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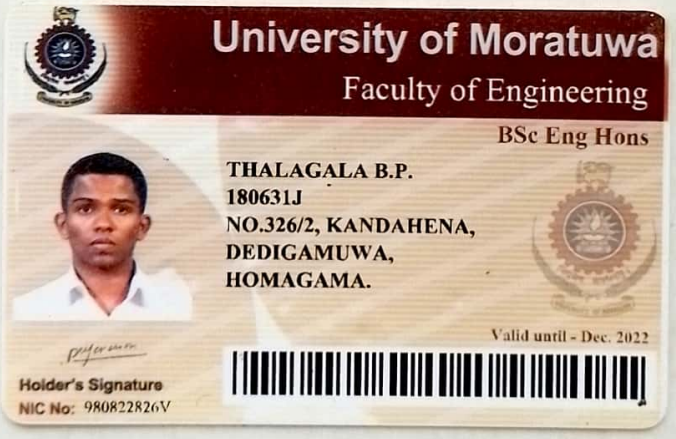
தேசிய பயிலுநர் கைத்தொழிற் பயிற்சி அதிகாரசபை

NATIONAL APPRENTICE AND INDUSTRIAL TRAINING AUTHORITY



DAILY DIARY

UNDERGRADUATE / DIPLOMA / CERTIFICATE

INDUSTRIAL TRAINING

APPRENTICE'S DAILY DIARY

Name : BIMALKA PIYARUWAN THALAGALA

Apprentice 's Private Address : 326/2, kandahena, Dedigamuwa.

Contact Phone Number : 0750296594 / 0112 141148

Category : ~~Degree (B.Sc. Eng.)~~ Special Industrial Training.

Field / Trade of Training : Electronic and Telecommunication Engineering

Registration Number given by the University/Institute/College : 180631J

Registration Number given by the NAITA : –

Name of Training Establishment : (1) L.E. Robotics (Pvt.) Ltd – Minuwangoda

Period of Training: From : 04/01/2022 To : 20/06/2022

(2) .....

From : ..... To : .....

NOVATION

Name and Address of Establishment	Workshops/ Worksites	Period		Signature of Officer In Charge (With Rubber Stamp)	Designation
		From	To		
LE Robotics (Pvt) Ltd. 100/4, Divulapitiya Rd, Minuwangoda.	– Do –	04/01/2022	20/06/2022	L.E. ROBOTICS (PVT.) LTD. Engineer - In - Charge	

WEEK NO: 01

FOR THE WEEK ENDING
Sunday 09/01/2022

TRAINING LOCATION
LE Robotics (Pvt) Ltd

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	01/03	—
Tuesday	01/04	* A brief introduction about the company, including history, progress and current status was given. * observed the machines used in industrial robot arm manufacturing (Lathe/milling/computer neumarical control[CNC])
Wednesday	01/05	* Responsibilities and Tasks were assigned to each trainee. * Initiated the feasibility study of the task "Machine vision based Real time trajectory Generation" * Learnt the basics of robot arm motion planning.
Thursday	01/06	* Investigated the tradeoffs between, traditional and Deep Learning based Machine Vision algorithms in resource constrained environment. * Referred several research and conferrence papers.
Friday	01/07	* A discussion was carried out about Non-Disclosure Agreements (NDA) and Intellectual Property (IP) of a company * Review a source code written in "C" programming language to identify best practices in codebase maintainance.
Saturday	01/08	} - Weekend -
Sunday	01/09	

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

The task that was assigned: Machine vision based Real time Trajectory Generation for an industrial articulated/SCARA robot arm.

Primary task carried out in the week: Feasibility study of ~~the~~ different algorithms to achieve the object detection portion of the above task.

* During the feasibility study two main approaches for object detection was identified.
  1. Traditional machine vision algorithms.
  2. Deep Learning based machine vision algorithms

* The inevitable tradeoff between accuracy and the speed was identified as the primary concern when choosing an algorithm for the object detection, when it comes to resource constrained embedded systems.

* Therefore, it was decided to incorporate a traditional machine vision approach to address the object detection problem, as those algorithms are optimized for performance and minimum computing resource when it is compared with deep learning based algorithms.

* A documentation was initiated to document the feasibility study and the progress.

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SIGNATURE OF TRAINEE

REMARKS AND CERTIFICATION BY THE ENGINEER /T.O

Satisfactory.

L.E. ROBOTICS (PVT.) LTD.

.....
Engineer - In - Charge

DATE : 12/01/2022

.....
DESIGNATION AND SIGNATURE

WEEK NO: 02

FOR THE WEEK ENDING
Sunday 16 / 01 / 2022

TRAINING LOCATION
LE Robotics (Pvt) Ltd.

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	01/10	* A discussion was carried out about commercialisation a product which involves Intellectual Property (IP) of a company * * Feasibility study was continued and finalized one algorithm.
Tuesday	01/11	* A presentation about "Non-Disclosure agreements" was ~~prepared to~~ presented ~~in front of~~ to the trainees of LE Robotics. * Further documentation of the selected object detection algorithm was added.
Wednesday	01/12	* Learnt about, how to choose a suitable hardware platform for a given embedded system. * A discussion was carried out about ~~optimizi~~ designing optimal hardware architecture for a given algorithm.
Thursday	01/13	* Initiated implementing an algorithm ~~for~~ from a Research paper named as "Topological Structural Analysis of Digitized binary Images by border following".
Friday	01/14	— Tamil Thai Pongal Day. —
Saturday	01/15	—
Sunday	01/16	—

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

Primary Task Carried out In the week = Learnt about how to select a proper hardware platform (processor) which is suitable and optimal for a given algorithm. optimal in the sense:- with minimum execution time and minimum cost.

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Engineer in - Charge

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Detailed description of the steps to follow:

(i) Select an algorithm which is suitable for the given task.

(ii) Investigate the modules and the most fundamental functions that the algorithm composed of.

(iii) Findout the types of most basic operations that are used inside those modules / functions. (addition / multiplication / floating point operation)

(iv) Compute the time complexity according to those basic operations.

(v) Select a processor which has sufficient "clock rate" to run the algorithm within the desired time duration. (real time.)

Problems encountered: Finding related research papers of functions inside "opencv" python library.

* Solved the problem by ~~finding the~~ tracing the functions descriptions in opencv documentations!

SIGNATURE OF TRAINEE

REMARKS AND CERTIFICATION BY THE ENGINEER /T.O

Satisfactory, focus on proper gramanatical usage

L.E. ROBOTICS (PVT.) LTD.

Engineer - In - Charge

DATE : 18/01/2022

DESIGNATION AND SIGNATURE

WEEK NO: 03

FOR THE WEEK ENDING

Sunday 23 / 01 / 2022

TRAINING LOCATION

L.E. Robotics (Pvt) Ltd.

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	01/17	- Duruthu Full moon Poya Day -
Tuesday	01/18	* continued the implementation of contour finding algorithm described in the paper "Topological structural Analysis of digitized binary images by border following."
Wednesday	01/19	- study leave for semester 5 end of semester exams -
Thursday	01/20	- study leave for semester 5 end of semester exams.
Friday	01/21	* Implemented and debugged linked list data structure using C language which is required for further implementation of the algorithm (mentioned above).
Saturday	01/22	—
Sunday	01/23	—

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

Primary task carried out in the week: Continued the implementation of algorithm from the paper mentioned above.

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Engineer - In - Charge

CamScanner

University of Moratuwa

Department of Electronic and Telecommunication Engineering

February 17, 2022

Dear Sir or Madam,

Compensation for Leaves Taken to Sit for Exams During Industrial Training

Thank you for offering industrial training for the students at the Department of Electronic and Telecommunication Engineering, University of Moratuwa.

With reference to the letter dated January 12, 2022, thank you for granting leave (leave on the exam dates and one day prior to each exam as study leave) for the students to complete the Semester 5 exams as per the schedule mentioned below.

Module	Date
Applied statistics	20 January 2022
Numerical methods	22 January 2022
Industrial management	24 January 2022
Multidisciplinary design, innovation and venture creation	26 January 2022
Business economics and financial accounting	28 January 2022

This is to confirm that the that the leave the interns took for exams can be compensated after the official 24-week internship period is complete.

Thank you.
Yours sincerely,

Dr. Ranga Rodrigo
Head of the Department
head-entc@uom.lk
+94 11 264 0416

50 YEARS OF EXCELLENCE
CamScanner

~~Problems encountered:~~ Struggled to ~~solve~~ debug a C program which involved pointers.

