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Weight Based Pick And Place Robot WithDigital Counter

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Abstract: Usually, the sorting activities are done from our nativity to demise typically ranging from sorting of simple matter to complex merge sort. The process of separating the objects based on their parameters is known as sorting. Generally, the sorting mechanism is carried out manually in industries and market. As human labours are involved in sorting the objects thereis a lack of work efficiency, time accuracy, and manufacturing precision. As human cannot do error free work, even the work gets compromised at some point due to loss of energy and also the maintenance of time becomes a major criterion. In order to overcome these flaws, the automation has come into picture. The robots are used to automate the work in each and every field. Weighing is the main criteria for the exchange of the goods. As weighing cannot be done manually, the automation is useful for the accurate measure of weight of products in industries and fruits, vegetables in the market. So, in our robotic based project we are designing the weight-based pick and place robotic arm in order to segregate the desired sample.

1. Introduction

In order to overcome the time consuming, less efficient and inconsistent method of manual sorting, in this proposed work the automatic object sorting based on weight is done and shipment of the predefinedsample is done using robotic arm. It harmonize the motion of robotic arm to choose the item shifting onconveyor belt. It ambitious in segregating the predefined items primarily based totally on weight whichcan be coming at the conveyor via way of means of choosing and setting the items in its respective pre-programmed location, whereas undefined items are thrown into the trash. Thereby removing the monotonous work completed via way of means of human, accomplishing accuracy. In this work an advanced Raspberry pi 3 B+ processor is used and a pi-camera to detect the object on weighing plate.

The sample is kept on the weighing plate, when the pi-camera recognizes the desired object, Raspberry pi 3 B+ processor crosschecks the images captured by the predefined dataset of COCO model. When the sample recognized is same as predefined sample (in this work tomato is been chosen as a sample) then it is weighted using 1 kg load cell and HX711 module and passed on to the conveyorbelt, then it comes to robotic arm for its pick and place activity. The programming language used for Raspberry pi is Python in this work. Finally, in this proposed work the robotic arm picks the predefined object and places them in the carters based on weight. The count of the objects in the carters are displayed digitally on the LCD. If an unprescribed sample is detected it's been thrown to trash.

2. Related Works

This paper gives a robot arm manipulate gadget made with a Raspberry PI. The Raspberry PI, the cardboard length notable laptop, that's the primary factor of this manipulate gadget [1]. The roboticarm is a mechanical arm which can be programmed to behave like a human arm. An anthropomorphic robotic arm is developed and implemented in this work, and is operated from a remote location using python. The paper's main

objective is to introduce a device with one robot used for selecting and putting applications in industries. This system has Robot-Control-Communicating Modules [2]. This paper describes an effective strategy for lowering cost while taking the issues into account. Raspberry pi is used, that's an open-source Linux primarily based totally board that's interfaced with digital digicam. The images are captured using camera, and programming language used for Raspberry pi is Python in this work. The conveyor belt and the robotic arm movement is are controlled by DC motors [3]. The vision of the project is to make a robot that has the capability of pick a pre-specified object and placing it in separate divisions and the python code has been formulated for creating a robotic arm with image processing [5]. Object detection in OpenCV has been successfully implemented using algorithms from Computer Vision and Deep Learning modules that could recognize and classify entities in a live feed from PiCam, Python libraries with CNN, and TensorFlow. Object detection is exploited in many fields where computer vision projects are implemented, such as the computerized self-driving car. Object detection, often known as computer vision, is a technical subject that aims to automate all or most of the tasks that a human visual system can undertake [6]. This project will be supplied with a load cell, HX711, and Raspberry Pi, as well as software designed in the Python programming language. The load cell and HX711 will be used in this project. The Raspberry Pi will function as the system's key controller. The primary aim of this research is to design a digital weight scale to replace the existing conventional weighing scale. [7]. We present a proposed model for object detection in this paper that uses an anchor free detection method, treats the sample as a whole with the advanced semantic properties uses new gravity centred sample detection method which is achieved by using COCO dataset which is kind of dataset used in machine learning to train the model to detect the samples. [8] And finally the digital display (LCD) is added in order to get the count of the predefined object in their respective carters based on weight.

