

In18-IT-EN3992

Industrial Training

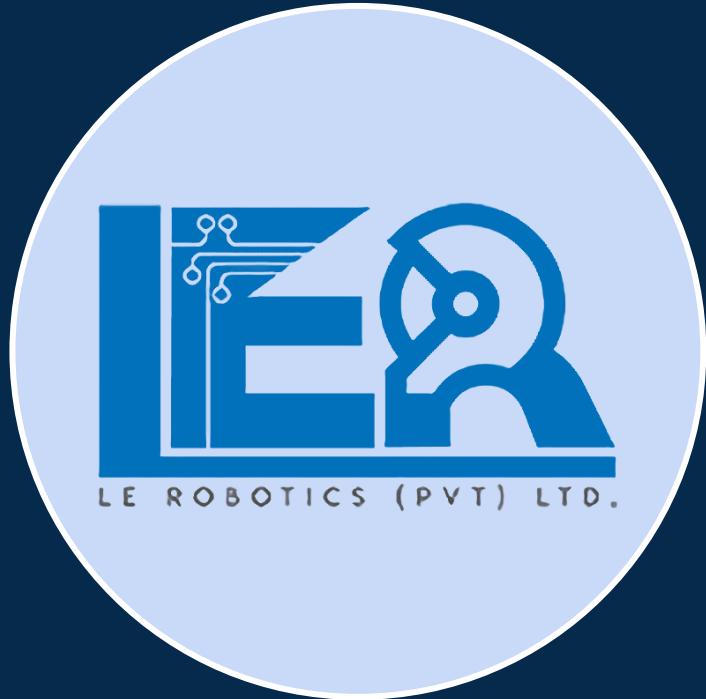
@ L.E. Robotics (Pvt.) Ltd.

Bimalka
(Former Engineering Intern)

Supervised By
Prof. J.A.K.S. Jayasinghe

Engineer In-Charge
Miss. J.A.L. Jayasinghe

<http://www.lerobotics.lk/>



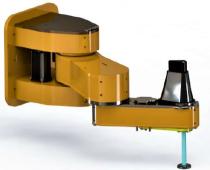
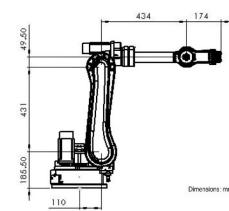
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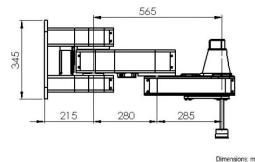
Description of the Organization



Robot Dimensions



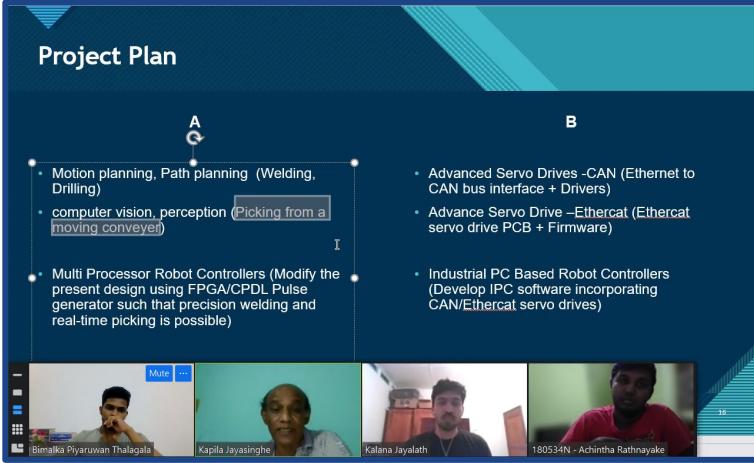
Robot Dimensions



- L.E. Robotics (Pvt.) Ltd. is a local R&D facility located in Minuwangoda, Sri Lanka.
- Offers fully customisable robotics solutions for various automation needs
- Established in 2005 by Prof. J.A.K.S. Jayasinghe who is a senior professor in ENTC
- Products manufactured:
 - **6 DOF Robots** - Robots with six degrees of freedom
 - **4 DOF Robots** - Robots with four degrees of freedom
 - R&D of the related technologies (servo motors and their drivers)