Problems encountered: struggled to solve a bug which involved manipulation of pointers in C language. Later it was realized that ~~life~~ ~~time~~ the bug was due to the lack of knowledge of a life time of a variable ~~withing~~ within different scopes. ~~and~~

The bug was solved using pointers of pointers!

The concepts of pass by value, pass by reference were deeply studied in regard to function calls in C language.

SIGNATURE OF TRAINEE

REMARKS AND CERTIFICATION BY THE ENGINEER /T.O

Satisfactory

L.E. ROBOTICS (PVT.) LTD.

DATE : 01/02/2022

Engineer - In - Charge

DESIGNATION AND SIGNATURE

WEEK NO: 04

FOR THE WEEK ENDING

Sunday 30 / 01 / 2022

TRAINING LOCATION

L.E. Robotics (pvt) Ltd

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	01/24	- Study leave for semester 5 end of semester - exams
Tuesday	01/25	* Implemented ~~the~~ a part of the algorithm mentioned in previous week, in order to find the first nonzero pixel of a Moore neighbourhood of a given pixel. * ~~Implemented~~ ~~an~~ effi optimized the same using enumerators in C language.
Wednesday	01/26	* Implemented border following algorithm part of the main algorithm and debugged it. For the border traversing concepts of Moore Neighborhood ~~and~~ was used. ~~Counter clockwise~~
Thursday	01/27	* The algorithm from the paper "Topological Structural Analysis of digitalized binary images" was ~~im~~ completed to a satisfactory level. * Debugged the algorithm using test images.
Friday	01/28	* Carried out timing comparisons of the algorithm ~~on~~ using different ~~algorithms~~ (~~c lan~~ languages. ("c" and "python") * Observed how efficient the "opencv" python library functions. with respect to the algorithm developed by me.
Saturday	01/29	—
Sunday	01/30	—

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

Primary work carried out in the week: Completion of the main algorithm of the paper "Topological Structural Analysis of a digitized binary images by border following", by adding the border following algorithm to the main algorithm.

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* The concepts of Moore Neighboorhood of a pixel was used when implementing the "borderfollowing" part of the main algorithm. ~~The pixels indexed 1, 2, 3, 4, 5, 6, 7, and 8~~

1	2	3
8		4
7	6	5

center pixel

Moore Neighbourhood: pixels indexed from 1 – 8 are known as the moore neighbourhood of a pixel. This concept has variety of applications in the computer vision literature.

#

* Calculating time it takes to execute a function call in python: This time can not be accurately calculated if we use only a single function call to measure it. As the reason for that frequent shifts between processes of an operating system can be shown.

sol^n: Run the function call for around (100 – 1000) times and get an average time of execution. That was found to be consistent over time.

SIGNATURE OF TRAINEE

REMARKS AND CERTIFICATION BY THE ENGINEER /T.O

Satisfactory, Good approach towards summarizing the work done & problems encountered.

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Engineer - In - Charge

DATE : 01/02/2022

DESIGNATION AND SIGNATURE

WEEK NO: 05

FOR THE WEEK ENDING

Sunday 06 / 02 / 2022

TRAINING LOCATION

L.E. Robotics (Pvt) Ltd.

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	01/31	* Wrote functions to generate and visualize test images and processed images respectively using "python". * Initialized a project to develop the same algorithm from the paper in ~~ARM~~ Atmega32A micro controller.
Tuesday	02/01	* Set up AVRDUDE for Atmel Studio in order to program the Atmega32A microcontroller. and installed drivers for USBasp cable. * Investigated the function of the algorithm in the Atmega32A.
Wednesday	02/02	* Implemented necessary programs to measure the time it takes to run the contour detection algorithm inside the Atmega32A microcontroller.
Thursday	02/03	* Successfully run the algorithm inside the Atmega32A for an ~~an~~ integer type image of size 8x12. Sizes greater than that do not work inside the microcontroller due to limited ~~stogra~~ storage.
Friday	02/04	* Learnt about several git (version controlling commands) to, create a branch / switch between branches / ~~and~~ and switch working copy of the project to specific commit.
Saturday	02/05	* Started studying two research papers related to ~~machine~~ automatic inspection based robot motion planning. —
Sunday	02/06	—

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

Primary work carried out in the week } : Made necessary changes to the original algorithm in order to make it run inside an AVR enhanced RISC (Reduced Instruction set computer) architecture based 8 bit microcontroller. (Atmega32A)

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Challenges:

⊛ Timing Analysis of a function call inside the micro controller. } : General purpose "C" language has the "time.h" library inorder to measure the time inside a program. However, when it comes to "Embedded C" which is used to program AVR micro controllers, there is no such ready made library available. Therefore a method to calculate time duration between two events had to be implemented using "Interrupt Service Routines" (ISR) of the AVR microcontroller.

Problems Encountered:

The maximum size of image that could be stored inside microcontroller was (8x12) (integer type), eventhough it could go more than that theoritically. } : Since we used Atmel Studio software to build our solution, we have no control over the memory allocation of the flash memory inside the AVR micro controller. However, there exist a way which gives us the fully control over those

memory allocation → project solution → Debug folder → .map file

It was found that methods are described in documentation of "avr-libc".

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SIGNATURE OF TRAINEE

REMARKS AND CERTIFICATION BY THE ENGINEER /T.O

* Satisfactory
* Briefly explain (when possible) the usage of software & equipment when first mentioned.

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Engineer - In - Charge

DATE : 08/02/2022

DESIGNATION AND SIGNATURE

WEEK NO: 06

FOR THE WEEK ENDING

Sunday 13 / 02 / 2022

TRAINING LOCATION

LE Robotics (Pvt) Ltd.

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	02/07	* Investigated the feasibility of using Raspberry Pi (RPi) (a single board computer) for real time object detection. * Installed the Operating System (OS) to RPi.
Tuesday	02/08	* Investigated about ~~various~~ different methods of installing OpenCV (an open source computer vision algorithm library written in C++ language. * Installed OpenCV on RPi.
Wednesday	02/09	* ~~Done~~ Started implementing the paper "Automated visual Inspection: Position Identification of Object for Industrial Robot Robot Application based on Color and shape" using (C++) on Raspberry Pi using OpenCV.
Thursday	02/10	* Completed the paper implementation upto object detection and drawing bounding boxes around detected objects. * Carried out a timing? analysis for that part.
Friday	02/11	* Learnt about compiling C++/C language programs using "Makefile". * Wrote a script to compile the previously mentioned object detection code.
Saturday	2/12	* Went through ~~the~~ a set of tutorial videos, which are related to image processing using Field programmable Gate Arrays (FPGAs).
Sunday		—

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

Primary work carried out in the week:

* Investigated the capabilities of Raspberry Pi (single board computer) on real time object detection.
* Did a timing analysis of ~~the~~ ~~the~~ a sub module of the object detection algorithm on Raspberry Pi.

Problems Encountered :

(I) Compiling a C language program with multiple source files and header files on Raspberry Pi. : Learnt the concept of "Makefile" which can be used to ~~compile the source files and/header to and to~~ automate the process of compiling and linking multiple source files, using (Linux Shell.) (The Linux command line Interpretor.)

(II) Compiling custom OpenCV (the opensource computer vision library) for Raspberry Pi. to optimize the resource usage. : Precompiled packages of ~~of~~ OpenCV are available for Windows / iOS / and Android. ~~only~~ However there is no official precompiled version of that for Raspberry Pi. Therefore openCV must be ~~com~~ built ~~using~~ by compiling the source codes of openCV library in Raspberry Pi. During the compilation we can set different parameters to optimize the ~~installing~~ openCV for Raspberry Pi.

