

In18-IT-EN3992

Industrial Training

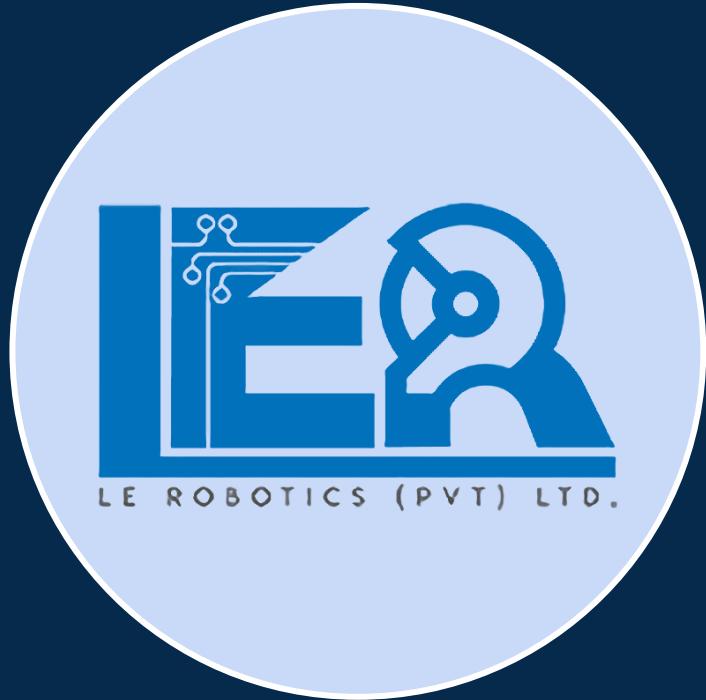
@ L.E. Robotics (Pvt.) Ltd.

Bimalka
(Former Engineering Intern)

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

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

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



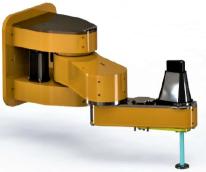
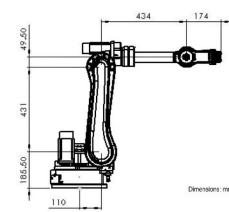
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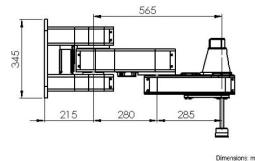
Description of the Organization