3. Methodology

This section comprises of the apparatus and simulation tools that were used to set up the experimental framework in this work.

3.1. Hardware

3.1.1. Raspberry pi 3B+. It is core processor in this work. It is used monitor and coordinate with the input sensors, output actuators and robotic arm.

3.1.2. Robotic Arm. It consists of mainly two parts, first is gripper part and second is gear box part. Both are made of laser cut metal and acrylic. Gripper and gear box consists of dc motor each which assembly supports to pick and place the objects from one place to other.

3.1.3 DC Motor. Motors are used for mechanical movement of robotic arm. In this work two DC motors of 12V and 30 rpm are having been used.

3.1.4. L298 Motor Driver. It is the motor driver which is connected to the two dc motors of the roboticarm to control the speed and direction of the robotic arm. It can drive the dc motors of voltage 5v to 35v, current up to 2 amperes.

3.1.5. Stepper Motor. It is moulded at the base of the robotic arm used for the axis movement of the robotic arm. We are using NEMA 23 stepper motor.

3.1.6. TB6600. TB6600 driver is to control direction and speed of the stepper motor. By using this driver, the steps per revolution of the stepper motor with micro stepping up to 3200 or even more is been achieved.

3.1.7. Torque Motor. Torque motors are a wider diameter motors. High torque will be generated by Torque motors at moderate speeds. Voltage: 6V to 18V, RPM: 30.

3.1.8. Relay. Relays are the electro mechanical switches and in this automation process they are used for the protection of ac and dc circuits. It is used to run the servomotor for conveyer belt.

3.1.9. Load Cell. It is the primary component used in this work for the weight calibration of the sample placed on it. It converts the force being applied on it into electrical output signal. Load cell converts the weight of the sample to a corresponding voltage form.

3.1.10. HX711. It is basically amplifying sensor. It also consists of A/D converter. It used to amplify the output of load cell and converts it digitally and fed to controller to calculate the weight.

3.1.11. Servomotor. It is basically amplifying sensor. It also consists of A/D converter. It used to amplify the output of load cell and converts it digitally and fed to controller to calculate the weight. And its used to tilt the plate on the sample which is been placed, so that conveniently the sample moves either to conveyor belt or to the trash.

3.1.12. LCD. It is the actuator used to display the count of sample in each carter and the weight of the sample. We are using 16-characters 2-line liquid crystal display. We can display up to 32 characters including letters, numbers and special characters.

3.1.13. I2C. Inter integrated circuit bus it is synchronous, bidirectional and half duplex. I2c is shared bus system. It is interfaced with LCD.

3.1.14. Picamera. It is used to capture the image of the objects for the object recognition.

3.2. Software

3.2.1 Raspbian OS

Raspberry Pi OS is an open system software in which we have written our code in python. We have included few libraries that are required and have kept in a folder. Here we are using tensor flow lite api for interpreter class. We are using tflite runtime package. Python packages required for classify picamera are numpy, picamera, pillow.