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REMARKS AND CERTIFICATION BY THE ENGINEER /T.O

satisfactory

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Engineer - In - Charge

DATE : 15/02/2022

DESIGNATION AND SIGNATURE

WEEK NO: 08

FOR THE WEEK ENDING
Sunday 27 / 02 / 2022

TRAINING LOCATION
L.E. Robotics (Pvt) Ltd

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	02/21	* Implemented camera calibration algorithm using openCV, in order to extract intrinsic / extrinsic parameters. * Photographed the checkerboard pattern using a static camera in order to feed to the algorithm.
Tuesday	02/22	* Went through the documentation of openCV camera calibration and realized they have assumed the user to input photographs of a static checkerboard using a moving camera. (Not the otherway around)
Wednesday	02/23	* printed a new checkerboard, pasted it on a constructed real world coordinate system. * Generated real world coordinates of the corners of checkerboard w.r.t the world coordinte system, and photographed it ~~using~~ as specified.
Thursday	02/24	* completed camera calibration. * Extracted intrinsic and extrinsic parameters ~~of~~ of the camera using the openCV algorithms. * Saved obtained parameters into text files for future usage.
Friday	02/25	* Verified real world to image plane coordinate transformation using extracted parameters. * Started implementing image plane to real world mapping, using pseudoinverse method. (A method to find inverse of a non square matrix.)
Saturday		
Sunday		—

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

Primary task carried out in the week: Camera calibration to find intrinsic and extrinsic parameters of the given camera for object detection.

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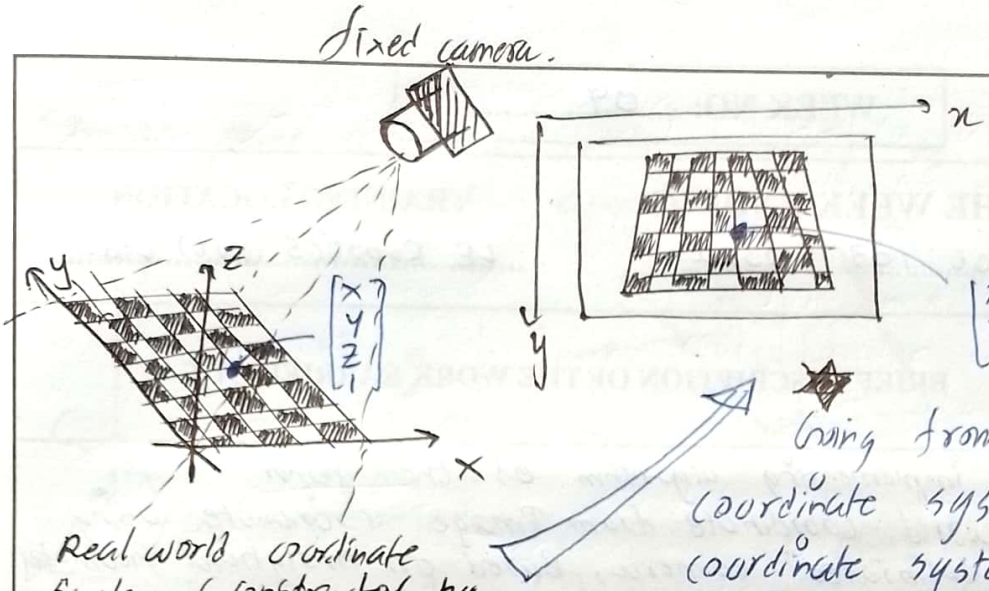
Engineer - In - Charge



Going from real world coordinate system to image coordinate system is an obvious task. ~~which can~~ That's what a camera does.

scaled image coord: $\begin{bmatrix} dx \\ dy \\ d \end{bmatrix} = \underbrace{\begin{bmatrix} * & * & * & * \\ * & * & * & * \\ * & * & * & * \end{bmatrix}}_{3\times 4} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$ Homogeneous Real world coord:

(projective transformation matrix.)

☹ !! However, the backprojection from image plane to real word is not straight forward, as we ~~[illegible]~~ loose all the depth information, when we take an image of a real world object. There are various methods to solve this problem in literature.

Priyanka

SIGNATURE OF TRAINEE

REMARKS AND CERTIFICATION BY THE ENGINEER /T.O

Good.

L.E. ROBOTICS (PVT.) LTD.

Engineer - In - Charge

DATE : 01/03/2022

DESIGNATION AND SIGNATURE

WEEK NO: 09

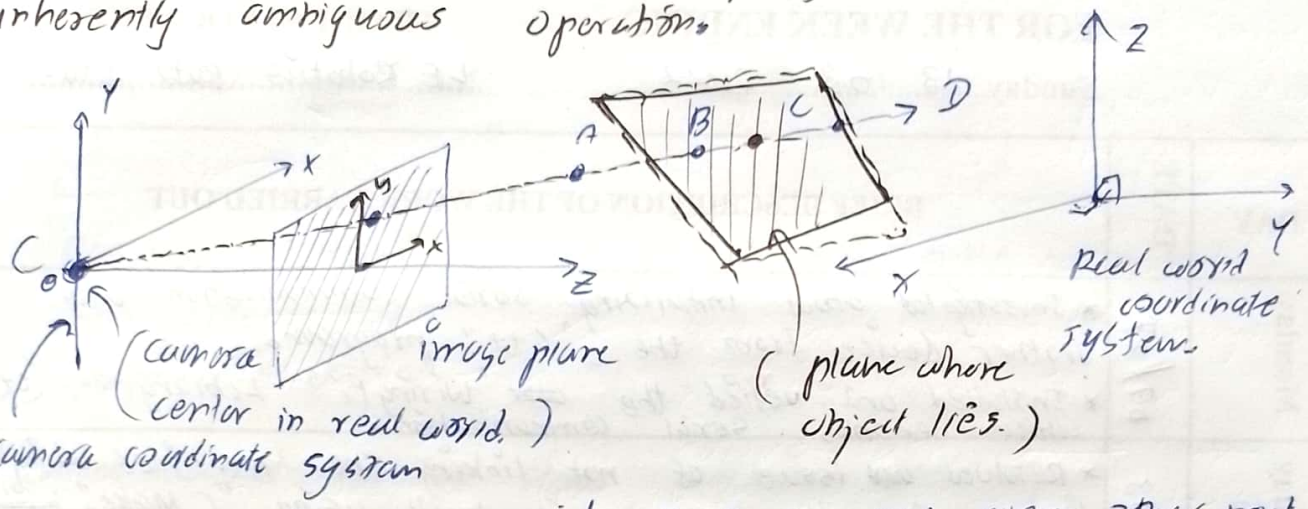
FOR THE WEEK ENDING Sunday 06/03/2022	TRAINING LOCATION L.E. Robotics (Pvt) Ltd.

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	28/02	* Started implementing algorithm of the paper "Real world coordinate from Image coordinate using single calibrated camera, Based on analytical Geometry"
Tuesday	01/03	* Algorithm's performance was analyzed and observed that it gives successful outcomes! * Documented the methods followed, and cleansed the code.
Wednesday	02/03	* Extended the object detection algorithm to map image coordinates back to the real world. * Analyzed the time taken for the full task.
Thursday	03/03	* Changed object detection algorithm from "connected component analysis based" to "contour analysis and contour, the moment analysis based." (the moment: scale and rotation invariant ~~moment.~~) - quantity used for ~~image~~ object classifications.) * Cleansed the main code for better understanding. by defining functions for tasks and dividing code into sections.
Friday	04/03	*
Saturday		—
Sunday		—

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

primary work carried out in the week: Implemented ~~code~~ ~~using~~ the paper using both Python and C++ languages and integrated image coordinate to real world mapping functions to main ~~code~~ object detection code, along with object orientation detection algorithms.

* Image plane to real world mapping of coordinates is inherently ambiguous operation.



* The reason is that point A, B, C and every other point lies on the C to D lines map to the same point on the image plane.

* Real world point can be approximated if we know the equation of the line joining camera center and real world point) and equation of the plane that the object lies, with respect to the real world.

* Point of intersection of that plane and the line gives the real world coordinate.

SIGNATURE OF TRAINEE

REMARKS AND CERTIFICATION BY THE ENGINEER /T.O

Satisfactory.

L.E. ROBOTICS (PVT.) LTD.

Engineer - In - Charge

DATE : 11/03/2022

DESIGNATION AND SIGNATURE

WEEK NO: 10

FOR THE WEEK ENDING

Sunday 13/03/2022

TRAINING LOCATION

LE Robotics (Pvt) Ltd.

