LINE FOLLOWER FOR SURVEILLANCE CAMERA MONITORING SYSTEM

YEW YUAN SOON

This Report Is Submitted In Partial Fulfillment of Requirement for the Bachelor Degree of Electronic Engineering (Wireless Communication) with Honors

Faculty of Electronic and Computer Engineering

Universiti Teknikal Malaysia Melaka

June 2017

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : .Line Follower For Surveillance Camera Monitoring System

....

Sesi Pengajian :

1	6	/	1	7

Saya ....YEW YUAN SOON.......................................

mengaku membenarkan Laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (√) :

☑ **SULIT***   *(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

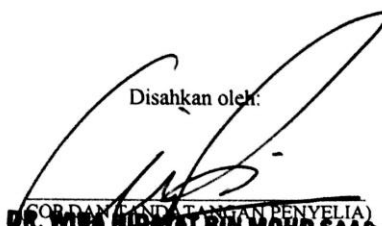☐ **TERHAD****   **(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

☐ **TIDAK TERHAD**

Disahkan oleh:

(TANDATANGAN PENULIS)

(COP DAN TANDATANGAN PENYELIA)
DR. WIRA HIDAYAT BIN MOHD SAAD
Pensyarah Kanan
Fakulti Kejuruteraan Elektronik Dan Kejuruteraan Komputer
Universiti Teknikal Malaysia Melaka (UTeM)
Hang Tuah Jaya
76100 Durian Tunggal, Melaka

Tarikh: 1 / 6 / 2017

Tarikh: 1 / 6 / 2017

DECLARATION

"I declare that this report "Line Follower for Surveillance Camera Monitoring System" is the result of my own research except at cited in the references".

Signature   : ....

Author   :   YEW YUAN SOON   .

Date   : ....1/ 6/ 2017........................

"I hereby declare that I have read this report, entitled "Line Follower for Surveillance Camera Monitoring System" and it fulfills the requirements of the scope and quality for the Bachelor of Electronic Engineering (Wireless Communication) with Honors".

Signature　　　　　　: ....

Supervisor's name　　: DR. WIRA HIDAYAT BIN MOHD SAAD.

Date　　　　　　　　: 1/6/2017

ACKNOWLEDGEMENT

First and foremost, thanks to the Council of Universiti Teknikal Malaysia Melaka for offering me a Bachelor's Degree course under the Faculty of Electronic and Computer Engineering (FKEKK) which allow me to have a great surrounding to expand my knowledge, and also as a stepping stone for me before entering the working field. Next, I would like to extend my gratitude to everyone that assisted and supported me throughout my journey in Bachelor's Degree life.

First, I would like to give millions of thanks to my supervisor, Dr. Wira Hidayat Bin Mohd Saad for his wise advices and constant supervision on me which allow me to complete this project in great success. He was always there ready to lend his ear to me in expressing my hard times, yet did not forget to share his idea and related information that helped me in making progression in the project. Next, I would like to express my gratitude towards my parents and fellow friends for their assistance and encouragement which help me in the completion of this project.

Once again, I would like to give thanks to everyone who gave support to me. They were all greatly appreciated.

ABSTRACT

In this project, a mobile surveillance camera monitoring system is introduced to assist in solving the limited coverage problem facing by the conventional surveillance camera which is usually installed at a fixed position. Line follower is chosen to provide mobile movement of the mobile surveillance camera monitoring system. Both Arduino and LabVIEW platforms are involved in this project, where a line follower robot is designed and programmed using Arduino IDE, then followed by developing a monitoring system using LabVIEW. The hardware component used in the project consists of Arduino Uno board, two G15 servo motors, a G15 servo driver, an infrared line sensor, a webcam, and a NI MyRIO. With MyRIO connected to LabVIEW wirelessly, hence the monitoring process also can be carried out wirelessly.

