MUKESH PATEL SCHOOL OF TECHNOLOGY MANAGEMENT & ENGINEERING

Technical Internship Program 2021

Executive Summary Report

On

Coordinate Detection and Visual Inspection using Raspberry Pi

By:
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Course: B. Tech (Computer Engineering)
Semester: VI **Division:** E
Roll No.: E008 **SAP ID:** 70021018074

Project Time Frame: 2 Months
Organization: PBOPlus

Controlling Office: Plot No 64, Basement, Okhla Phase III, Okhla Industrial Area, New Delhi, Delhi

Company Details

Name of the organization: PBOPlus

Location of the organization: New Delhi

Background of the organization:

PBOPlus, a pioneer consulting firm in the field of business process management, offers services which include Process Consulting, ERP, Industrial Automation, Robotics, and IoT. Our aim is to help our customers achieve reduction in business costs and increase in value for their clients thereby increasing profitability and/or business growth. We reduce departmental silos within organizations through cross-functional processes and horizontal organizational structure changes that leads to increased customer alignment and improved organizational effectiveness. Being manufacturing experts, the driving reason for leaders at PBOPlus to foray into Robotics was to diversify into the manufacturing domain. Doing so, we were able to further align ourselves with the organization's vision of helping businesses to stay free of repetitive tasks and focus on profitability.

About the department:

The main purpose of an industrial robot is to replicate human motions/actions. Specific industrial functions require very high levels of precision or repeatability. Also, few of these industrial functions may also prove to be extremely dangerous for human beings in terms of health, environment, and safety. "Hazardous Processes" which include steel melting, metal casting and many more may turn out to be particularly life-threatening for the staff working in factories.

Being manufacturing experts, the driving reason for leaders at PBOPlus to foray into Robotics was to diversify into the manufacturing domain. Doing so, we were able to further align ourselves with the organization's vision of helping businesses to stay free of repetitive tasks and focus on profitability.

We are supported by extensive knowledge of how the manufacturing industry operates. We understand the intricacies of:

- How to place a factory?
- How to run a factory smoothly?
- What parts need to be produced in – house and what needs to be outsourced?

I was working under Mr. Karunesh Jha, Head of Robotics and Automation, to understand the working and challenges faced in this field of expertise. He guided me to work towards small scale projects that I could automate at home.

About Project

- **PURPOSE**

The purpose and goals of Raspberry Pi modules and Vision Detection is:

1. **Control Lights:**
   Basic LED module connected to a Raspberry Pi can easily control the status (ON / OFF) of the LED, its behaviours (BLINKING) and its illumination (BRIGHTNESS) from simple code. These help in Smart IoT Lights implementation.
2. **Security:**
   With the help on a camera and a motion sensor connected to a Raspberry Pi, it is possible to capture images when motion is detected. These systems act as security systems to help prevent from theft and burglary.
3. **Face Detection:**
   OpenCV library in Python is widely used for vision inception and face detection can be used for video surveillance, facial recognition, biometrics etc. It can also be advanced by using different machine learning techniques to not just detect a face on the screen but also be able to recognize who it is by learning for sample test data.
4. **Real Time Object Detection**:
   To be able to detect multiple objects on screen helps in traffic, autonomous cars, factories, etc. It can also be improved by detection what object is being captured in the camera. For example, a car, a person etc.
5. **Web Server, Cloud Storage, VPN etc**
   A Raspberry Pi is a multi-purposed computer and with the help of different Python libraries it can be used as a web server to host websites locally or on the internet. It can also be used as a cloud storage to backup data and it also has the capability to act as a virtual private network (VPN). It can also be used as a NAS, a bot for Twitter, digital photo frames etc.

- **SCOPE**

The scope of this project is creating small-scale projects to help in the understanding Robotics and how every component has a different set of rules, pros and cons. It is aimed to help beginners in the field understand that robotic modules are built with multiple sensors and cameras and it is highly complex for all of their sensors to work in co-ordination with one another. Taking inputs in different formats and give outputs in different formats that is accessible and understandable to other sensors and the programmers is required.