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	03/07	* Investigated about initializing serial communication with another device from the "C++" program. * Installed and verified the "Wiring Pi" Library for (C++/C) which enables serial communication.
Tuesday	03/08	* Resolved issue of not linking the mentioned WiringPi library, when the program is built using "C Make". * Extended the main object detection code to setup serial communication link with external device.
Wednesday	03/09	* Investigated about how the serial communication happens between two devices that are compatible with UART (universal Asynchronous Receiver-Transmitter) protocol. * Implemented data to "byte" conversion algorithm to use with the protocol
Thursday	03/10	* Refactored the code to handle different requests made by the main robot controller, using ("switch-case") procedure in C++ * Fixed several bugs in the code and cleansed the code.
Friday	03/11	* worked on finding a way to simulate the communication between robot arm and the program. * Found out that it can be done through the help of terminal emulator and USB to serial converter cable connected to the Raspberry Pi.
Saturday		— Weekend
Sunday		—

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

Primary work carried out in the week: Extended the object detection algorithm to serial communicate with the main robot controller to perform operations, when requested.

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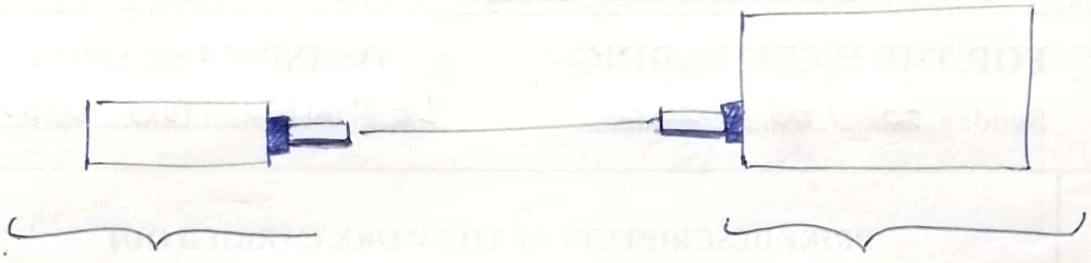

* Object detection modal starts working according the commands and requests issued by the main controller. This objective is achived through a serial communication link established between two devices.

* However USB works in 5V whereas Raspberry Pi works in 3.3V logic level. This incompatibality is addressed using special hardware called as FTD232R USB-UART chip.

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REMARKS AND CERTIFICATION BY THE ENGINEER /T.O

Satisfactory

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.....
Engineer - In - Charge

DATE : 15/03/2022

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DESIGNATION AND SIGNATURE

WEEK NO: 11

FOR THE WEEK ENDING

Sunday 20 / 03 / 2022

TRAINING LOCATION

LE Robotics (Pvt) Ltd.

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	14/03	* Started documenting the work done in first two months, that is related to object detection model implemented in the Raspberry Pi Single Board computer
Tuesday	15/03	* Add the documentation and guide for the "camera calibration". * Add the related Python scripts to the document and linked them ~~in~~ ~~the~~ to the ~~main~~ explanation.
Wednesday	16/03	* Add guidelines to ~~install~~ ~~and~~ build and install the optimized version of the OpenCV for Raspberry Pi. * Add challenges faced during that build process and methods to solve.
Thursday	17/03	- Full moon Poya Day -
Friday	18/03	* Add ~~overall~~ system description / system overview / and ~~the~~ the explanation ~~of~~ of the main object detection algorithm. * Appended the necessary scripts and linked them to the description.
Saturday		Weekend.
Sunday		

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

Primary work carried out in the week. :- Documentation of the vision system, which ~~describes~~ includes,

(i) Required software installations,

(ii) Code explanations (written in Python)

(iii) Algorithm explanations.

Engineer - In - Charge

* Learnt about proper documentation techniques used in industry, and types of documentations.
* Learnt new techniques to use in LaTeX document processing platform.

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REMARKS AND CERTIFICATION BY THE ENGINEER /T.O

Satisfactory
Can further explain new techniques learnt in the Details & notes section

L.E. ROBOTICS (PVT.) LTD.
Engineer - In - Charge

DATE : 22/03/2022

DESIGNATION AND SIGNATURE

WEEK NO: 12

FOR THE WEEK ENDING
Sunday 27 / 03 / 2022

TRAINING LOCATION
LE Robotics (Pvt) Ltd.

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	03/21	* Reformat the documentation according to the IEEE conference papers style. * Developed a c++ code to capture template images which will be used to classify objects.
Tuesday	03/22	* Extended the code to process template images, ~~and~~ extract their contours and save those contours. * Learnt about file handling using "fstream" in c++.
Wednesday	03/23	which can be used to both read and write from/to files. * Removed hard coded parts from the source codes and include functions to get necessary data ~~file by~~ by using files.
Thursday	03/24	* Restructured the source code into object oriented programming styles to improve the clarity and readable of the code. * Included more comments for code self explaining.
Friday	03/25	* Started implementing a User Interface to calibrate the camera, which will be used for object detection. * Created a simple basic layout for the application using
Saturday	03/26	Visual studio's "Windows Forms App (.Net Framework)" template.
Sunday	03/27	- Weekend -

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

Primary work carried out in the week. = Restructuring the source code which was in a single file to seperate source and header files by following object oriented programming style in c++.

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* Learnt new concepts:

(i) C++ object oriented programming (OOP): OOP is a programming paradigm that relies on the concept of classes and objects. It is used to structure a software program into simple / reusable piece of code blueprints (usually called classes.)

(ii) C++ file handling using fstream: C++ programming lang. provides the class "fstream" to both read and write from/to files.

(iii) User Interface designing using "windows Forms Application (.Net Framework) of visual studio. This is based on "C#" programming language.

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REMARKS AND CERTIFICATION BY THE ENGINEER /T.O

satisfactory

L.E. ROBOTICS (PVT.) LTD.

Engineer - In - Charge

DATE : 29/03/2022

DESIGNATION AND SIGNATURE

WEEK NO: 13

FOR THE WEEK ENDING

Sunday 03 / 04 / 2022

TRAINING LOCATION

LE Robotics (Pvt) Ltd.

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	03/28	* Finalized the User Interface's form layout design. * Add necessary methods to access camera and show video stream through the "picture Box" tool in forms.
Tuesday	03/29	* Changed the target (.Net) framework's version to 4.6.1 and made necessary changes in the code to be compatible with it. * Downgraded Emgu CV package to 4.5.1 version.
Wednesday	03/30	* Add initial methods of camera calibration (using functions in Emgu CV. (image preprocessing (chessboard pattern detection * Add methods to generate real world object points that ~~are~~ correspond to detected corners in the chessboard images.
Thursday	03/31	* Add guidelines for novice ~~user~~ user to make it easy to understand how to use the software.
Friday	04/01	* Implement methods to handle XML files to save calibrated camera data in such a way that the format is compatible with C++ opencv.
Saturday	04/02	- weekend -
Sunday	04/03	

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

Primary work carried out in the week:

* Design the layouts the user interface for an application to carry out camera calibration.
* Implemented methods for it's buttons and other ~~tools~~ components to get the job done.

~~Challenges~~ Problems Encountered. } : ① At first the latest version of Emgu CV (4.5.5.4823) was used to implement the application and it was found that it lacks some of the documentation. Therefore I had to downgrade the version to 4.5.1. to carry out the implementation further.

Note that "Emgu CV" is a wrapper for "Open CV" open source computer vision library, for (.Net) compatible languages such as C#. ["C sharp"].

② writing data to xml files:- The data that is obtained through camera calibration must be written to a file for future use. Here the writing should be done in such a way that the format is compatible with "OpenCV C++", where we run the actual object detection framework.

.....
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REMARKS AND CERTIFICATION BY THE ENGINEER /T.O

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Engineer - In - Charge

DATE : 05/04/2022

DESIGNATION AND SIGNATURE

WEEK NO: 14

FOR THE WEEK ENDING
Sunday 10 / 04 / 2022

TRAINING LOCATION
LE Robotics (Pvt) Ltd

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	04/04	* Initialized implementing the Application for object classification trainer. * Designed a user interface for the mentioned App. * Debugged some bugs in the code. ~~using~~ of that App.
Tuesday	04/05	* Implemented methods to extract objects contour and save ~~these~~ it with a name to a dictionary type data structure. * Investigated about the optimal methods to get required features from object's image.
Wednesday	04/06	* Complete the basic functionality of the mentioned Application. * Documented necessary details to build the project without problems in visual studio.
Thursday	04/07	* Extended functionality of the Application to provide steps to use the application (for beginer ~~u~~sers.) * add ~~butto~~ enable/disable sequence for buttons to make it easy to understand how to use the software.
Friday	04/08	* Restructure the Application to have a hierarchycal structure rather than a flat user interface.
Saturday	04/09	- weekend -
Sunday	04/10	

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

Primary work carried out in the week: Implemented a complete ~~user~~ Application to
1. calibrate a camera
2. Train the ~~da~~ object classifier model used in object detection.