4. System Modelling and Simulation.

4.1. Architectural Model.

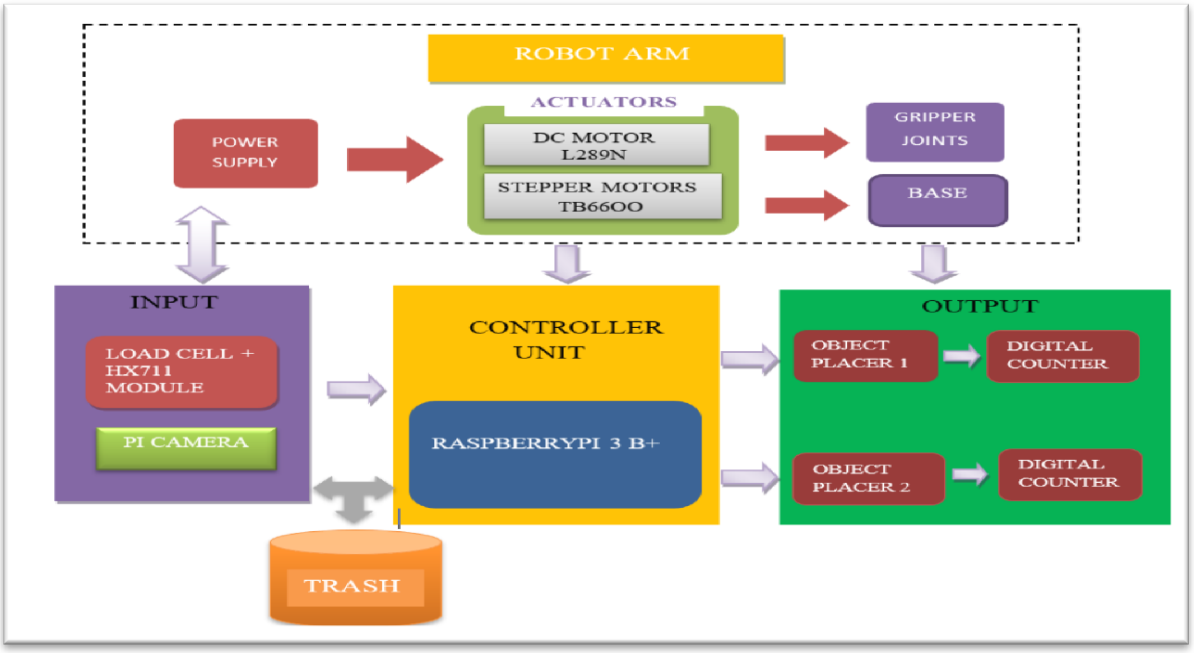

Figure 1. Detailed block diagram of weight-based pick and place robot with digital counter.

4.2. Implementation.

The block diagram is illustrated in Figure 1. Raspberry pi is used as core element. First the mechanical part i.e., the robotic arm is designed for pick and place operation. It consists of base, links, joints, and gripper. The robotic arm used in this paper consists of a single joint. Stepper motor is connected to the base of the robotic arm for the movement in left and right direction. 12V DC motor is connected at the joint for the movement in upward and downward direction. Another 12V DC motor is connected to the gripper for grasping

and releasing the objects. Both 12V DC motors are driven using L289n module which is powered up using adapter.

In Raspberry pi, Raspbian OS based on Linux is used for processing the hardware. Code is written in Python for identification and detection of sample.

We place the sample on load cell which is driven using HX711 module to measure the weight of the sample. The camera module takes the picture and saves it in Raspberry pi SD card. If the specified sample is placed, the plate on which load cell is placed and image processing is happening tilts towardsconveyor belt and throws the object on to the conveyor belt. Otherwise, the plate throws the sample to the trash. Servomotor is used for tilting operation. The conveyor belt is driven by high torque DC motorto carry the sample till the robotic arm. Now the robotic arm picks the sample and as per the pre checked weight of the sample, the robotic arm grabs the sample and if the sample weight is below threshold, it places the sample to carter1 else places the sample to carter2. We use LCD display as digital counter to count the samples in both carters.