ABSTRAK

Dalam projek ini, sistem pemantauan kamera pengawasan mudah alih diperkenalkan supaya dapat membantu dalam menyelesaikan masalah liputan yang terhad yang dihadapi oleh kamera pengawasan konvensional yang biasanya dipasang di kedudukan yang tetap. Robot pemandian garisan dipilih dalam projek ini sebagai sumber untuk memberi pergerakan mudah alih kepada sistem pemantauan kamera pengawasan mudah alih. Kedua-dua platform Arduino dan LabVIEW terlibat dalam projek ini, di-mana robot pemandian garisan direka dan diprogramkan menggunakan Arduino IDE, kemudian diikuti dengan menciptakan sistem pemantauan dalam LabVIEW. Komponen yang digunakan dalam projek ini mengandungi Arduino Uno, dua motor servo G15, penggerak bagi motor servo G15, sensor infra merah, kamera web dan NI MyRIO. MyRIO yang boleh berhubung dengan LabVIEW tanpa wayar, maka proses oemantauan juga boleh dijalankan secara wayarles.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Project Overview

Surveillance camera are playing quite an important role since it was being implemented decades ago to reduce and control the criminal rate especially in public areas. But somehow the coverage region is limited as it is installed at a fixed position. Thus, in this project a mobile surveillance camera is introduced to have increased region of coverage than a single fixed position surveillance camera. Line following robot is chosen to provide mobility to the surveillance camera monitoring system.

Line-follower robot is considered as one of the autonomous robots. It generally follows the line that is drawn on the ground which the user predetermines its destination and route [1].

Conventional line-follower robot mainly uses light sensitive sensor or sets of infrared transceiver to verify the position of the 'line' while the correct coding makes the robot to follow the 'line' that it detected. It is a kind of robot that can be easily designed and built, as it only requires of those easily obtainable components, a micro-controller, and simple coding.

There have been robotic competitions made around the world which allows people, mostly youngsters to compete using their very own-build-robot which satisfy the terms and conditions of the competition. Line-follower robot was one of the challenges in the competition.

As time passed, more version of line-follower robot has been proposed. Most of them introduce changes to the conventional line-follower robot, which enable it to function better. Among those improvements are path planning [2][3][4][5], smoother movement [6], and faster signal processing speed [7].

Study shows that most of the line follower makers focus on the path planning of the line-follower robot, then to smoothen its movement when following a path. These ideas are also involved in the line-follower robot that is being proposed by this study. In this study, the proposed line follower robot is using a webcam to capture image, and through image processing carried out by the NI MyRIO which act as controller and processor, that allow communication between signals from webcam and infrared transceivers, then execute action to the G15 servo motor to allow the robot to avoid potential obstacles that block its way.

1.2   Problem Statement

The surveillance camera installed on the wall limits the monitoring region in residence area due to its fixed position on the wall. Although using a 360-degree surveillance camera seems to be a solution for this problem, but what if the area that needs to be monitored is the surrounding of a residential area, where the cameras are to be installed on the walls of houses instead of poles on the streets.

Besides, surveillance camera does nothing than save everything it captured in a data storage and waiting to be disposed after a certain period to clean up spaces for latest monitoring video file. Even though when there is time where people need to view back the video files, it could be time consuming and exhausting to consider what they wanted to see in those video playback files.

1.3 Objective and Scope

1.3.1 Objective

The aim of the study is to develop a line-follower for surveillance camera monitoring system. To achieve that, following objectives need to be accomplished:

a. To design a line following robot with surveillance camera installed.

b. To develop a monitoring system for a line following robot.

c. To perform analysis on the surrounding from the monitoring system.

1.3.2 Scope of Work

This project focused on three aspects to fulfil all three objectives of this study. Firstly, a line following robot is designed using Arduino Uno, Rero G15 cube servo motors, and a Rero Infrared line sensor. Arduino platform is used in designing this line following robot, where an Arduino Uno board is used to conduct serial communication with the servo motors and the line sensor. Arduino IDE software is used to compile the code for serial communication between the hardware so that they react accordingly as what have been written in the code. A line path is prepared to test for its line following capability.

Secondly, an UI for monitoring purpose is constructed using LabVIEW and wirelessly connected to NI MyRIO device. A webcam is connected to the MyRIO as a medium to capture images and display on the UI in LabVIEW software for monitoring purpose.

Finally, the UI previously created in LabVIEW is further modified to add in image filter functional blocks to enable image processing and data manipulation while monitoring. A digital I/O on the NI MyRIO is connected to the Arduino Uno as an aid to manually stop or resume the movement of the line following action.

CHAPTER 2

LITERATURE REVIEW

In this chapter, we are going to discuss on some topics related to the surveillance camera and line follower robot. Studies have been done related to these topics, including some presented ideas and suggestions.

