipated onto the ground plane as appeared in Figure 2.3.

Figure 2. 3 Picture of the way taken by the camera

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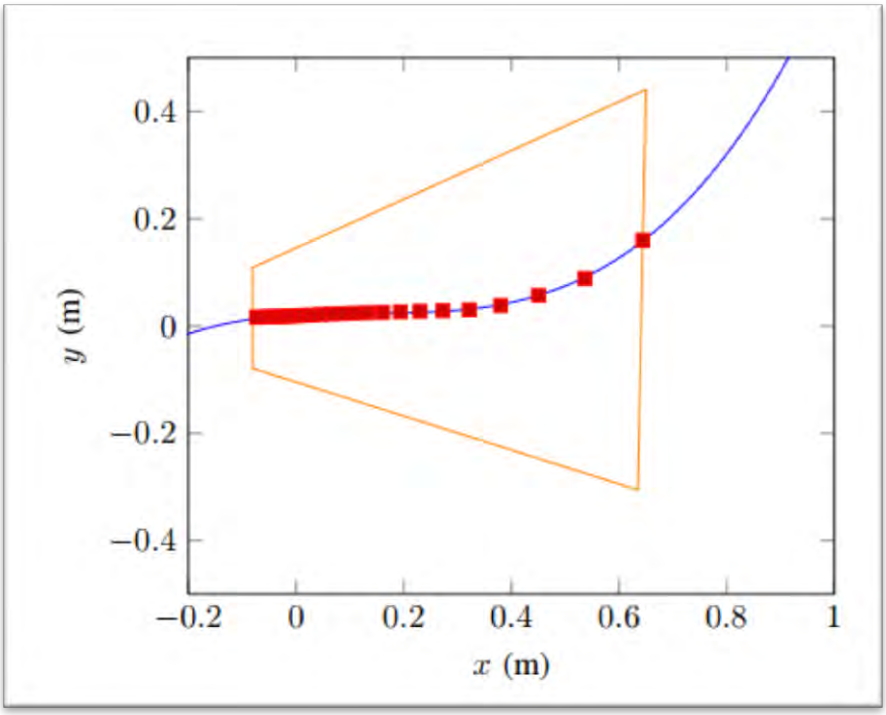

Figure 2. 4 Projection of the focuses owning to the way onto ground plane.

As a conclusion, firstly the mobile robot can effectively track a straight way, which demonstrates the viability of the fuzzy directing controller. Furthermore, the upsides of the fuzzy velocity controller are appeared by following a path with curved section.

Based on Masaaki Shibata et al. (2011) the visual tracking control to a fast moving object for stereo vision robot by using high speed cameras. The following deferral because of the objective movement ought to be stifled with a few methodologies; selection of the propelled control procedures, modification of the controller parameters, presentation of superior vision frameworks. The ways, embracing those methodologies are analyzed to accomplish the non-deferred visual following. And after that, the commitments for the postponement concealment in every methodology are investigated. Therefore, it is found that both the higher input picks up and the higher recurrence of the picture catching are required at the same time to understand the great execution in the visual following. It is found that the higher estimations of both the feedback gains and the capturing frequency are important to accomplish the great execution, at the same time. Particularly,

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the following postponement is smothered to around 10% of the picture width in the examinations with the best tuned parameters.

According to Gang Peng et al. (2012) route and movement control are key methods in the savvy mobile robot framework. Vision information is the most critical approach to see the environment, the vision-based, insightful control methods worried on Pioneer II mobile robot framework are introduced. The article seeks, picture division based on HSV (Hue-Saturation-Value) shading mode, grouping calculation and area based on CCD vision sensor.

Based on Muneeb Shaikh et al. (2011) a vision tracking system for mobile robot by utilizing Unscented Kalman Filter (UKF). The proposed framework precisely gauges the position and introduction of the mobile robot by incorporating information got from encoders, inertial sensors, and active beacons. These positions and introduction assessments are utilized to pivot the camera towards the objective amid robot movement. The UKF, used as an efficient sensor fusion algorithm, is a progressed sifting strategy which lessens the position and orientation errors of the sensors. The outlined framework makes up for the slip mistake by exchanging between two diverse UKF models, which are intended to slip and no-slip cases, individually. The slip indicator is utilized to identify the slip condition by looking at the information from the accelerometer and encoder to select the either UKF model as the output of the system.

The proposed vision following system gets the robot's evaluated position information from the either Kalman filter block. The mobile robot has in-plane direct movement along the x and y axis, and pivot movement along the z-axis. Figure 2.4 demonstrates the robot's movement and area information in the Cartesian coordinate system.