4.3. Flow Chart.

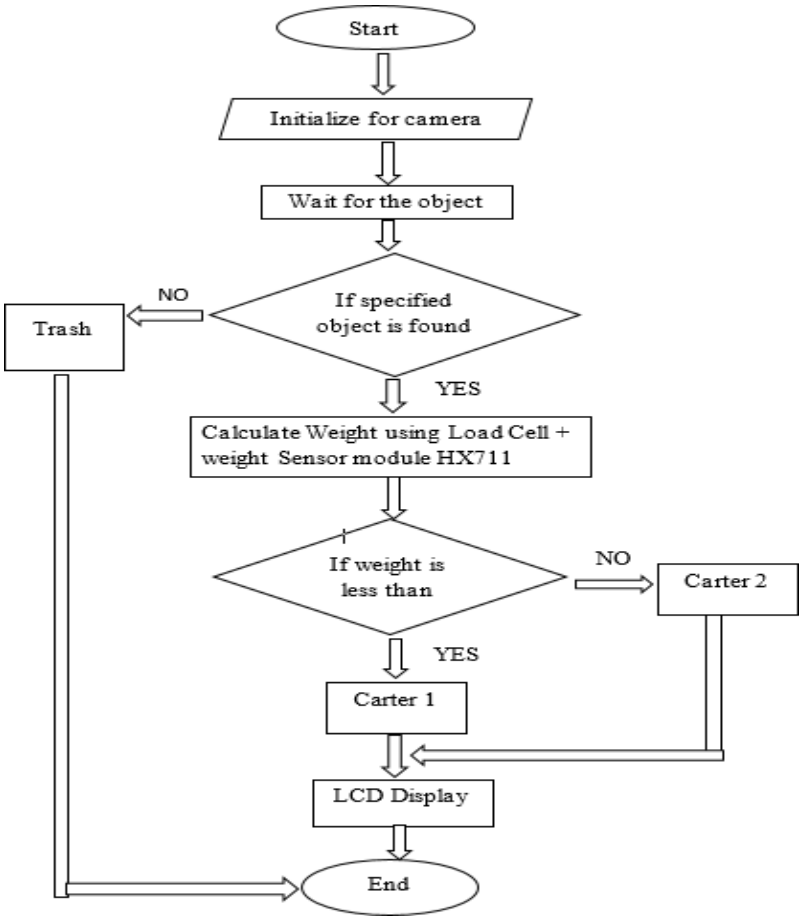

Figure 2. Flow Chart- Step to step operation flow of this work.

5. Results and Discussion.

5.1. Case Analysis

Initially the sample is been image processed under the pi camera and the weight is calculated using load cell which is kept below the sample. After recognizing the prescribed sample, the plate on which its placed turns towards the conveyor belt. The sample then traces the path in conveyor belt and comesto a position where the robotic arm can pick the sample. After picking, robotic arm puts the sample to respective carter based on weight

by the command from raspberry pi. Here we have kept the threshold for our project as weight = 45g. If unprescribed samples are detected the plate on which sample is been kept turns to the opposite of the conveyor belt.