2.1   Surveillance System, Important?

In the society today we could see a surveillance camera everywhere as they are planted in the streets, shops, restaurants, hotels, and sometimes even in refrigerator, but just about how important to have surveillance cameras?

Different people tends to have different ways of thinking on the importance of surveillance camera. But most of us know that surveillance system can somehow control the criminal rate, although not remove, but it does provide peace at certain point.

At the point of view of law enforcement agencies, they have been searching hard for new technologies to increase public safety. The most common yet effective tools to use is still the surveillance cameras. There is an interesting fact that I am totally agreed to, mentioned in [8] which it sounds a bit of psychological theory, saying that the surveillance cameras are utilized in public surveillance system for the aid of crime prevention because people like you and me would possibly refrain from criminal activity if we know that we are being watched. This has clearly given the great example on how important are the surveillance cameras and systems even until today.

In the same published report [8], there are some data analysis on the effect of implementing surveillance cameras at certain areas of different country that are identified as high-crime areas. Eventually proven that the criminal rate reduces after the implementation of surveillance cameras.

Apart from that, some people may feel insecure due to privacy issues. At some public places, the image captured by the surveillance camera might be used by other unauthored party where one's private life may be ruined, yet there has no law to prevent ones' private information being collected and used [9].

Back to the importance of the surveillance cameras, other than reducing the criminal rate to a certain percentage, it as well being used to combat 'anti-social behavior', which are mainly related to sick behavior like urinating in public, traffic violation, and vandalism actions [10].

There are plenty of researches made to enhance the capability of the surveillance cameras. As what has been discussed in [11], existing surveillance systems are said to have several drawbacks, such as high expenses to replace old cameras to higher resolution cameras, large storage for saving data files, computation power in processing data, and so on.

2.2   What Is a Line Follower?

A line follower is a robot that operates though moving along a black or white color line path. For the machine to do so, some components are required to act as the sensor and processor, and with the help of some simple circuitry and plenty of programming to enable those components to 'interact' with each other as a whole body.

For a conventional line follower robot, normally light sensitive sensor or infrared transceiver is used to verify the color on the ground surface (black and white). The light intensity reflected on black or white surface are different. Therefore, when come to comparison, more infrared light is reflected on the white surface than the black surface, and result in lower voltage value detected at the sensor on black surface, as

well as higher voltage value detected at the sensor on white surface. By doing simple programming, the voltage values detected at the sensors can be converted into digital data, hence they can be the reference for the machine to verify the black and white surfaces.

2.3   How A Line-Follower Robot Follows the Line?

Just being able to verify the surfaces of the ground is not enough. The machine has to be able to navigate itself to actually move following the path (black or white surface). The algorithm that helps the machine to learn to sense the path must be able to communicate with the serial motors that control the direction of movement of the machine according to the line path prepared.

A clearer explanation can be viewed if we fixed the number of set of Infrared Transceivers. In the case as shown in Figure 2.3-1, 3 sets of Infrared Transceivers are used and are aligned in a horizontal straight line. We consider the output of the transceiver as HIGH if the Infrared beam is reflected on white surface, and LOW if the Infrared beam is absorbed by the black surface. If the path line is black in color, meaning that there will have 4 situations that may happen. First, the sensor at the left side has LOW output while the others have HIGH output. Second, the middle sensor has LOW output while the others have HIGH output. Third, the sensor at the right side has LOW output while the others have HIGH output. Forth, all the sensors show HIGH output.
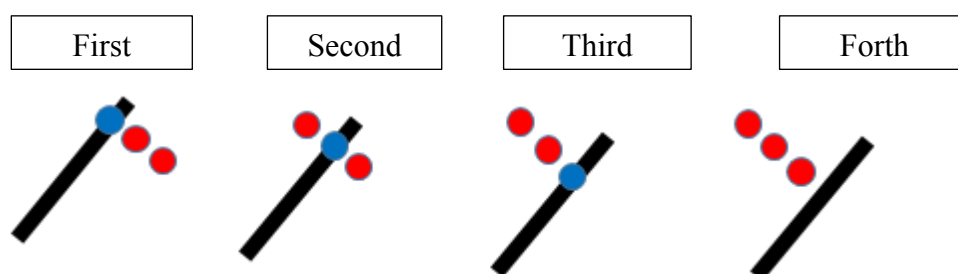
Figure 2.3-1 The illustration of 4 situations of 3 sets of transceiver

If the first situation occurred meaning that the robot is shifted right side away from the line. In this case, the servo motor should slightly turn to the left. In second situation, the line is at the center and the servo motor should go straight. In the third situation, the robot is shifted left side away which mean that the servo motor should slightly turn to the right to retain the output of second situation.