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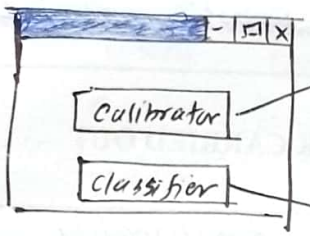
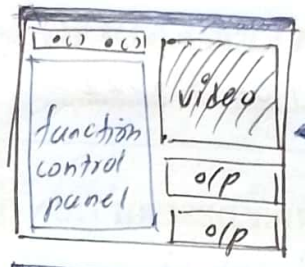
Engineer - In - Charge

CamScanner

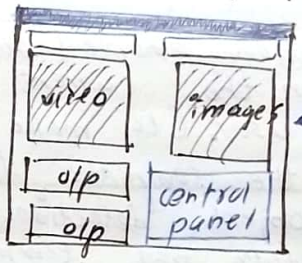
user interface for camera calibration and object classifier trainer.



Top level Application



← User interface layout of camera calibrator



← User Interface layout of classifier trainer.

Problem encountered: The opencv version that is used inside ~~open~~ (Emgu.CV) [the C# wrapper for opencv] is compiled for (x86) architecture and therefore ~~the~~ our application must be built targetting (x86) architecture, otherwise it will give build errors!

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Engineer - in - Charge

DATE : 12/04/2022

DESIGNATION AND SIGNATURE

WEEK NO: 15

FOR THE WEEK ENDING	TRAINING LOCATION
Sunday 17 / 04 / 2022	LE Robotics (Pvt) Ltd.

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	04/11	* Added button enable / disable functionality depending on the current step of the process, to guide the user. (to make it easy to use the software.) * Verified the complete functionality of the application.
Tuesday	04/12	* Updated object detection framework to get the calibration data and template objects' data by reading XML files generated by the previously mentioned application. * Added object classification algorithm to the object detection framework.
Wednesday	04/13	- Day prior to Sinhala and Tamil New Year -
Thursday	04/14	- Sinhala and Tamil New year -
Friday	04/15	- Good Friday -
Saturday	04/16	- weekend -
Sunday	04/17	

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

Primary work carried out in the week:

* Verified the functionality of camera calibrator and object classifier trainer applications.
* Add methods to read XML files to get calibration data and template objects' data. (to the main object detection framework)

Learnt : * New methods to guide the user of an application ~~towards the~~ to get the job done using the software without doing unnecessary things. (eg: interactive guidelines / button enable / disable functionality depending on the current step of the process.)

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REMARKS AND CERTIFICATION BY THE ENGINEER /T.O

Satisfactory

L.E. ROBOTICS (PVT.) LTD.

Engineer - In - Charge

DATE : 19/04/2022

DESIGNATION AND SIGNATURE

WEEK NO: 16

FOR THE WEEK ENDING

Sunday 24 / 04 / 2022

TRAINING LOCATION

L.E. Robotics (PVT) Ltd.

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	04/18	* Documented, ~~the~~ how to use the "Camera Calibrator" software. * Added extensions to the software to view corresponding user manuals.
Tuesday	04/19	* Completed the development of the "Classifier trainer" application. * Composed new documentation on how to use ~~it~~ the software to train the object detection model.
Wednesday	04/20	* Finalized user manuals of "camera calibrator" and "classifier trainer" softwares. * Checked performance of the object classification modal and identified its drawbacks to improve it.
Thursday	04/21	* Added required functionalities to send the files that are generated by Windows software to the Raspberry Pi. (Where the actual object detection happens).
Friday	04/22	* Created a seperate software to transfer files between Windows PC and the Raspberry Pi. * Linked that software to the main software to make the overall process easy.
Saturday	04/23	} - weekend -
Sunday	04/24	

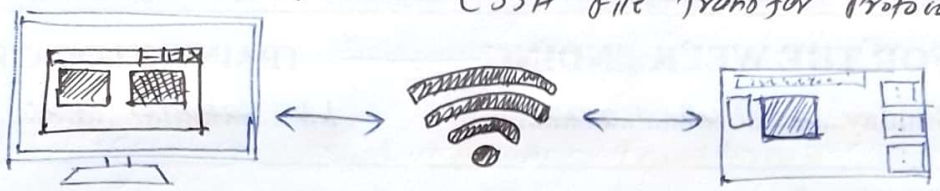
DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

Primary work carried out in the week. } :* Documented "Camera calibrator" and "classifier Trainer" applications.

* Implemented methods to transfer the generated files ~~of~~ by the mentioned applications to Raspberry Pi.

CamScanner

~~Learn~~ File transferring ~~between~~ to a remote host using SFTP (SSH File Transfer Protocol).



PC which the "camera calibrator" and the "classifier-trainer" ~~two~~ applications are run.

Both are connected to the same network!

Raspberry Pi Single Board computer where the object detection framework is run.

* SFTP (SSH File Transfer Protocol) : is an extension to the SSH (Secure Shell) protocol. The SFTP provides ~~ways~~ methods to ~~a~~ ~~Network~~ file access / file transfer / and file management ~~all~~ over any reliable data stream. (Here I have used the ~~Local~~ ~~Area~~ ~~Network~~ ~~with~~ a Local Area Network established through a Wifi Router.)

* "WinSCP" (a free and open source file transfer protocol) package in visual studio was used for implementation.

SIGNATURE OF TRAINEE

REMARKS AND CERTIFICATION BY THE ENGINEER /T.O

Good

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Engineer - In - Charge

DATE : 26/04/2020

DESIGNATION AND SIGNATURE

WEEK NO: 17

FOR THE WEEK ENDING Sunday 01 / 05 / 2022

TRAINING LOCATION LE Robotics (Pvt) Ltd.

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	04/25	* solved a problem with object classification model which led to misclassify some objects. * Add new methods to the application in order to visualize the objects which are already in the database.
Tuesday	04/26	* Identified that the object classification, entirely depending on the shape of the contour do not give satisfactory results. * started looking for alternatives.
Wednesday	04/27	* Initialized implementation of a new classification model which is based on "Bag of visual words" and "Support vector machines". * Designed basic layout of the application to facilitate for the new changes.
Thursday	04/28	* Implemented a sophisticated method to save ~~training~~ images to suit them to be used in training the classifier.
Friday	04/29	* Investigated efficient feature detection methods used in computer vision, that can be used inside an embedded system. * Started implementing "ORB" feature detector.
Saturday	04/30	} - weekend -
Sunday	05/01	

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

Primary work carried out in the week. } :

(I) Identified weaknesses of ~~the~~ classifying objects, depending entirely on the shape of the contour of an object.

(II) Therefore, investigated alternative methods for object classification.

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Solution (proposed): Image classification based on SIFT and SVM.

SIFT: Scale-Invariant Feature Transform: a computer vision algorithm to detect and describe recognizable, distinctive features from an ~~imp~~ image. (wikipedia)

SVM: In machine learning "support vector machines" are "supervised learning" models with associated learning algorithms that analyze data for classification. (wikipedia)

Method:

Feature Extraction → K-means clustering to create the vocabulary → Calculate Bag of words descriptors for each image → Multiclass SVM classifier training → Predictions

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When using certain Method / Technique specific terminology try to explain those terms for clarity of the reader.

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DATE : 03/05/2022

DESIGNATION AND SIGNATURE

WEEK NO: 18

FOR THE WEEK ENDING Sunday 08/05/2022

TRAINING LOCATION L.E. Robotics (Pvt) Ltd.

