

Report on

Pick and Place assignment

ASE-9306 Introduction to Robotics and Automation

A report submitted to the Department of Automation Engineering of Tampere University of Technology for partial fulfillment of the requirements of Introduction to Robotics and Automation course.

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1. Introduction

In this report, design, developing and coding technique of a robot of 3 DOM is discussed. This assignment aims to acquire and implement the real devices, real-world problem and solution technique along with learned concepts in the course.

2. Main objective and Requirements

The main objective of this project is to design a robot of 3 DOM which can detect the different color of pieces and pick up them from their predefined location and placing them in a specific location with the predefined color order. Environment and Components

Hardware part:

- To build the physical structure of the Robotic arm, LEGO Mindstorms set is used (Figure1).
- As controller, Raspberry Pi model 3 and BrickPi3 is used(Figure 2).



Figure 1: LEGO Mindstorms



Figure 2 Coupled Raspberry Pi and the Brickpi boards

Software part:

- To define and create the required logics of robot operations through Raspberry Pi3 and Brickpi3, Python programming language is used.

3. Developing the model

3.1. Phase 1: Developing 1st Model

To make the end effector Initially, the light sensor and two simple Lego bricks are used (Figure 3). After that, the base and the arm are built in the shown manner (Figure 4). In Phase 1, the matters are observed: lack of accuracy, low capacity of grabbing pieces, unstable base, low working area, unable to stack the pieces.



Figure 3: Initially developed end effector



Figure 4: Initially developed base and arm

At the ending of this phase, a drastic change in end effector can be observed. Also, the touch sensor is introduced in the end effector to verify the presence of the pieces (Figure 5, [Click here](#) for video).



Figure 5: End effector

3.2. Phase 2: Improving 1st Model

In this phase, the joint between the base and the end effector is improved with the more stable base, the algorithm of the program is refined (Figure 6, [Click here](#) for video).



Figure 6: Phase 2 model

3.3. Phase 3: Final Model

In Phase 3, every part of the whole model is improved. An additional touch sensor is added to the base to precisely locate the dropping position. In the gripper additional block is added to get an accurate result from the touch sensor. Two wheels are placed at the end of the structure to support and stabilize the whole robot(Figure 7, Click here [Situation 1](#), [Situation 2](#) and [Situation 3](#) for videos).

In Phase 3, the following matters can be highlighted:

- Accurately sensing and positioning the pieces
- Controlled speed of all actuator
- Stable structure