If the forth situation occurred, the robot is away from the line. In this situation, the servo motor should reverse backward to trace back its previously position where the line was still in contact.

2.4   Other Improvements on Conventional Line-Follower Robot

Apart from the conventional line follower robot that simply detect and follow path using only light sensor, people have always trying to improve the functionality of the line follower robot. Most people proposed on a line-follower robot that do path planning [2][3][4][5]. Path planning is carried out through the algorithms that enable the robot to be notified of the possible obstacles and choose other line path or self-generate a path to avoid the obstacle and fall back on the line path.

The examples, such as the implement of hand gesture to control the movement of the robot and draw line on the field board [2], implement of vision camera to detect color thus choose desired path with a specific color line [3], implement of Ant Colony Optimization (ACO) with an extra feature called Perception Radius that estimate best route when facing obstacles [4], and implement of image processing technique and background subtraction using FPGA [5].

Next, improvement in the smoothness of the movement of the robot while following the path has also been discussed [6]. Proportional-Integral-Derivative controller (PID controller) used to make the robot better in following the line path, where the error limit is first set by the user and processed by PID controller which then generates the velocity commands for the servo motors.

More 'parts' added on to the machine means more signals need to process. As a result, delay of certain commands could happen (even though the delay time is very short) if a micro-controller is used. This is due to the hardware structure of the micro-controller is fixed. Operations which it can do are predefined, and usually carried out in a sequential manner by the user using their preferred software.

2.5   Existing Monitoring Usage

Monitoring systems are developed to allow people to know the updated status of desired field. In the study, monitoring system are applied in various fields, such as for health monitoring [12][13], traffic monitoring [14], pollution monitoring [15], and more. With the monitoring system applied, users are able to carry out the monitoring process, mostly wirelessly to observe and record the related information for data analysis and design best action to be taken if any down-side scenario found through the data analysis process.

Monitoring performance is also important to provide user fast and precise output of the monitoring field. There are some platforms and devices being used for monitoring system, including using MATLAB [16], Respberry Pi [17][18], LinkIt One and Yeelink [19], and LabVIEW [20]. Different platforms and devices used may provide different performance and experience for the monitoring process, and of course the method used in system setup for different platforms tend to be different, thus choosing a preferred one is far more important in designing a functional system.

CHAPTER 3

METHODOLOGY

This project is divided into three stages of work progress. First stage is the development of a line following robot using Arduino. Second stage is the development of monitoring system using LabVIEW, and lastly combine both the Arduino and LabVIEW into a line following monitoring system. The project slow charts are shown in Figure 3.1-1 for first stage, Figure 3.2-1 for second stage, and Figure 3.3-1 for the last stage.
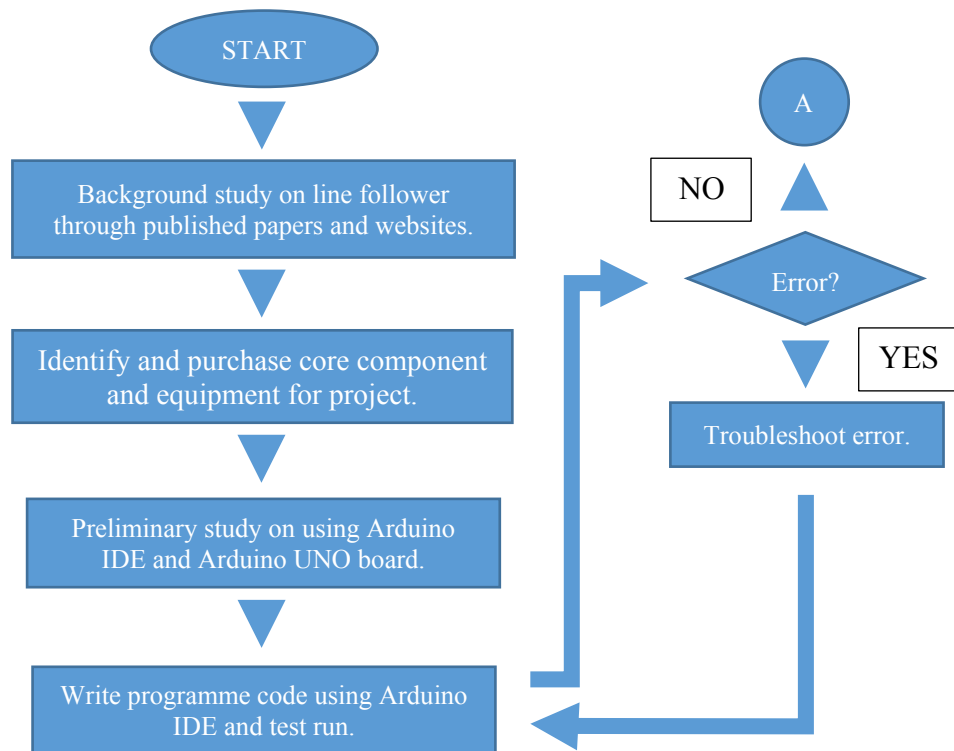
3.1   Arduino