Robot Dimensions



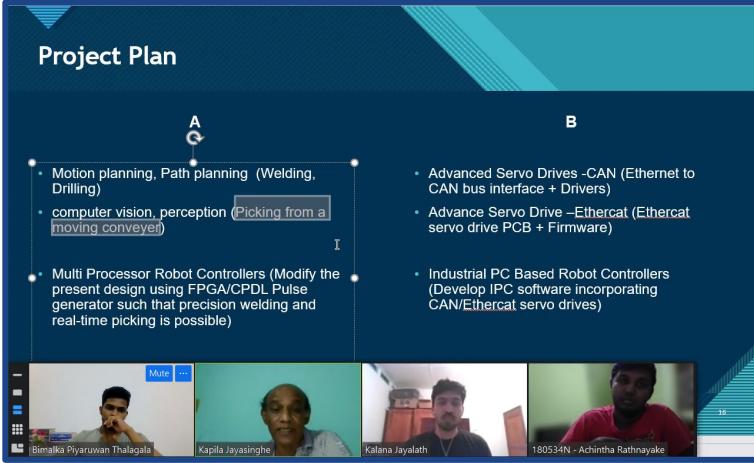
Robot Dimensions



- 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

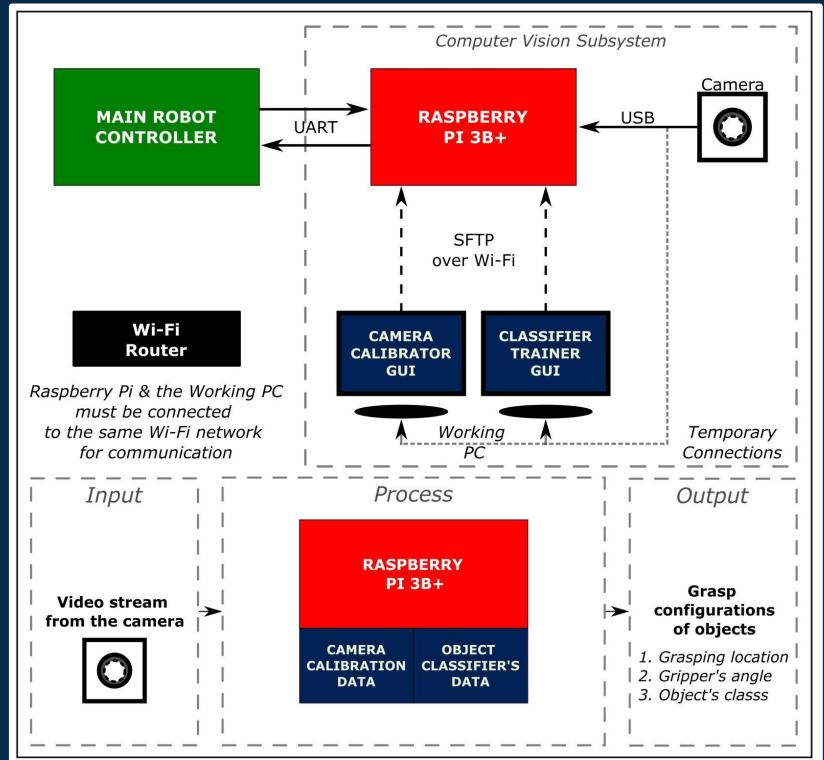
- Advanced Servo Drives -CAN (Ethernet to CAN bus interface + Drivers)
- Advance Servo Drive –Ethercat (Ethercat servo drive PCB + Firmware)
- Industrial PC Based Robot Controllers (Develop IPC software incorporating CAN/Ethercat servo drives)

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

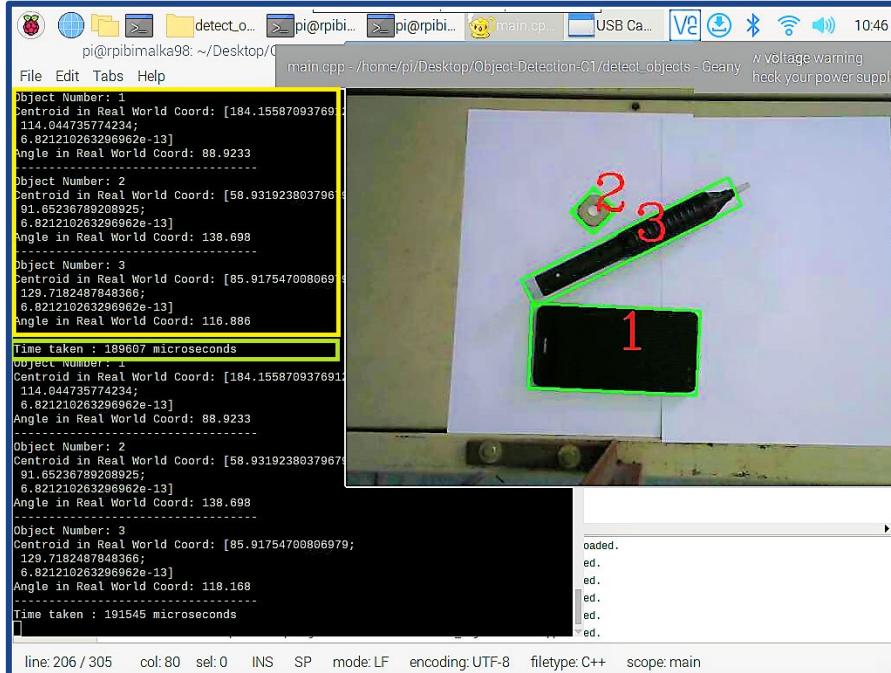
- Projects Assignment was done about a month prior to the commencement of internship
 - two project plans were offered
 - we agreed to move forward with plan A (on left)
- Facility familiarization after commencement of the internship
 - introduction to industrial robot arm designing
 - machinery required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

