

## E. Project Resources

This appendix serves to a brief guide to others who wish to implement the resources used for conducting this project.

### 1. Qt

Qt (pronounced “cute”) is a free and open-sourced widget toolkit for creating GUI. It is compatible with multiple platforms such as Windows, Linux, and macOS. This was used for the creation of our GUI.

**How to download:** Qt can be downloaded from the Qt website (<https://www.qt.io/>). There is a free and commercial version that can be downloaded. For the scope of this project, the free version is sufficient. In order to properly install this software,

**Prerequisites:** In order to properly use Qt, programmers must be:

- Proficient in C++ (see Learning C++ later in the appendix)
- Basic knowledge on how to use Microsoft Visual Studios
- Link OpenCV to the project opened in QtCreator (Qt’s own IDE)
- Link Microsoft Visual Studios compiler to project opened in QtCreator

**Links for learning:** Below are helpful links for learning Qt

- ProgrammingKnowledge’s beginner series teaching widget tools, windows, etc.  
<https://www.youtube.com/playlist?list=PLS1QulWo1RIZiBcTr5urECberTITj7gjA>
- Rbaleksandar series on integrating OpenCV and using signals and slots (Part 1 – Part 4)  
<https://www.youtube.com/watch?v=vKIEzqmeajQ>
- VoidRealms’s video on Qt Debugger <https://www.youtube.com/watch?v=B7UsWtyhXh4>
- VoidRealms’s guide on QThread (for concurrent processing) (Part 1 – Part 6)  
<https://www.youtube.com/watch?v=JaGqGhRW5Ks>

### 2. MATLAB Deep learning toolbox

The Deep Learning Toolbox <sup>™</sup> ( formerly Neural Network Toolbox <sup>™</sup>) is a toolbox provided (through purchase) with in the MATLAB software. It provides a platform for designing and implementing the Neural Network used for particle translation. The weights achieved from the model is the most important feature.

**How to download:** MATLAB and its toolbox may be purchased and downloaded directly from the website (<https://www.mathworks.com/>).

**Prerequisites:**

- Proficiency in MATLAB
- Understanding of NN

**How to create Neural Network in Matlab:** The Neural Fitting app is a GUI that allows users to build their NN. Programmers can learn how to properly use it through:

<https://www.mathworks.com/help/deeplearning/gs/fit-data-with-a-neural-network.html>. In addition the the GUI programmers may code it. The MATLAB mathworks platform should be used to answer any specific questions or address any problems.

**Acquiring NN Weights:**

[https://www.mathworks.com/help/deeplearning/ref/getwb.html?s\\_tid=doc\\_ta](https://www.mathworks.com/help/deeplearning/ref/getwb.html?s_tid=doc_ta)

### 3. ArUco

ArUco is an open sourced library that is used through OpenCV. It is used for detecting squared fiducial markers (“ArUco markers”) in images.

**Prerequisites:**

- Proficiency in C++
- Download and set up OpenCV and OpenCV - contrib
- Download Microsoft Visual Studio

**Links for learning:**

- OpenCV documentation on how to use Aruco markers  
[https://docs.opencv.org/3.4.0/d5/dae/tutorial\\_aruco\\_detection.html](https://docs.opencv.org/3.4.0/d5/dae/tutorial_aruco_detection.html)
- Original documentation by creators is on an open access google doc  
<https://docs.google.com/document/d/1QU9KoBtjSM2kF6ITQjQ76xqL7H0TEtXriJX5kwi9Kgc/edit>
- Rafael Muñoz Salinas (the creators) video tutorial on ArUco  
<https://www.youtube.com/playlist?list=PL7EOs-8ZXfMb2qRog9wOa3Ar-EyvRYdrp>

### 4. OpenCV 3.4.5

OpenCV (Open Source Computer Vision Library) is an open sources library for computer vision and machine learning softwares. Multiple libraries are used in order to create the image segmentation features needed to track, and identify objects for our system.

**How to download:** OpenCV can be downloaded from the GitHub repository

(<https://github.com/opencv/opencv>). Please follow the documentation on the github to download and install the base OpenCV library. To download the required contrib libraries, please follow this youtube link (<https://www.youtube.com/watch?v=MMDABTypnZg>).

**Documentation:** Can be found on the OpenCV doc website (<https://docs.opencv.org/>) be sure to specify the version you wish to use. This contains information about all libraries and their functions.

**Links for integrating OpenCV with various platforms:**

- Stackoverflow response for setting up OpenCV with Qtcreator. Look at second answer  
<https://stackoverflow.com/questions/15881913/how-to-link-opencv-in-qtcreator-and-use-qt-library>
- Video on how to integrate OpenCV with Microsoft Visual Studios:  
<https://www.youtube.com/watch?v=oJ6fh-XLjtg>

## 5. Eigen 3.3.7

Eigen library is a C++ matrix library used to deploy our trained neural network into the C++ codebase.

**How to download:** The full eigen library can be downloaded and installed using the following link (<https://eigen.tuxfamily.org/dox/GettingStarted.html>).

**Documentation:** Comprehensive documentation on all available functions and packages can be found here (<http://eigen.tuxfamily.org/dox/>).

## 6. C++ Programming Language

C++ is a object-oriented programming language with low-level language capabilities. The majority of the project was coded in C++. This is a prerequisite for all other softwares except Matlab.

**How to download:** Can be accessed through Microsoft Visual Studios (MVS). See the MVS section below.

**Prerequisite:** Microsoft Visual Studios

**Learning:** There are multiple online course and resources available to learn C++ online. Lynda.com and udemy are some website used to learn C++.

## 7. Microsoft Visual Studios (MVS)

MVS is an integrated development environment. This was used to prototype and test back-end code before deployment into the QtCreator platform to create our GUI.

**How to download:** The community version was downloaded from the website (<https://visualstudio.microsoft.com/downloads/>). Be sure to download C++ development atmosphere.

**Links for learning:**

- Steps provided by Microsoft on how to install MVS (<https://docs.microsoft.com/en-us/cpp/build/vscpp-step-0-installation?view=vs-2019>)

## 8. Roboclaw

Roboclaw 2x60A motor controllers are directly connected to the GUI and send current through our coils. These hardware components are controlled through a C++ library of functions.

**How to download:** Several libraries to control the roboclaw can be found on the product web page ([https://www.basicmicro.com/RoboClaw-2x60A-Motor-Controller\\_p\\_8.html](https://www.basicmicro.com/RoboClaw-2x60A-Motor-Controller_p_8.html)). It's important to note that a C++ implementation of this library (which our project uses) is not available on the website. In general, our C++ implementation is based on the Arduino roboclaw library (see link product page link). The actual implementation can be found in the software package attached to this report.

**Prerequisite:** ROS Serial Library (<http://wiki.ros.org/serial>).