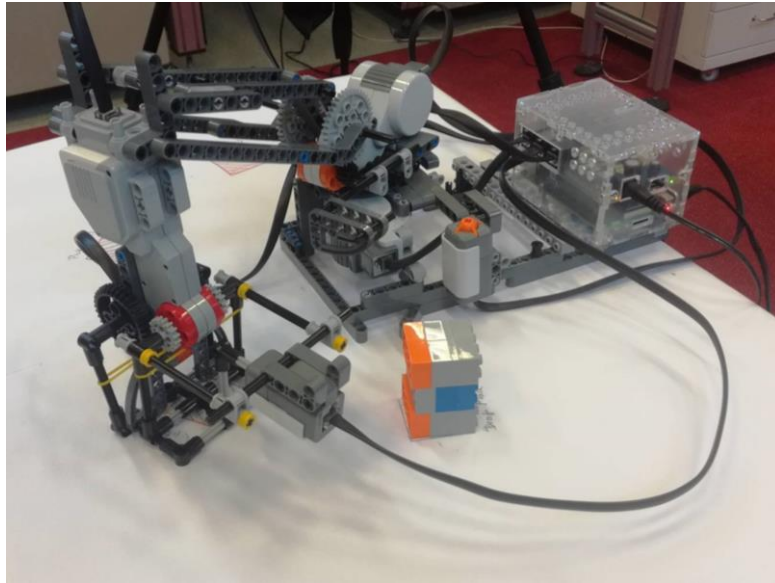


Figure 7(a): Final Model

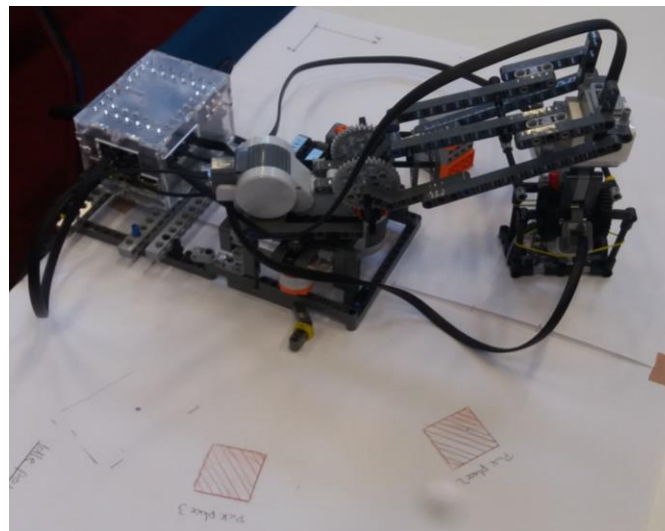
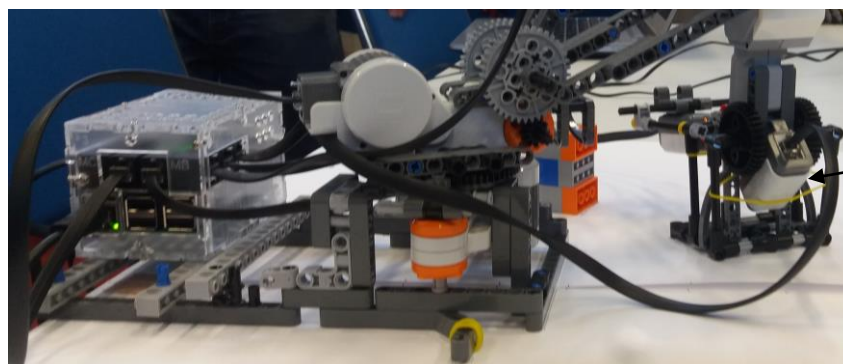


Figure 7(b): Side view of final model



Light sensor for end effector

Figure 7(c): Side view of final model

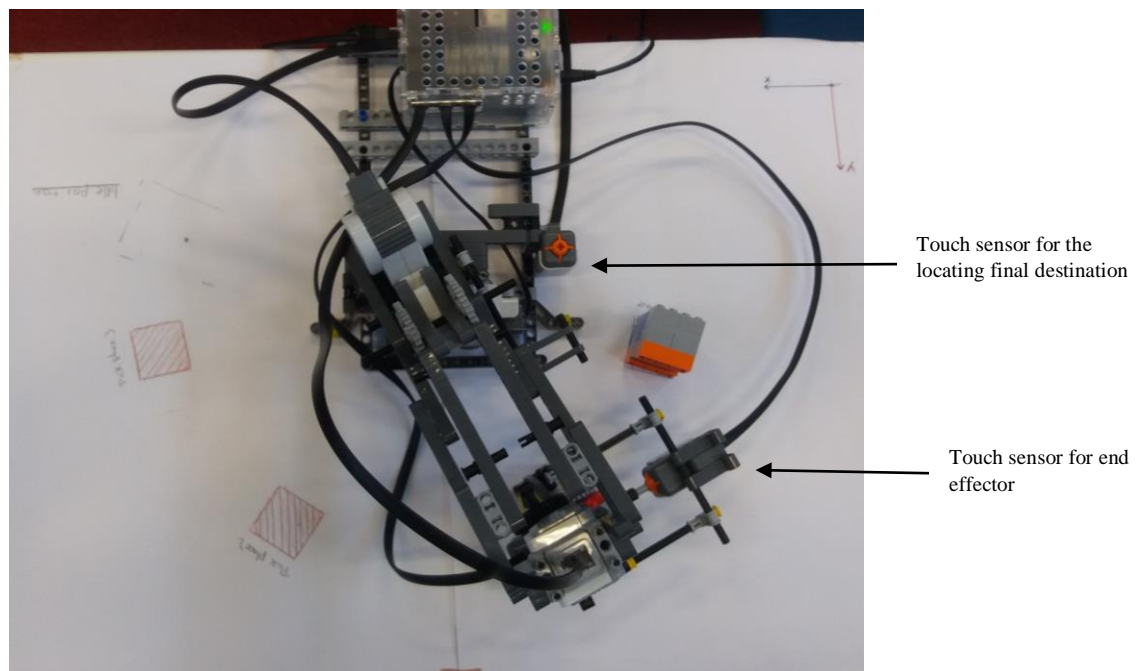


Figure 7(d): Top view of final model

4. Description of used ports

Description of used ports is shown in table 1:

Name on the BrickPI3	Port Name	Description
MA	Port_A	For opening and closing the end effector
MB	Port_B	For rotating base
MC	Port_C	For moving up and down the whole end effector
MD	Port_D	Not in use
S1	Port_1	Touch sensor for end effector
S2	Port_2	Light sensor for end effector
S3	Port_3	Touch sensor for the locating final destination
S4	Port_4	Not in use

Table: 1

5. The algorithm of the program:

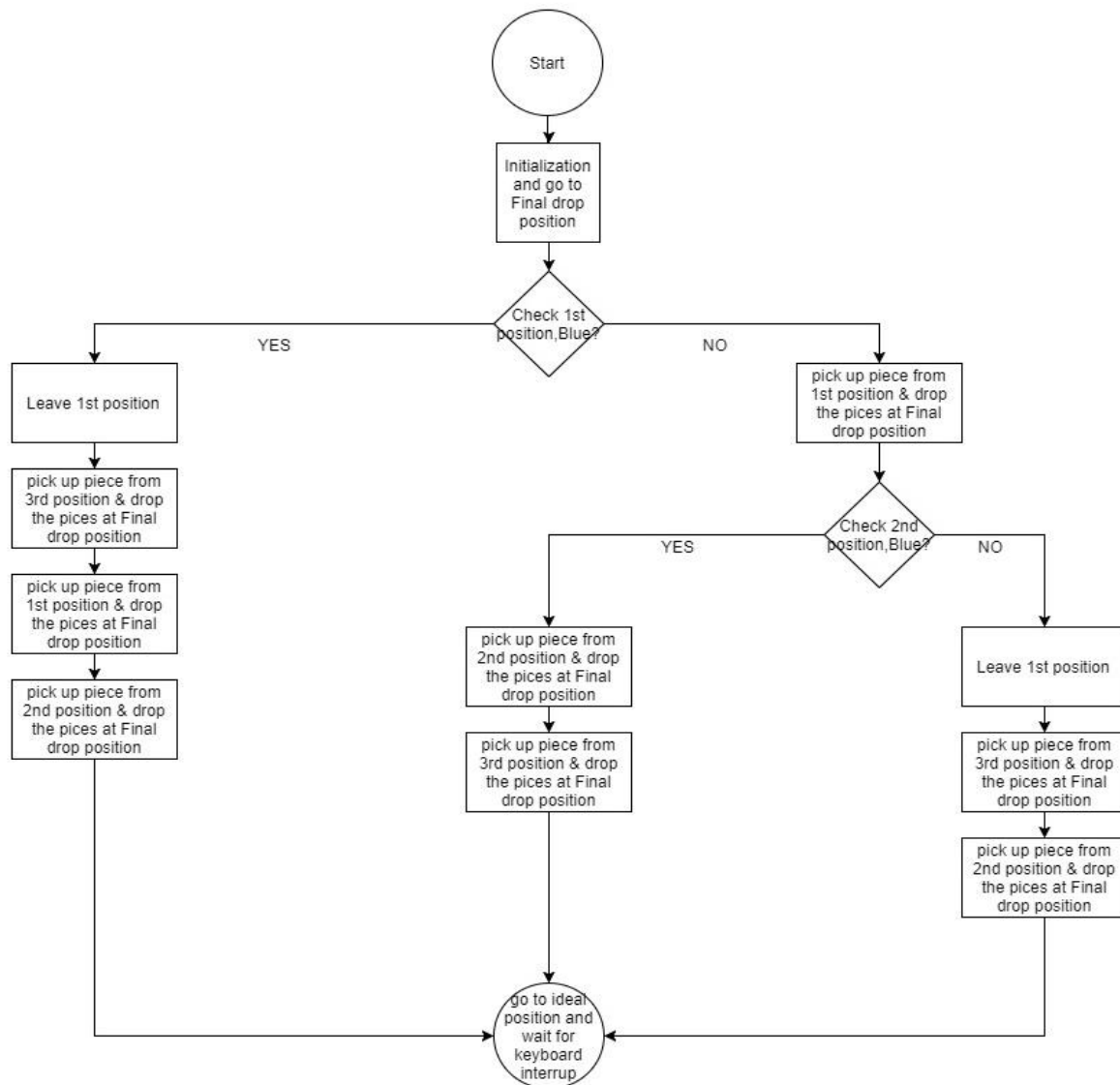


Figure 8: Algorithm

6. Conclusion

Forward kinematics is used to locate the target position. In the final model, the unique gripper can hold comparative large and heavy object. The developed robot successfully identifies and locates the pieces as well as stack them in predefined color order.