Familiarization work carried out

Project Plan



A

- Motion planning, Path planning (Welding, Drilling)
- computer vision, perception (Picking from a moving conveyor)
- Multi Processor Robot Controllers (Modify the present design using FPGA/CPDL Pulse generator such that precision welding and real-time picking is possible)

B

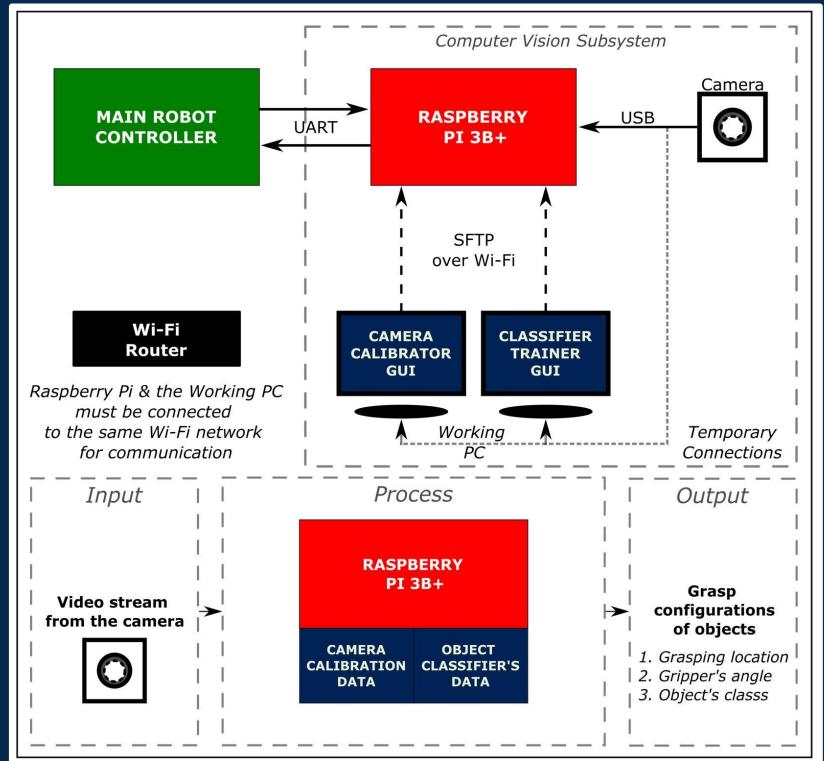
- Advanced Servo Drives -CAN (Ethernet to CAN bus interface + Drivers)
- Advance Servo Drive –Ethercat (Ethercat servo drive PCB + Firmware)
- Industrial PC Based Robot Controllers (Develop IPC software incorporating CAN/Ethercat servo drives)

Bimalka Piyanuwara Thalagala Kapila Jayasinghe Kalana Jayalath 180534N - Achintha Rathnayake

