**Embedded Systems: Robot Project**



Johnson Domacasse(4471709)

Harm Nieuwland(4926749)

Date:

Teacher: Suzana Andova

[Document history 3](#_Toc150154918)

[Terms, Abbreviations 3](#_Toc150154919)

[1. Introduction 4](#_Toc150154920)

[2. System Description 4](#_Toc150154921)

[3. System Design 4](#_Toc150154922)

[4. System Structure 4](#_Toc150154923)

[5. System Behavior 4](#_Toc150154924)

[6. Recommendations & Conclusions 4](#_Toc150154925)

[7. Reflection 4](#_Toc150154926)

[8. References 4](#_Toc150154927)

List of Figures

List of Tables

1. Pin Configuration………………………………………………………………………………………………………………………….4

# Document history

|  |  |  |  |  |
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| 0.1 | 2023-11-06 | Draft | Johnson | Document creation |
| 0.2 | 2023-14-11 | Draft | Johnson | Phase 1 documentation |

# Terms, Abbreviations

|  |  |
| --- | --- |
| Abbreviation | Description |
| IR sensor | Infrared red sensor |
| US sensor | Ultrasonic sensor |
| MCU | Micro controller unit |
| ARR | Auto-reload register |
| PSC | Pre scaler |

# Introduction

# System Description

*This section of the report is dedicated to give a brief description of what our team did to accomplish the robot project. We give a brief description of what the project entails and how we solved it.*

The robot project has 3 main components that function together to form one entire system. These components are the ultrasonic sensor, the 2 Servo motors, and the infrared sensors. Each one of these components code, were compiled and analyzed to then be combined into one final machine. Below is a small description of each sensor and their purpose:

1. ***Ultrasonic sensor:*** The ultrasonic sensor acts as our feedback “giver” later on in the project when we implement feedback control systems as well. In the first design of the robot, it will simply act as a stop mechanism for the robot. Additional details will be given in the implementation phase 1 section.
2. ***Infrared sensors:*** The infrared sensors act as the steering wheel for the robot. Based on if the sensor is detecting a black line both straight or curved, it will alter send this information back to the program so the robot can steer accordingly based on the results.
3. ***Servo motors:*** The servo motors act as the wheels for the robot. It will start driving at a specific speed and based on the information it gets from both the ultrasonic – and the infrared sensors. More information on their calibration can be found in the implementation section.

Each sensor is connected on specific pins that are exclusive to the code that will be provided along wit this document. See table 1 for PIN configuration of the robot project. Be advised, some pins have the wire color attached to them because the wires are attached to the robot itself.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Actuator | Pin Name | Wire Color |
| 1. | Ultrasonic Trigger | PB5 | - |
| 2. | Ultrasonic Echo | PB6 | - |
| 3. | Right-side Servo(clockwise rotation) | PA0 | - |
| 4. | Left-side Servo(counter clockwise rotation) | PA1 | - |
| 5. | IR OUT1 (leftmost) | PA3 | White |
| 6. | IR OUT2 | PA2 | Orange |
| 7. | IR OUT3 | PA10 | Green |
| 8. | IR OUT4 | PB3 | Orange |
| 9. | IR OUT5 (rightmost) | PB4 | Green |

*Table 1. Pin configuration*

# Design Phase 1

*This section of the report will be dedicated to how the design of the robot is structured. For this project, we will only be using a state machine to show what is happening through out the robot processes. See figure 1 below for complete state machine.*

# Implementation Phase 1

*This section of the report will be dedicated to explaining the choices made behind certain parts of the robot project implementation. These can include for example which timers were used, or why certain values for certain registers were chosen and more. Note: For the remainder of the robot project, the clock speed of each implementation will be set to 16MHz.*

## 4.1 Servo implementation

For the servo implementation, the knowledge that was gained from the timers output assignment was applied first. Using the alternate function mapping table from the MCU datasheet**[6]** and the knowledge of setting up and using the timers**[4],** the servo implementation was then configured correctly PIN-wise.

The reasoning behind the usage of the values 32 and 45000 for the PSC and the ARR respectively was determined again using the following formula:

Since our desired frequency was a frequency of 50Hz (for a 20ms period), we end up with a value of 320000. We thought initially that our PSC and ARR values would be 32 and 10000 then but when read with the logic Analyzer, we noticed that these signals were not that of a 20ms period. In the end we manually calibrated it to approximately 20ms by having the ARR value be at 45000.

With that being said the values that are being sent to the servo also has to be changed. Take the clockwise rotation for now. To spin the servo at 100% we need to pulse it with 1280 and 0% would be 1470. Through trial and error and using the analyser, we came to a conclusion that for the servo to spin clockwise at 100%, we would need to pulse it with the value of 2768. So this value we divided by the initial 1280. We get a constant of 2.16217.

## 4.2 Ultrasonic implementation

## 4.3 infrared implementation

## 4.4 combined implementation

# Testing Phase 1

*This section of the report will be dedicated to explaining the steps that were taken in order to test the completed phase 1 of the robot project. This will include a scenario description and results.*

# Design Phase 2

# Implementation Phase 2

# Testing Phase 2

# Reflections

# Bibliography

[1] – reference for ultrasonic datasheet

[2] - reference for infrared datasheet

[3] - reference for servo datasheet

[4] – reference for reference manual

[5] - reference for nucleo user manual

[6] - reference for nucleo datasheet