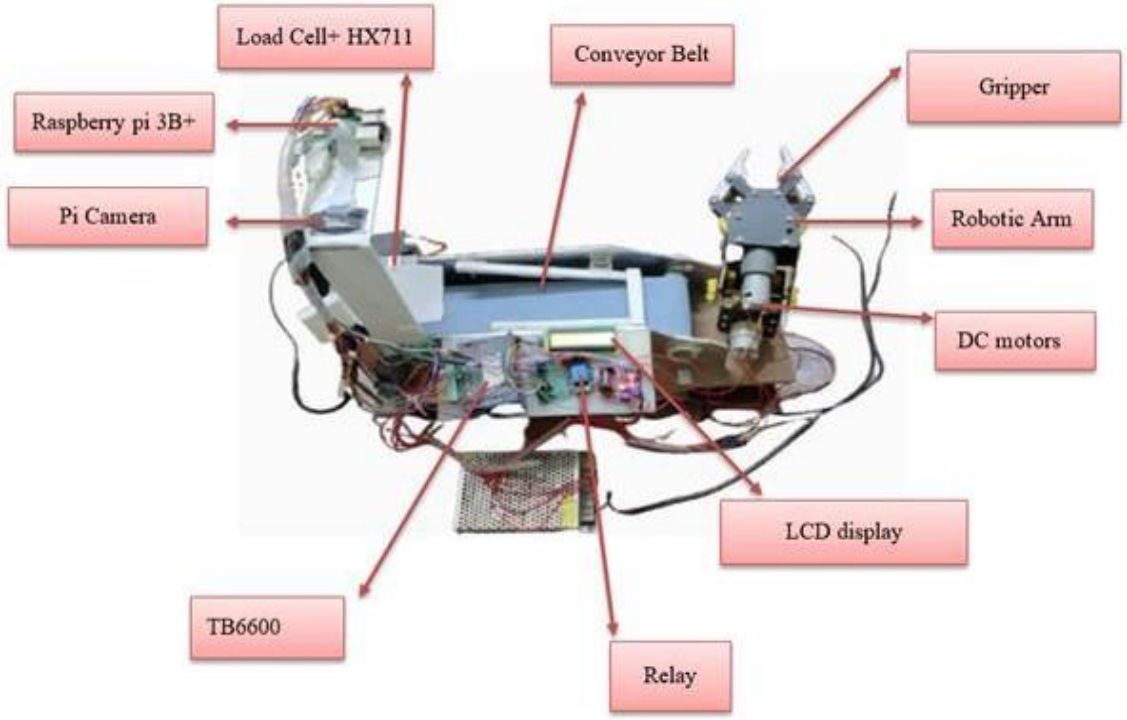

Figure 3. Hardware Setup.

5.1.1. Experiment 1

Sample = Tomato

Case1. Tomato of weight more than threshold

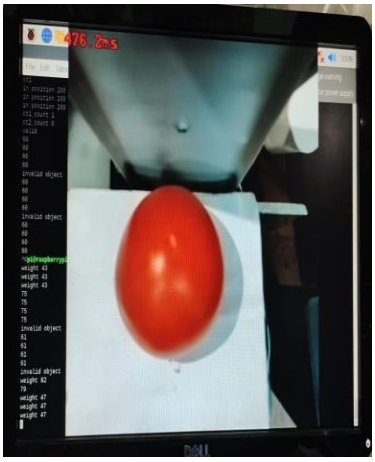

Figure 4. Tomato being processed monitor screen.

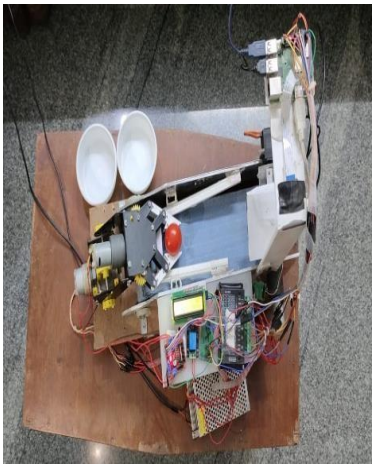

Figure 5. Robotic arm picking the sampleon moved on conveyor belt.

Figure 6. Digital display showing weight and the count value

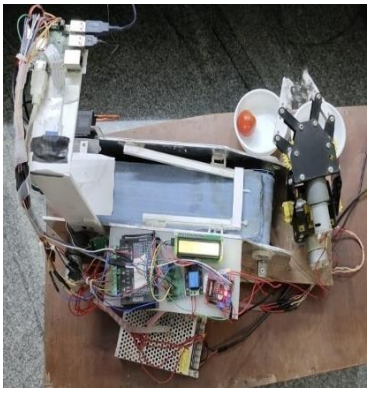

Figure 7. Sample been placed in Carter2

Here we have taken the sample greater than threshold i.e 58g > 45g (threshold). Thus the robotic arm puts the sample to the carter 2.