Work Details

- **TECHNOLOGIES:**

1. Python

Python is an interpreted, high-level, general-purpose programming language. Python's design philosophy emphasizes code readability with its notable use of significant whitespace. Its language constructs and object-oriented approach aims to help programmers write clear, logical code for small and large-scale projects.

Python is dynamically typed and garbage-collected. It supports multiple programming paradigms, including procedural, object-oriented, and functional programming. Python is often described as a "batteries included" language due to its comprehensive standard library.

- Use of Python in the project: Implementation of all modules and control of General Purposed Input Output Pins (GPIO Pins) is done using Python programming language
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2. OpenCV

OpenCV (Open-Source Computer Vision Library) is an open source computer vision and machine learning software library. OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in the commercial products. Being a BSD-licensed product, OpenCV makes it easy for businesses to utilize and modify the code.

The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms. These algorithms can be used to detect and recognize faces, identify objects, classify human actions in videos, track camera movements, track moving objects, extract 3D models of objects, produce 3D point clouds from stereo cameras, stitch images together to produce a high resolution image of an entire scene, find similar images from an image database, remove red eyes from images taken using flash, follow eye movements, recognize scenery and establish markers to overlay it with augmented reality, etc.

- Use of OpenCV in the project: This Python library is used in multiple modules like face detection, object detection etc.

3. Raspberry Pi

The Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation in association with Broadcom. The Raspberry Pi project originally leaned towards the promotion of teaching basic computer science in

schools and in developing countries. The original model became more popular than anticipated, selling outside its target market for uses such as robotics. It is widely used in many areas, such as for weather monitoring, security cameras etc. because of its low cost, modularity, and open design.

It is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python.

- Use of Raspberry Pi in the project: It is the heart of the project as all circuits and modules made are connected and coded on the Raspberry Pi.
- Model Used: Raspberry Pi 3 B+

4.HTML

The Hyper Text Markup Language, or HTML is the standard markup language for documents that are to be designed for being displayed in a web browser. It is assisted by technologies such as Cascading Style Sheets and scripting languages such as JavaScript.

- Use of HTML in the project: HTML is creating a simple webpage for Smart Lights IoT implementation.

5. CSS

Cascading Style Sheets is a style sheet language used for describing the presentation of a document written in a markup language such as HTML. CSS is an integral part of the World Wide Web, alongside HTML and JavaScript.

- Use of CSS in the project: CSS is used in designing the webpage created.

6. Tkinter

Tkinter is a Python binding to the Tk GUI toolkit. It is the standard Python interface to the Tk GUI toolkit, and is Python's de facto standard GUI. Tkinter is included with standard Linux, Microsoft Windows and Mac OS X installs of Python. The name Tkinter comes from Tk interface

- Use of GUI interface to control LEDs.

- **Application Specification/Requirements:**
    - **Functional Requirements:**

- LED Control System: LED lights can be controls and the frequency of blinking and brightness is also easy to control. This programmed code is used in Smart Lights systems to implement IoT.
- Face Detection: The camera module connected to the Raspberry Pi captures an image and processes it to give an output. It also prompts the no. of faces it detected.
- Security Camera System (Motion Detection): A movement within the motion sensors range triggers the camera to capture an image of the person that activated the motion sensor.
- 3D Coordinate System: When the Raspberry Pi and the connected gyroscope senses any movement, the sensor is programmed to output the angular velocity (degree per second) that is the coordinates or the module.

- **Non-Functional Requirements:**

1. **Performance and Scalability**:

Performance defines how fast a software system or its particular piece responds to certain users' actions under certain workload. In most cases, this metric explains how much a user must wait before the target operation happens (the results, motion sensor is activated, etc.) given the sensitivity of the components (camera, gyroscope etc.) used. Scalability assesses the highest workloads under which the system will still meet the performance requirements.