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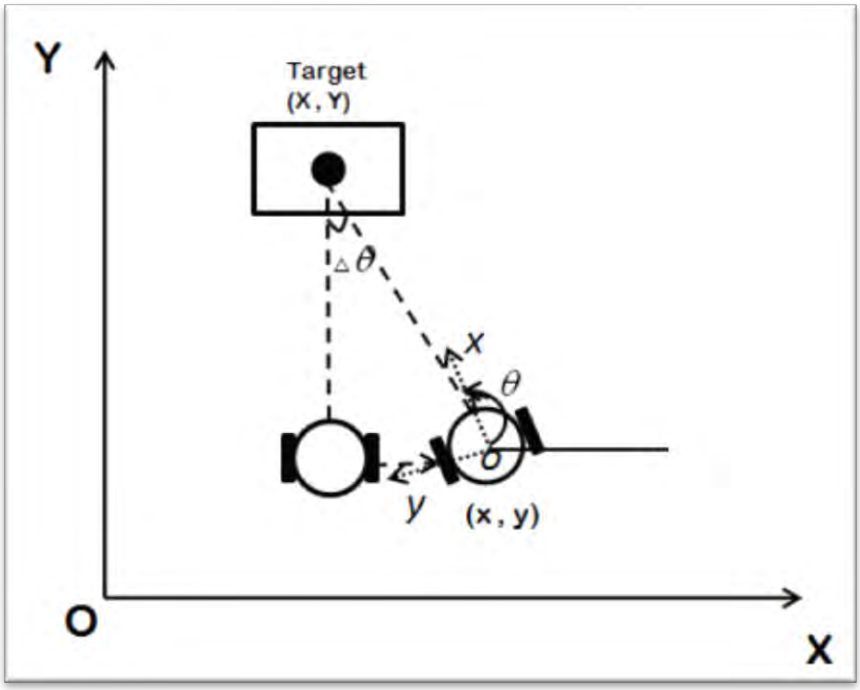

Figure 2. 5 The system depicting robot's motion and orientation on the Cartesian coordinate.

Composed system can find robot position by essentially lessening position blunders of the sensors, and consistently follow the objective with a superb vision following achievement rate under all the condition and situations.

According to Sriram Emarose et al. (2015) the robot utilizes a webcam to confine and track the object of interest and a SONAR is utilized as a part of conjunction with the camera to gauge separation between the robot and the item. A 3 DOF automated arm is mounted on the robot to control the articles inside its workspace. The robot is fitted for working in various lighting conditions. A visual feedback circle is set up between the article and the robot for constant tracking. Path arranging of the robot is done based on the mean of the item area from 5 casings to acquire smooth move.

The robot uses the BeagleBone Black (BBB) as its core processor to execute extensive image processing techniques to search and track the object of interest. The BBB also acts as a master and commands the two other microcontrollers, MSP 430 and Arduino. The MSP 430 microcontroller is

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responsible for monitoring the illumination in the robot`s surroundings using the OPT 101 photodiode and triggers the onboard lighting of the robot The Arduino UNO microcontroller receives control commands from the BBB and which in turn drives the DC motors of the robot and the servo motors of the robotic arm. The limit switch in the gripper of the robotic arm sends a feedback to the BBB when the object is picked up. Figure 2.5 shows the robot development.

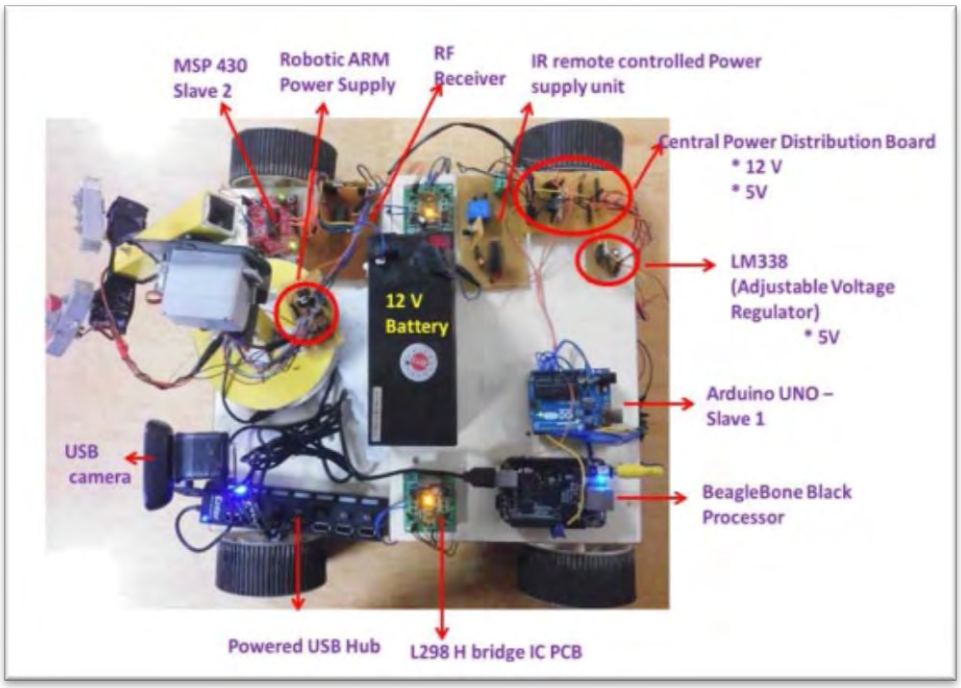

Figure 2. 6 Monocular Vision Based Autonomous Indoor Mobile Service Robot development

The Arduino UNO microcontroller controls the DC motors of the robot and servo motors of the mechanical arm. It ceaselessly listens for control commands from the master controller, BeagleBone Black processor and performs the comparing activities. Figure 2.6 shows the operational flowchart of the robot.

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