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	05/02	Initialized implementing an object classifier based on SIFT (Scale Invariant Feature Transform) and Support Vector Machines. Debugged an error given by the support vector Machine. Changed feature detection method to SIFT, as ORB (oriented
Tuesday	05/03	FAST and Rotated BRIEF) descriptor found to be not working properly. Train the SVM (support vector Machine) classifier using a set of template images. Test the accuracy of the classifier and found that it gives ~~around~~
Wednesday	05/04	around 0.9 accuracy (90%) Add script to the main windows application to send the files which includes information (parameters of the trained classifiers) to the Raspberry Pi. Learnt about different algorithm
Thursday	05/05	parameter saving methods implemented in opencv. ~~The~~ Extended the base object detection framework to use SIFT and SVM based classifier. Implemented methods to get the required algorithm parameters from
Friday	05/06	the file sent by main windows application. * Handled an exception ~~given~~ ~~by~~ raised by the SVM classifier when a new image is passed for prediction. * Demonstrated ~~the~~ performance of the system to the supervisor.
Saturday	05/07	* Cleansed the code by removing ~~unne~~ unnecessary code snippets (unwanted comments / unwanted debugger methods) * Started a literature survey on "grasping methods" when picking an objects by a robot arm.
Sunday	05/08	– Weekend –

[~~compensation~~ (compensation for the casual leave on Friday (13th May)]

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

Primary work carried out in the week: * Extended the basic object detection framework to use SIFT and SVM based image classification.

* Implemented a new windows application to train the new classifier.

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Image classification method used in object detection framework.

Previous: Object's contour based classification method with low accuracy.

New: SIFT features based classifier which uses several support vector machines in one-vs-all approach.
(Has around 90% classification accuracy).

Problems Encountered: Method of saving and retrieving algorithm parameters ~~when~~ of the trained classifier.

Training phase of the classifier happens in the windows application → However? → Actual object detection model runs on the remotely located Raspberry Pi.

∴ we have to send the data related to trained classifier to the Raspberry Pi, in an OpenCV (open source computer vision library) compatible way.

Sol^n: Use OpenCV's "FileStorage" class! This class handles files in the way we need!

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REMARKS AND CERTIFICATION BY THE ENGINEER /T.O

Satisfactory

Avoid exclamation ~~points~~ mark in technical writing, ~~where~~ unless it's a warning, caution or specific scientific notation

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Engineer - In - Charge

DATE : 10/05/2022

DESIGNATION AND SIGNATURE

WEEK NO: 19

FOR THE WEEK ENDING Sunday 15/05/2022

TRAINING LOCATION LE Robotics (Pvt) Ltd.

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	05/09	* Carried out a literature survey on "object grasping position detection" methods. * Read several reserach papers on the mentioned topic to select an algorithm to implement.
Tuesday	05/10	– Company closed due to curfew – (whole day)
Wednesday	05/11	– Company closed due to curfew. (whole day).
Thursday	05/12	* Continued reading the found research papers to select a suitable method that ~~suits~~ ~~the~~ ~~fits~~ fits my allocated task. [Company closed at 12-30pm due to curfew]
Friday	05/13	– Casual Leave – [Compensated by working on ~~7th~~ saturday 7th of May (last week)]
Saturday	05/14	– { weekend } –
Sunday	05/15	

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

Primary work carried out in the week: Conduct a literature survey on object grasping position identification without using deep learning.

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* In computer vision literature there are many methods to identify the "grasping position of an object" using various deep learning techniques.

* However, my allocated task was to develop a vision system that does not use deep learning for any of its functionalities.

* Therefore finding a suitable algorithm / method was quite challenging due to a lot of constraints like time and resource usage.

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REMARKS AND CERTIFICATION BY THE ENGINEER /T.O

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Engineer - In - Charge

DATE : 17/05/2022

.....
DESIGNATION AND SIGNATURE

WEEK NO: 20

FOR THE WEEK ENDING Sunday 22 / 05 / 2022

TRAINING LOCATION LE Robotics (Pvt) Ltd

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	05/16	- Public, Bank and Mercantile Holiday - (Day following week full Moon Poya Day)
Tuesday	05/17	* Initialized implementing a method to identified grasping location of an object using SIFT (Scale Invariant Feature Transform) features and perspective transformation. * Added functions to ~~add~~ get mouse clicked points from the user on a given image.
Wednesday	05/18	* Added scripts to calculate Homography Transformation matrix between two given images using the matching key points extracted by SIFT algorithms
Thursday	05/19	* Benchmarked the performance of the algorithm on ~~achiving~~ achieving the mentioned task. * observed that algorithms, produces unreliable outputs and therefore not suitable for an industrial level application.
Friday	05/20	* Carried out a literature survey on methods to improve the performance of the mentioned algorithms.
Saturday	05/21	* Found a method named as improved RANSAC (Random sample consensus) to ~~improve~~ improve the algorithm's performance. * However, that also failed to give the expected results and therefore had to terminate further development of the task "grasping location detection")
Sunday	05/22	- weekend -

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

Primary work carried out in the week: Implementing an algorithm to determine grasping configurations for a detected object in order to grab it successfully by a pick and place robot.

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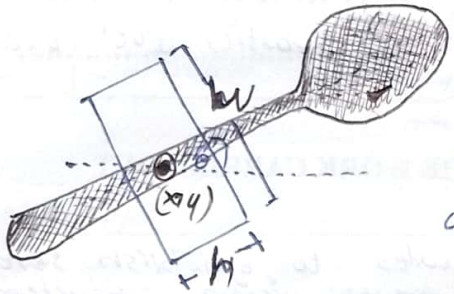
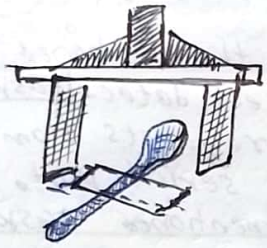
Grasp configuration of an object. $G = (x, y, w, h, \theta)$



In order to grab an object on ~~an~~ a conveyor we need few details about the object.

1. A location to grasp (x, y)
2. Width of the opening of a parallel plate gripper. (w) (End effector of a robot)
3. Orientation of the object with respect to a ~~given~~ known axis on the conveyor. (θ)



* Once we know these parameters of an object we can successfully grab the object using a pick and place Machine.
* There are deep learning based and traditional computer vision approaches to solve ~~these~~ problems and here I used a traditional method due to ~~re~~ hardware resoure constraints.

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.....
Engineer - In - Charge

DATE : 24/05/2022

.....
DESIGNATION AND SIGNATURE

WEEK NO: 21

FOR THE WEEK ENDING
Sunday 29 / 05 / 2022

TRAINING LOCATION
LE Robotics (Pvt) Ltd.

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	05/23	• Initiated implementing source codes to establish serial communication between the computer vision subsystem and the main Robot controller. • Wrote a library in C++ language for the mentioned task.
Tuesday	05/24	• Extended and restructured the main object detection framework's program to accept requests from the main robot controller, sent through serial port. • Added necessary documentation of the mentioned task to main documentation of the framework.
Wednesday	05/25	• Configured Raspberry Pi's hardware for reliable serial communication. • Implemented a method to send data from Raspberry Pi to main robot using "template function" concept in C++ language.
Thursday	05/26	• Cleansed the code ~~and~~, verified and demonstrated the functionality of the newly implemented serial communication process. • Documented the working principals of that.
Friday	05/27	• Updated the documentation of object detection framework by adding how to interact and make use of the associated two windows Graphical user Interfaces. [camera calibrator and "classifier trainer".] (GUI.)
Saturday	05/28	• Modified some of the codes in the mentioned (GUIs) to be more compatible with the framework. runs on Raspberry Pi.
Sunday	05/29	} - weekend

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

Primary work carried out in the week: } Extended the object detection framework's functionality to aid serial communication between the Raspberry Pi and the Main robot controller.