Figure 3.1-1 Flow chart in designing line following robot.

In this stage, the background of line following robot is studied. This including the basic structure and working principle of a line-follower, especially on using Arduino platform.

Preliminary study is conducted on the coding method, as well as the compiler required to program the Arduino board. In this case, Arduino IDE compiler is chosen and example codes provided in the compiler are studied and manipulated for the project requirements.

The user manuals for servo motor and infrared line sensor are available online, where they contain the details of the product specification which are necessary in developing functional codes in either compilers. Fortunately, there are open sources of Arduino library for the Rero servo motor. This library has defined all the coding function needed to program the Rero servo motor, thus reduce the complexity and the coding length while programming them.

Unfortunately, the Arduino library for Rero line sensor is not found online due to certain reason. However, this problem is solved through multiple attempt on creating and modifying Arduino library. The original library folder is duplicated and the source files in the folder are modified with added in new function declaration and commands. Precisely, the targeted source files are the '.h' and '.cpp' file. This modified library is imported and header is defined in the Arduino IDE. Sometimes, trying an error could be helpful, otherwise seek for help from supervisor or experts from university or online forums.
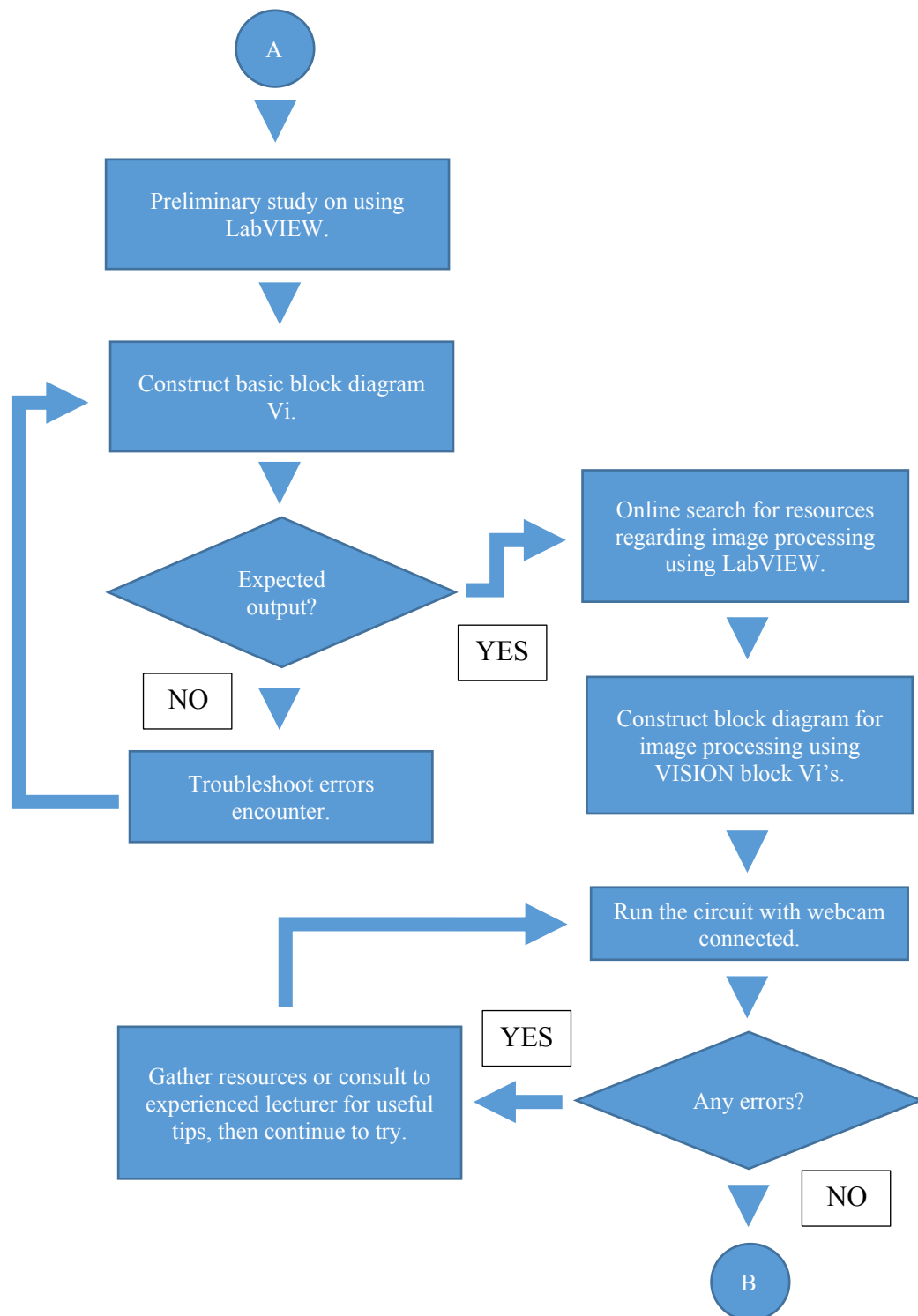
3.2 LabVIEW