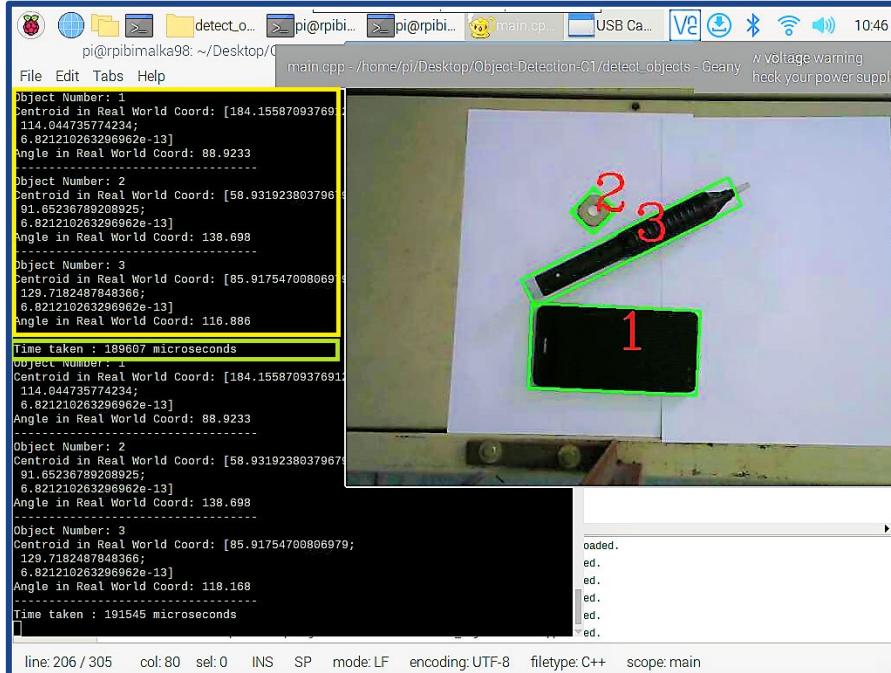
- Projects Assignment was done about a month prior to the commencement of internship
 - two project plans were offered
 - we agreed to move forward with plan A (on left)
- Facility familiarization after commencement of the internship
 - introduction to industrial robot arm designing
 - machinery required for industrial robot arm designing (CNC,Lathe,...)
- Non-Disclosure agreement

Project Work

- By title, the project that I was assigned, was “*Machine vision based Real-time Motion Planning for an Industrial Articulated Robot Arm*”.
- My contribution to that project
 - Developed an object detection framework
 - Developed an application for camera calibration (Camera Calib. GUI)
 - Developed an application to train an object classification model (Classifier Trainer GUI)