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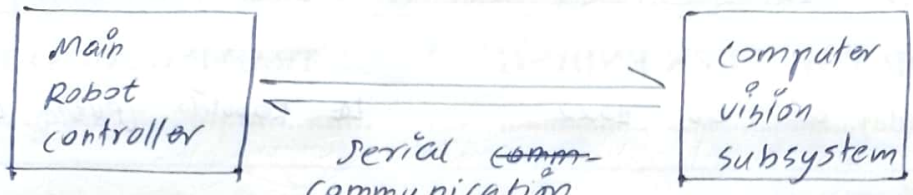
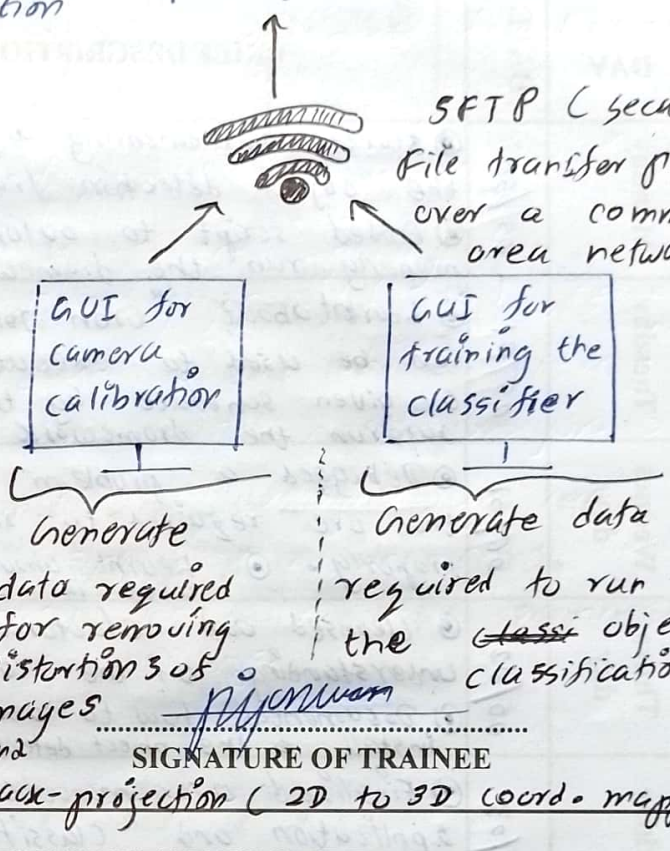


* Main Robot controller sends requests to the Raspberry Pi, for various task.

Communication between the Raspberry Pi and controller is established using UART (universal Asynchronous Receiver/Transmitter) circuitry, which receives and transmits serial data.



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REMARKS AND CERTIFICATION BY THE ENGINEER /T.O

Satisfactory.

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Engineer - In - Charge

DATE : 31/05/2022

DESIGNATION AND SIGNATURE

WEEK NO: 22

FOR THE WEEK ENDING Sunday 05 / 06 / 2022

TRAINING LOCATION L.E. Robotics (PVT) Ltd.

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	05/30	⊙ Started implementing a Linux shell script to automate the "object detection framework" installation. ⊙ Added script to automate environment configuration to properly run the framework.
Tuesday	05/31	⊙ Learnt about "Cron Jobs" in Linux systems which can be used to execute various tasks according to a given schedule by the user. ⊙ Added script to autorun the framework at device bootup.
Wednesday	06/01	⊙ Debugged a problem with one of the libraries that are required to run the object detection framework properly. ⊙ Learnt about various user permission types used in Linux systems. (read/write/execute)
Thursday	06/02	⊙ Cleansed and refactored the shell scripts for better understanding of the code. ⊙ Documented how to use the implemented scripts to install the object detection framework into a clean Raspberry Pi.
Friday	06/03	⊙ Finalized user manuals of the "Camera Calibrator" application and "Classifier Trainer" applications ~~which are~~ (two graphical user interfaces) that are ~~required to~~ needed to generate required data for object detection framework.
Saturday	06/04	} -weekend-
Sunday	06/05	

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

Primary work carried out in the week: Implementation of two Linux shell scripts to automate,

(i) Environment setting up for the object detection framework.

(ii) Building the object detection framework from its source files.

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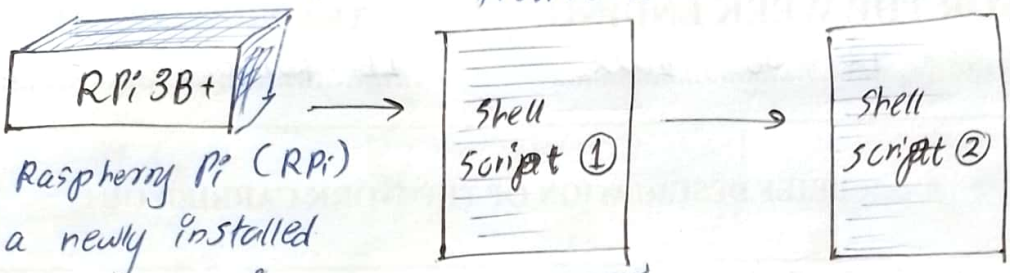
Engineer - in - Charge

Automated process of deploying the object detection framework.



The Raspberry Pi (RPi) with a newly installed Raspbian operating System.

the script which will be used to set up the environment to run the framework.

the script to automate the build process of the framework and make it run at RPi bootup.

Shell scripts: a computer program designed to be run by unix like command line interpreters. (Linux terminal / Ubuntu terminal / RPi terminal)

These scripts can be used to automate various cumbersome tasks we found in unix like operating systems.

SIGNATURE OF TRAINEE

REMARKS AND CERTIFICATION BY THE ENGINEER /T.O

Satisfactory. Good approach at summarizing the work done.

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Engineer - In - Charge

DATE : 07/06/2022

DESIGNATION AND SIGNATURE

WEEK NO: 23

FOR THE WEEK ENDING

Sunday 12 / 06 / 2022

TRAINING LOCATION

LE Robotics (Pvt) Ltd.

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	06/06	* started interfacing computer vision subsystem to the Pick and Place Machine. (the articulated robot arm) * Verified basic serial communication between the robot and the Raspberry Pi with the supervisor, using a test programe.
Tuesday	06/07	* Solved several problems found in handshaking (the state of initializing serial communication) when the actual robot is interfaced with the vision subsystem. * used oscilloscope to monitor Receiver and Transmitter Signalling between the robot and Raspberry Pi.
Wednesday	06/08	* Verified the successful communication upto the point, where the robot requests data of the detected objects from the vision module. (this comes after a successful handshake)
Thursday	06/09	* Added a method to write each step of serial comm. to a log file for debugging purposes. * Handled two requests of robot that were not documented previously by analyzing the main "C" program of the robot.
Friday	06/10	* Cleansed the code runs inside the Raspberry Pi by removing code snippets, that were used for debugging serial communication. * Added methods to verify whether the requested data is sent to the pick and place machine by the Raspberry Pi
Saturday	06/11	* Managed to run the robot a complete pick and place circle. * Identified various parts of the system that can be further developed to improve system performance.
Sunday	06/12	- weekend -

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

Primary work carried out in the week:

* Interfaced the computer vision subsystem to the pick and place robot.
* Verified the sucessful run of a single pick and place circle using the data provided by the vision module.

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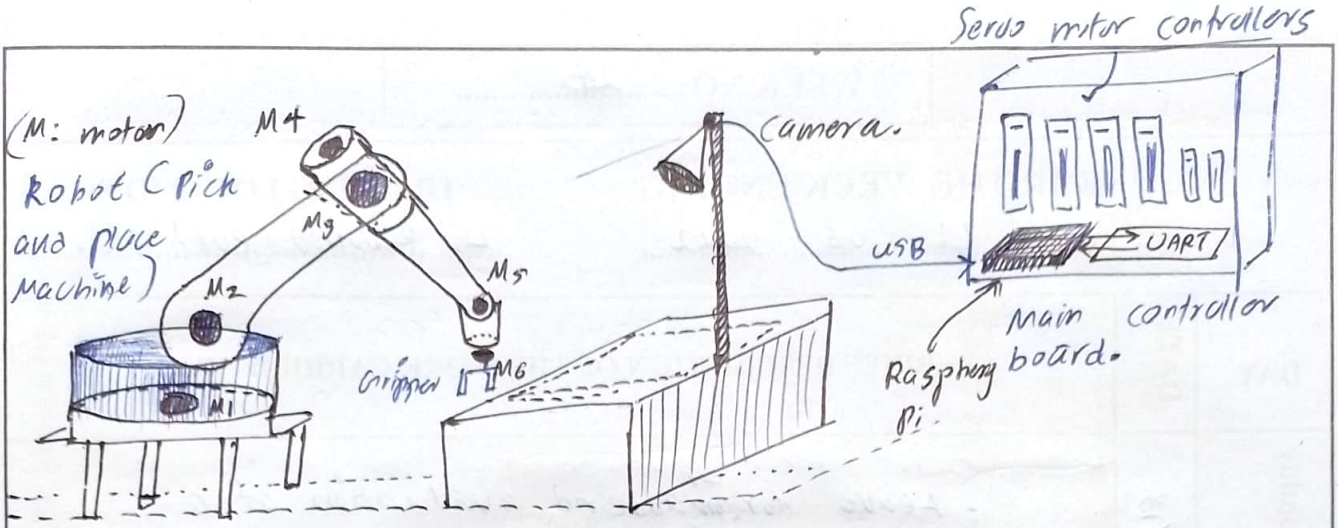
Engineer - In - Charge



Functionality of computer vision subsystem: Get a video stream from the camera → process images → Identify the location and orientation of objects → send them to the main controller using serial communication.