2. **Portability and Compatibility**:

Portability defines how a system or its element can be launched on one environment or another. It usually includes hardware, software, or other usage platform specification. Portability also has an additional aspect called compatibility. Compatibility defines how a system can co-exist with another system in the same environment.

3. **Supported Operating Systems:**

Raspberry Pi supports:

1. Raspberry Pi OS
2. Raspberry Pi OS Lite

3. NOOBS
4. Ubuntu
5. Manjaro ARM Linux
6. RISC OS Pi etc.

4. Hardware

1. Camera (5MP)
2. Motion Sensor
3. Gyroscope
4. Breadboard
5. Jumper Wires (Male to Female, Male to Male and Female to Female)
6. Resistors (1K Ohm, 300 Ohm etc.)
7. LED (Red, Green, White etc.)
8. Multi-meter
9. Display Screen
10. HDMI Cord
11. Micro USB
12. Keyboard
13. Mouse
14. Raspberry Pi

5. Compatibility Requirements:

PC: Windows® operating system, versions 10 Build 10240 or higher
MAC®: Mac OS X® 10.5 or higher
Python Version: 3.9
Pip Version: 21.1.2

6. Security:

This non-functional requirement assures that all data inside the system or its part will be protected against malware attacks or unauthorized access.

7. Reliability:

This quality attribute specifies how likely the system or its element would run without a failure for a given period of time under predefined conditions.

8. Usability:

Usability is yet another classical non-functional requirement that addresses a simple question: How hard is it to use the product?
Raspberry Pi is the gateway towards Robotics and AI and therefore is easy to use and beginner friendly.

Learning and Future Action Plan

- **LEARNING**

This project was aimed to get familiar with Robotics and Automation and help understand how large-scale implementations are done in real-world scenarios. This required building a strong foundation in Python and understanding of Artificial Intelligence (AI) and Machine Learning (ML) algorithms.

After gaining the basic knowledge required for the project, the next step moving forward was to implement the real-world applications on a small scale. This goal was achieved used a Raspberry Pi. Understand the power of this small computer gave high insights in the field of Robotics. Controlling LEDs from a GUI, to physically switch it ON/OFF, blink or change in brightness was similar to Smart IoT devices. Using a camera module for face detection successful was similar to its uses in facial recognition, security etc. Adding a PIR motion sensor to this camera module led to the development of a small-scale security system. The motion triggered the camera to take pictures or videos and store them in its memory. The gyroscope was used to implement a coordinate system and to be able to track the temperate, acceleration and coordinates successfully. All these small-scale implementations are miniature systems of systems used in Robotics professionally.

- **FUTURE SCOPE**

The current project is focused more on the basics and the fundamentals of how Robotics work. These mini projects and components of actual complex robotic machines. Therefore, to incorporate and combine all these small modules together to form a better and more reliable integrated machine will be an advancement and future scope. Also, to upgrade the sensors to the ones with high precision and accuracy is a must. This adds more reliability and gives more control to the programmer to achieve the required targets through these projects.

- **OVERALL LEARNING AND WORKING EXPERIENCE**

The technical internship at PBOPlus Ltd has been a professionally satisfying experience. The opportunity helped me to greatly expand my knowledge base and gain insights about working in the Robotics domain. It enabled me to interact with individuals displaying profound intellect and professionalism.

The internship has provided me a stepping stone towards working with highly skilled professionals and executives. I would like to extend my sincere gratitude to the Mr

Karunesh Jha, my industry mentor for sharing his invaluable inputs and enabling me to implement concepts in real life as a means to gain exposure and practical experience.

I would like to acknowledge the backing and guidance of all the Professors and staff of NMIMS' MPSTME for enabling students to go through a comprehensive industrial training to get a first-hand experience of working in the industry. I would also like to thank my Faculty Supervisor, Ms. Mohini Reddy for her continuous support and eagerness to help me throughout the duration of the internship. I would like to express my gratitude to my colleagues for their guidance during the entire period of the training that helped make this internship a memorable experience.

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