Case2. Tomato of weight less than threshold

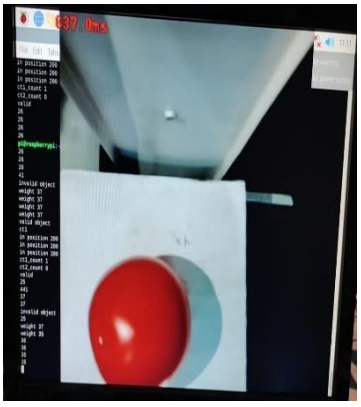

Figure 8. Tomato being processed monitor screen

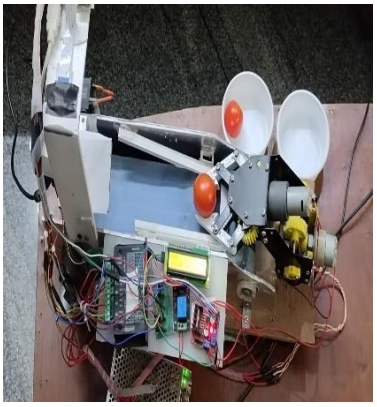

Figure 9. Robotic arm picking the sampleon moved on conveyor belt

Figure 10. Digital display showing weight and count value

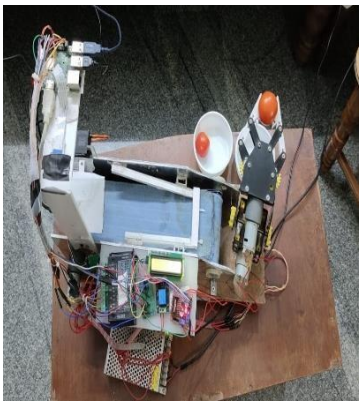

Figure 11. Sample been placed in Carter 1

Here we have taken the sample lesser than threshold i.e 26g <45g (threshold). Thus the robotic armputs the sample to the carter 1.

5.1.2. Experiment 2.

Sample = Lemon

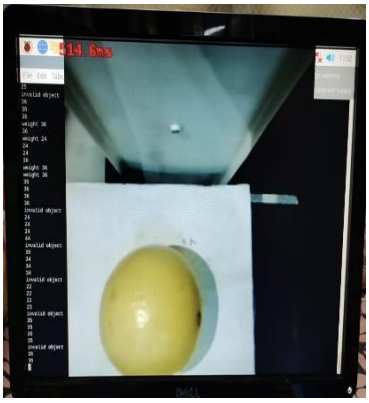

Figure 12. Lemon being processed monitor screen

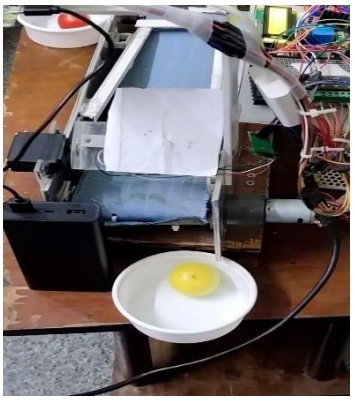

Figure 13. Sample been thrown to trashon the

Here our prescribed sample is considered as Tomato. But if we keep some other sample such as Lemon in this case then the plate on which image processing is happening turns to opposite side of conveyor belt and puts the sample to the trash.

5.1.3. Experiment 3.

Smaple = Onion

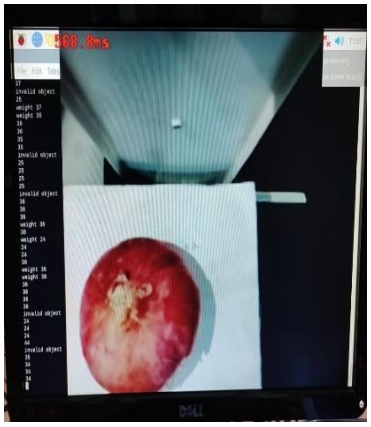

Figure 14. Onion being processed

Figure 15. Sample been thrown to trashon the monitor screen

If we considered other case in which we take onion as sample which is also not prescribed sample. Then the same process happens to onion as in case of Lemon. Thus, even onion when detected the plate pushes the onion to the opposite of conveyor belt and puts the sample to the trash.