Depending on those received data, pick and place machine plans
c) the required motion ~~and~~ (path). Therefore these ~~grasping~~ data must be precisely sent to the robot. For that a reliable serial communication link must be built between the robot and the Raspberry Pi. ~~This week~~

Mirwan
SIGNATURE OF TRAINEE

REMARKS AND CERTIFICATION BY THE ENGINEER /T.O

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Satisfactory

L.E. ROBOTICS (PVT.) LTD

Jaknil
Engineer - In - Charge

DATE : 15/06/2022

DESIGNATION AND SIGNATURE

WEEK NO: 24

FOR THE WEEK ENDING

Sunday 19 / 06 / 2022

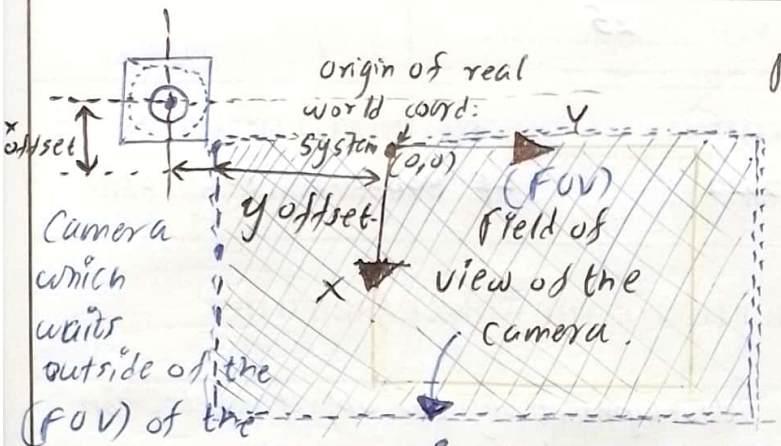
TRAINING LOCATION

LE Robotics (PVT) Ltd.

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	06/13	- Leave for attending evaluation of a Semester 5 module - (Leave was compensated by working on 06/11/2022)
Tuesday	06/14	- Poson Full Moon Poya Day -
Wednesday	06/15	* Verified the data transmission from raspberry Pi to the main robot controller using a debugging code. Then checked the behavior of the robot using the real/actual code. * Modified the developed GUI by adding new components, to add an offset of the end effector of robot
Thursday	06/16	* Added new functions to the modified GUI to save the coordinate offsets' data, while preserving the original calibration data. * Added interactive steps for the newly added software features.
Friday	06/17	* Debugged an error in the main object detection framework that has occured due to wrong camera calibration data. * Improved region proposing algorithm which runs before object detection to propose better regions and reduce false detection.
Saturday	06/18	- Weekend -
Sunday	06/19	* Fixed a major bug in the object detection framework that caused not to transmitting the orientation of a detected object. (It was found that it was due to data type mismatch in the program

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

Primary work carried out: Added a new feature to the exisisting LE object detector GUI, for getting coordinate offsets, of the end effector of the robot. (This is explained in next page with illustrations.)



Problem encountered: When Camera waits for an object, if it blocks the FOV (Field of view) of the Camera, that affects the detection of objects.

Solution: Adjust the waiting position of the camera, Such that it does not block the FOV.

* For this we can give enough offsets for the camera, measured from the origin. Then the actual position ~~w.r.t the camera~~ of a detected object w.r.t the camera can be given as follows.

g Position: $(x_{\text{real world coord.}} + x_{\text{offset}}, y_{\text{real world coord}} + y_{\text{offset}})$

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REMARKS AND CERTIFICATION BY THE ENGINEER /T.O

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Engineer - In - Charge

DATE : 21/06/2022

DESIGNATION AND SIGNATURE

(Additional week 01.)

WEEK NO: 25

FOR THE WEEK ENDING
Sunday 26 / 06 / 2022

TRAINING LOCATION
LE Robotics (pvt) Ltd.

DAY	DATE	BRIEF DESCRIPTION OF THE WORK CARRIED OUT
Monday	06/20	* Terminated further development of the object detection framework, to start documentation. * Removed unwanted code snippets of the mentioned program to clean it before finalizing. * Added more comments.
Tuesday	06/21	* Started documenting the installation process of the object detection framework, as well as the method of integrating it to the main robot controller. * Documented how to install an operating system to a ~~Raspberry~~ Raspberry Pi.
Wednesday	06/22	* Documented the installation processes related to dependancies of the object detection framework. (various libraries) * Documented the build process of the object detection program.
Thursday	06/23	* Documented the method of integrating the computer vision subsystem to the main robot controller. * Added methods to verify the successful system integration
Friday	06/24	* Created a separate document which can be used ~~to~~ as an aid for further development of the system. * Added possible areas of development of the object detection framework.
Saturday	06/25	} - weekend -
Sunday	06/26	

DETAILS AND NOTES OF WORK CARRIED OUT, PROBLEMS ENCOUNTERED AND HOW SOLVED ETC., DIMENSIONS AND SKETCHES TO BE GIVEN WHEREVER POSSIBLE

* This additional week was dedicated to ~~the~~ compose the documentation related to, building the computer vision subsystem and integrating it to the main pick and place robot.
* Because 'documentation' is an essential part when a project is handed over to the company.

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* Purposes of documentation can be listed as follows.

① Further development of the system in the future.

② Install the developed system in the future, when the employee who undertook the ~~proje~~ project is no longer there in the company.

③ Address the possible problems that can occur during the operation of the ~~robot~~ system.

④ Troubleshooting purposes/ required updates of the system.

Due to the reasons mentioned above, it is a good practice to properly document the work carried out during the employment. Moreover, it will be a great help to the one who is going to undertake the project when you leave the company.

~~Because he can start~~

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SIGNATURE OF TRAINEE

REMARKS AND CERTIFICATION BY THE ENGINEER /T.O

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L.E. ROBOTICS (PVT.) LTD.

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Engineer - In - Charge

DATE : 28/06/2022

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DESIGNATION AND SIGNATURE

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INSPECTION REPORT

NAME AND DESIGNATION OF OFFICER : – M. M. K. Satharasinghe – Inspector.

DATE 11/03/2022.

REMARKS : – The D/D has been updated well.

M.M.K SATHARASINGHE
INSPECTOR

SIGNATURE

NAME AND DESIGNATION OF OFFICER : – M. M. K. Satharasinghe – Inspector.

DATE 16/06/2022.

REMARKS : – The D/D has been updated.

M.M.K SATHARASINGHE
INSPECTOR

SIGNATURE

NAME AND DESIGNATION OF OFFICER :

DATE

REMARKS :

SIGNATURE

NAME AND DESIGNATION OF OFFICER :

DATE

REMARKS :

SIGNATURE

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INSPECTION REPORT

NAME AND DESIGNATION OF OFFICER : DATE

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REMARKS :

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SIGNATURE

NAME AND DESIGNATION OF OFFICER : DATE

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REMARKS :

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NAME AND DESIGNATION OF OFFICER : DATE

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REMARKS :

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SIGNATURE

NAME AND DESIGNATION OF OFFICER : DATE

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REMARKS :

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PROGRESS REPORT OF AN ESTABLISHMENT ON TRAINING PERFORMANCE

Name of Establishment : LE Robotics (Pvt) Ltd

Period of Training - From : 2022/01/04 To : 2022/06/20

Comments of Training Supervising Officer on Trainee's

1. Conduct very good

2. Attitude to work very good

3. Attendance Very Good. Did some additional days of work after contract period to cover the work to handover the finalised project.

NO. OF DAYS LEAVE TAKEN	AUTHORIZED	UNAUTHORIZED
05	05	—

Signature of the officer in-charge of training.
(with rubber stamp)

L.E. ROBOTICS (PVT.) LTD.
Engineer - In - Charge

PROGRESS REPORT ON PERFORMANCE FORM THE TRAINING ESTABLISHMENT

Name of Establishment : .....

Period of Training - From : ..... To : .....

Comments of Training Supervising Officer on Trainee's

1. Conduct

2. Attitude to work

3. Attendance

NO. OF DAYS LEAVE TAKEN	AUTHORIZED	UNAUTHORIZED

Signature of the officer in-charge of training.
(with rubber stamp)

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