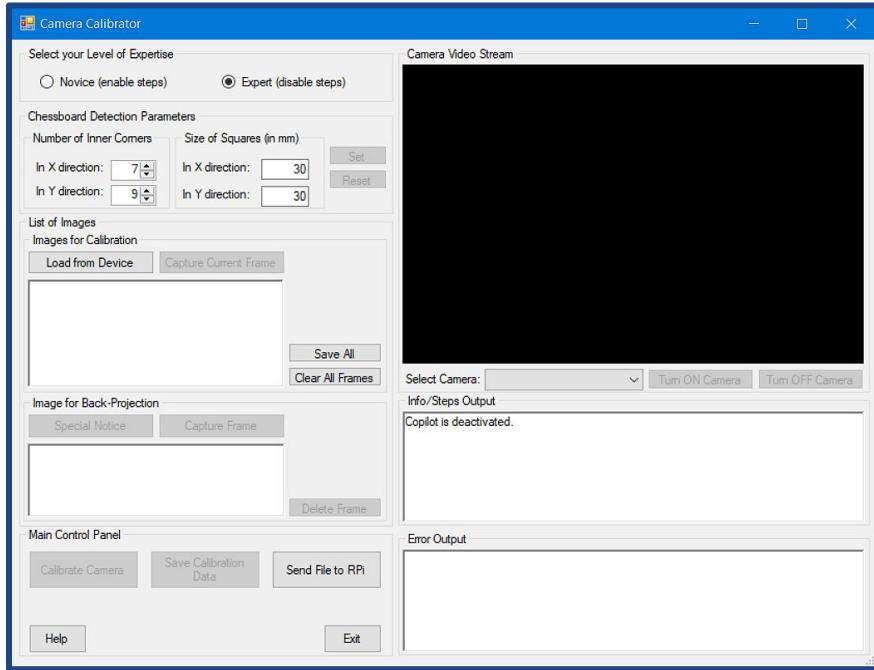


Object Detection Framework



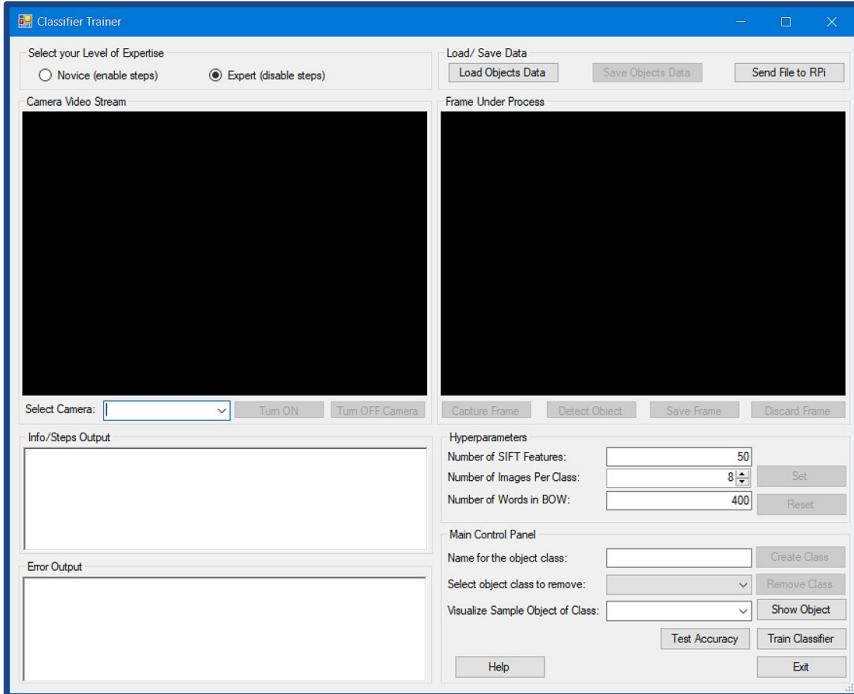
- Engineered from scratch
- Developed two associated Windows GUIs (coming up next)
- Capable of determining **grasping configurations** (location, orientation and object class) for a given object
- Implemented all the algorithms using **C++ and OpenCV** (a traditional Computer Vision approach)
- Documented working principles and guidelines to deploy the framework to the vision subsystem of pick and place machine

Camera Calibrator GUI



- Designed the user interface
- Developed required algorithms using **C#** and **Emgu CV**
- Composed the user manual for the software.
- Can be used to calibrate **any monocular camera** to be used in automatic pick and place machines
- Application is capable of generating required data, to remove the distortions of captured images to transform 2D image points back to a given 3D real world coordinate system with **an accuracy of ± 0.5 mm.**

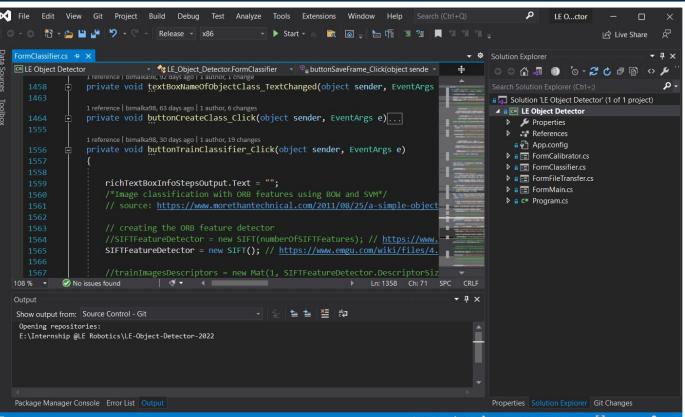
Classifier Trainer GUI



- Designed the user interface
- Implemented required algorithms using **C#** and **Emgu CV**
- Trained and tested the accuracy of the model on **industrial robot parts classification**
- Composed software's user manual
- Classification model uses, **SIFT** for feature extraction; **K-Means clustering** to create the Bag of Words (BOW); and Support Vector Machines (**SVMs**) for classification in One-vs-All approach.