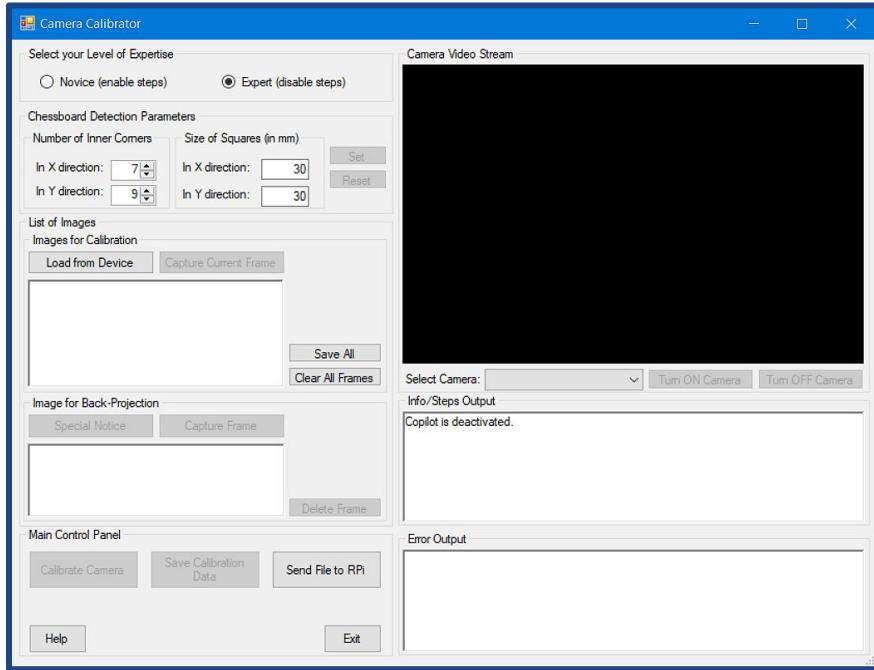


Object Detection Framework



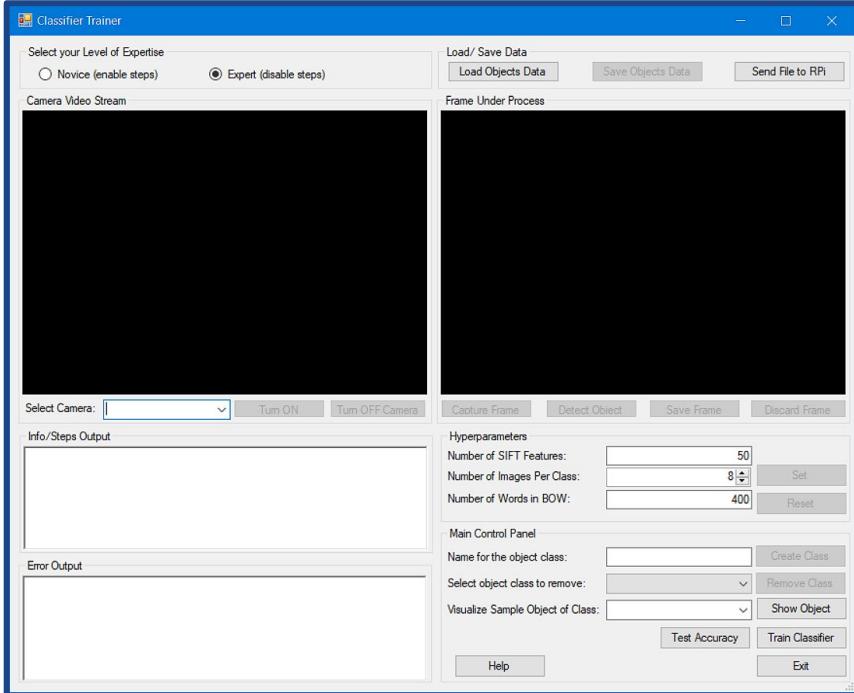
- Engineered from scratch
- Developed two associated Windows GUIs (coming up next)
- Capable of determining **grasping configurations** (location, orientation and object class) for a given object
- Implemented all the algorithms using **C++ and OpenCV** (a traditional Computer Vision approach)
- Documented 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.**