Figure 3.2-1 Flow chart in constructing LabVIEW monitoring system.

12

The next step after designing a functioning line following robot is to construct a LabVIEW monitoring system which wirelessly connected to NI MyRIO device. A webcam is connected to the MyRIO device as a monitoring aid.

Before started to design the monitoring system, some tutorials on using LabVIEW is studied. Tutorials include the construction of some simple block circuits using basic block components.

Problem encounter during the progress could also be solved through some hard work in finding for online sources. Especially on those block components used for image processing under category of 'Vision and Motion'.

In the construction of this monitoring system, some block Vis are used, such as the 'IMAQdx Open Camera VI', 'IMAQdx Configure Grab VI', 'IMAQdx Grab2 VI', and 'IMAQdx Close Camera VI'. Figure 3.2-2 shows the block diagram to display image captured from webcam to be viewed on a monitoring display.
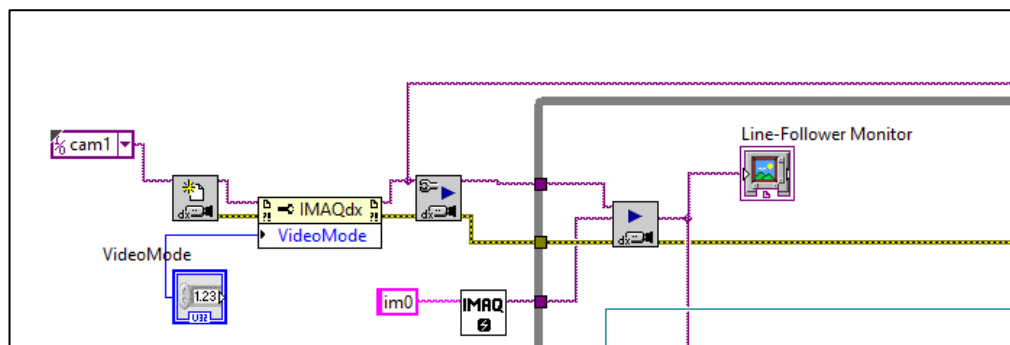

Figure 3.2-2 Block diagram to capture and display images from webcam.

The brief introduction for some of the Vision and Motions Block Vis from LabVIEW is shown in the Table 3.2-1.