Hands-on Experiences

- LE robotics Pvt. Ltd. had no experts in the CV field. I had to learn most of the things related to my assigned projects by actually doing them.
- An ideal opportunity to learn, unlearn and relearn various technologies really fast and with minimum supervision.
- Resources for Self-Learning
 - *Google Search • Stack Overflow • OpenCV Documentations • EmguCV Documentations • Research Publications*
- Usage of Open Source Software
- Usage of Modern Tools (CV & SE related)
 - *Visual Studio 2019 • Visual Studio Code • Git • CMake*

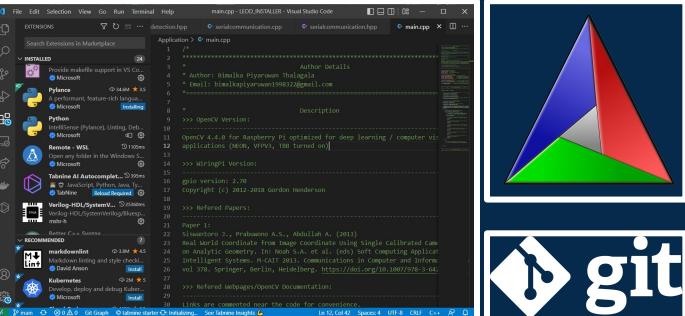


Screenshot of Visual Studio 2019 IDE showing the code editor with C# code for an object detection application, the Solution Explorer displaying project files, and the Package Manager Console.

```

private void buttonTrainClassifier_Click(object sender, EventArgs e)
{
    richTextBoxInfoStepsOutput.Text = "";
    //Image classification with ORB features using SVM
    // sources: https://www.morethantechnical.com/2011/08/25/a-simple-object-detection-with-svm-and-orb/
    // creating the ORB feature detector
    SIFTFeatureDetector = new SIFTFeatureDetector();
    //trainImagesDescriptors = new Mat(1, SIFTFeatureDetector.DescriptorSize, CvType.CV_32F);
}

```

Screenshot of Visual Studio Code showing a C++ file (main.cpp) with code related to OpenCV and CMake, and the Extensions sidebar showing installed extensions like Python, C/C++, and CMake.

```

1 // Main Application File
2 // Author: Bimalka Piyantha Thalagala
3 // Email: bimalkapiyantha9502@gmail.com
4 // Description
5 // OpenCV Version:
6 // CMake Version:
7 // WiringPi Version:
8 // git version: 2.17.1 (64-bit)
9 // Copyright (C) 2012-2018 Gordon Henderson
10 // Refered Papers:
11 // ...
12 // ...
13 // ...
14 // ...
15 // ...
16 // ...
17 // ...
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20 // ...
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24 // ...
25 // ...
26 // ...
27 // ...
28 // ...

```

Soft Skills Development

- Learning a new technical skill is not a big deal with the advancements in technology as everything is available at the fingertip
- However, mastering a soft skill is much harder and takes time
- LE Robotics Pvt. Ltd. was absolutely an ideal place to improve existing soft skills as well as to learn a new set of soft skills
 - **Problem-solving:** exposure to the world of 'Research publications', exposure to entire prototype development process (idea generation, research, planning and prototyping)
 - **Adaptability:** Companies and working environments are different from one another, have to deal with human beings with diverse mindsets
 - **Time management:** Proper planning and organization of the assigned tasks depending on their priority, knowledge of modern tools was also a plus point
 - **Professional work ethic:** Punctuality, Trustworthiness and obeying the NDAs, Respect the Intellectual Property (IP) of others
 - **Communication :** project demonstrations, various presentations and technical documentation preparations

SWOT Analysis

Organization

- Great vision towards "Made in Sri Lanka"
- Decades of experience in the industry
- R&D of very advanced technologies

S

W

O

T

Self

- Can work under minimum supervision
- A team player with critical thinking abilities
- Fast learner who learns as needed

- Underestimate myself when a new challenge is introduced

- Industrial automation is a fast growing field
- Professionals with both AI and Embedded Systems Engineering knowledge have a higher demand

- Below the average GPA in the department! (LOL)

Conclusion

- A whole new challenge which **demanded a diverse set of technical skills as well as soft skills**
- An opportunity to experience my full potential as an engineering student and **revealed my true calibre**
- No one is there to spoon-feed you in the industry and one must build a mindset of **working under minimum supervision**
- Being a **team player** and completing the assigned tasks well in advance, is a must to be successful in product development in the current fast moving industry
- **Inner peace matters** and one should **maintain work-life balance** to be a successful professional.

Thank You

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