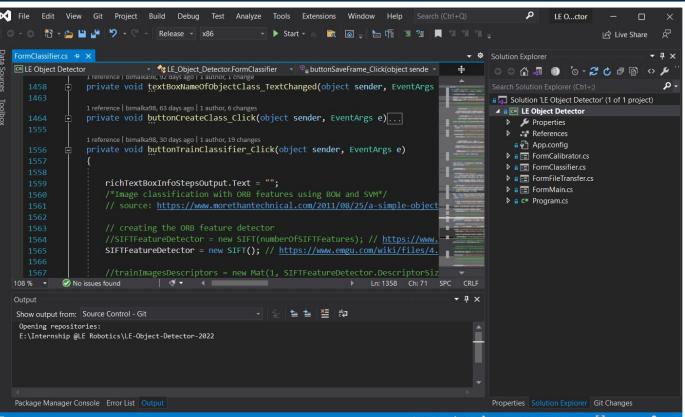
Classifier Trainer GUI



- 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*

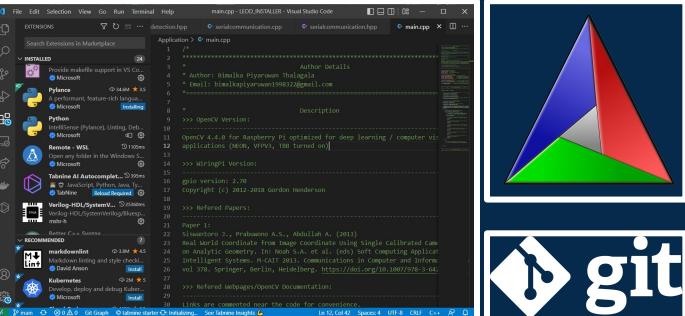


Screenshot of Visual Studio 2019 IDE showing the code editor displaying C# code for an object detection application, the Solution Explorer showing project files, and the Package Manager Console.

```

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 with code and a 3D pyramid visualization.

```

// Main Application File
main.cpp - LLVM - INSTANT - Visual Studio Code
File Edit Selection View Go Run Terminal Help
main.cpp
1 /*
2 * Author: Bimalka Piyarathna Thalagala
3 * Email: bimalkapiyarathna9502@gmail.com
4 */
5
6 // Description
7
8 // OpenCV Version:
9 // 3.4.1
10 // OpenCV 4.4.0 for Raspberry Pi optimized for deep learning / computer vision applications (cvdnn, H.265, TBB turned on)
11
12 // WxWidgets Version:
13 // 3.1.1
14
15 // g++ version:
16 // 8.3.0
17 // Copyright (C) 2012-2018 Gordon Henderson
18
19 // Refered Papers:
20
21
22 Silvano J., Prabhawna A.S., Abdullah A. (2011)
23 Real World Coordinate from Image Coordinate using Single calibrated Camera
24 Application of Computer Vision for Smart Manufacturing and Soft Computing Applications in Intelligent Systems, H-CATT 2011, Communications in Computer and Information Sciences, vol. 376, Springer, Berlin, Heidelberg, https://doi.org/10.1007/978-3-642-22380-9_64
25
26
27
28 >>> Refered webpage(s)/openCV Documentation
29
30 Links are commented near the code for convenience

```

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

Self

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

W

- Heavily depends on the interns
- Well-being or the career growth of the employees was not of their concern

- Underestimate myself when a new challenge is introduced
- Can not tolerate any kind of injustice

O

- Industrial automation is a fast growing field
- Very few competitors in the market

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

T

- Slow product development speed in a fast moving industry
- Competitors who dominate the global market (KUKA)

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