5.2. Tabular and Graphical analysis

Table. 1. Experimental tabulation of Classification and Separation.

TrialNo.	Sample	eight(g)	Number of counts inCarter 1	Number of counts inCarter 2	Trash
1	Tomato	58	0	1	-
2	Tomato	26	1	1	-
3	Tomato	56	1	2	-
4	Tomato	30	2	2	-
5	Tomato	38	3	2	-
6	Tomato	53	3	3	-
7	Tomato	60	3	4	-
8	Tomato	20	4	4	-
9	Tomato	42	5	4	-
10	Tomato	50	5	5	-
11	Lemon	26	Remains same	Remains same	Trash
12	Lemon	30	Remains same	Remains same	Trash
13	Onion	36	Remains same	Remains same	Trash
14	Onion	48	Remains same	Remains same	Trash
15	Lemon	34	Remains same	Remains same	Trash

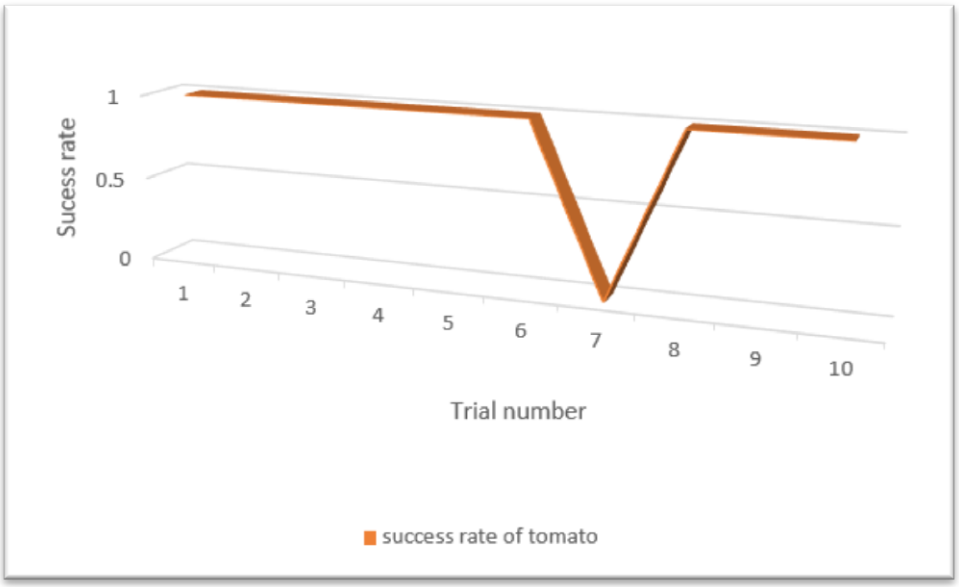

Figure 16. Success Rate

6. Conclusion

Here pick and place robotic arm is developed to differentiate the samples based on the weights using weight sensors and then place the objects in a pre-programmed or specific place. The number of objects placed in the specified position is determined and displayed by digital counter. The samples are detected and identified by training the model using machine learning process with the help of COCO dataset. By this it will become easier task to separate the samples without the aid of human help. By which accuracy and efficiency can be increased and the human effort, errors and time can be minimized.

7. Future Scope

As everything are becoming automated, there is a need to increase the efficiency and outcome. In the future the proposed system can be developed by implementing intelligence to the gripper so that it could grab and leave any kind of objects of any predefined shape and size. The robotics can be implemented ranging from the markets to the industries where in the market the robot can be used to weigh the fruits and vegetables and separate accordingly, it can also be implemented in the food industries, and other types of industries where products are separated based on weight. Thus, by savingthe manual power and increasing the productivity rate and creating well advanced environment.

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