University of Victoria

Department of Mechanical Engineering

MECH 458/554 - Mechatronics

Initial Design Report

Rushi Nathvani
V00835408

Sreejith Munthikodu
V00903589

March 8, 2018

1 Introduction

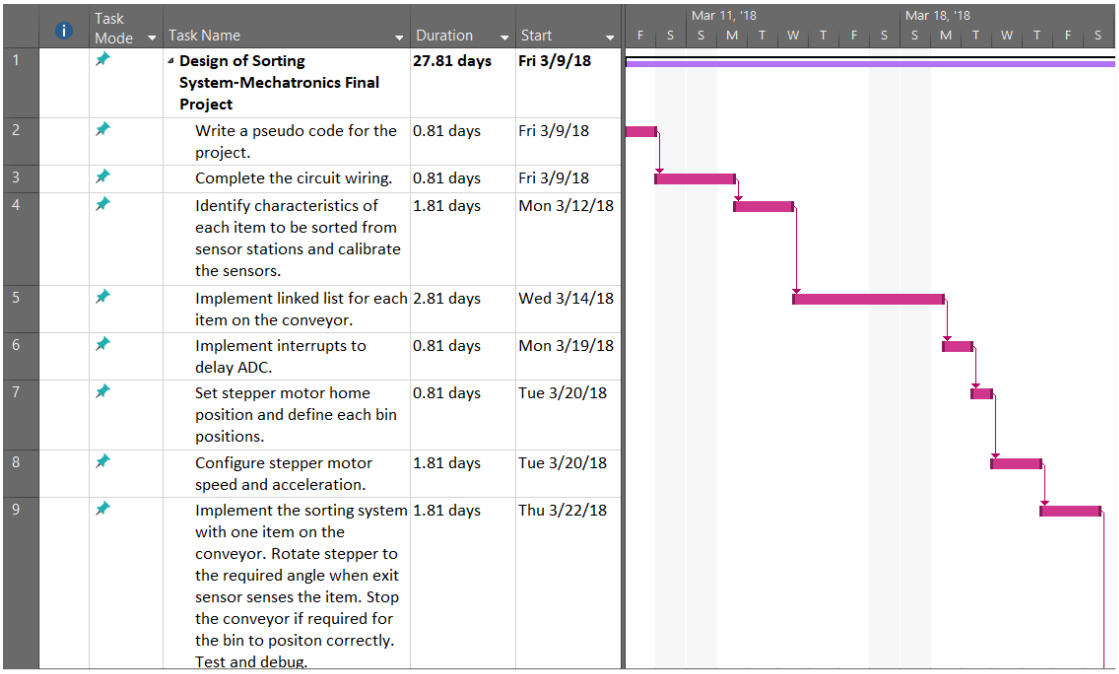
The objective of this project is to design a high performance inspection system, implement it using the microcontroller AT90USB 1287 and demonstrate the functionality. The design objective of the inspection system is to sort items of varying materials and colors into an appropriate bin in shortest time and with the greatest possible accuracy.

The design uses the 8 bit 1 MHz AVR family microcontroller AT90USB 1287 as the heart of the system. A DC motor is used to drive the conveyor belt which moves the items to be sorted. A bipolar stepper motor is used to rotate and position the appropriate bin to collect the items when they fall from the conveyor at the end of travel. Three sensor stations which consists of optical, ferromagnetic and reflective sensors, are used to identify the type and color of the items on the conveyor and also to determine whether the item has reached the end of the conveyor.

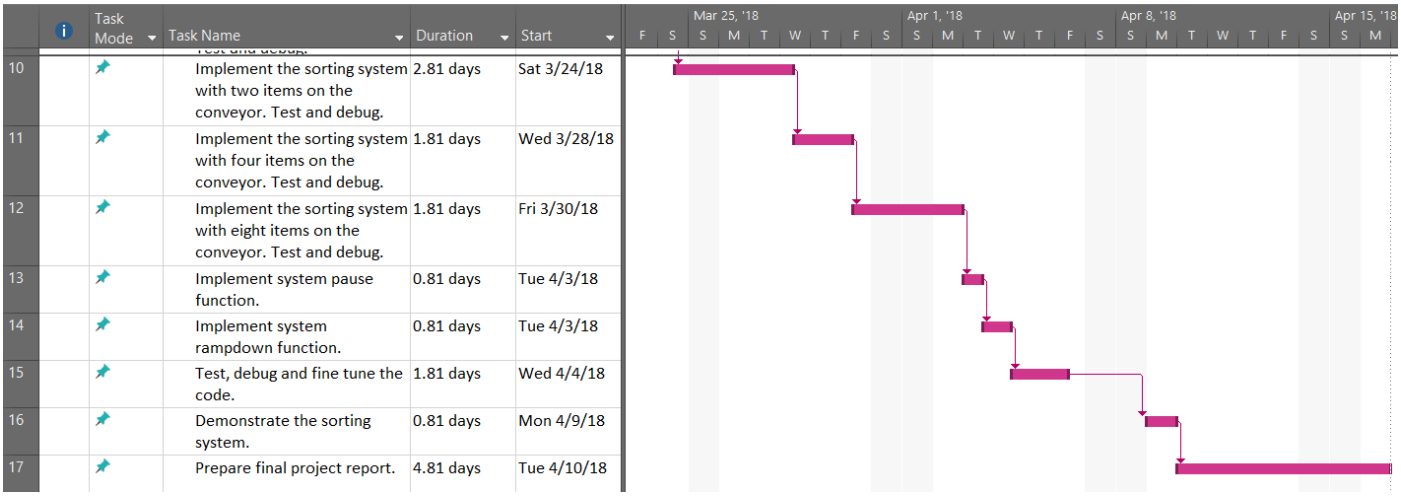
The implementation of the design calls for advanced coding of microcontrollers that includes set up the timers, implement dynamic linked list using pointers, use interface circuits to control stepper motor and DC motor, generate PWM signal to control DC motor, use interrupts and implement Analogue to Digital Converters.

The possible challenges in the project includes identifying the characteristics of items using various sensors without any errors, use various interrupts in their appropriate context and tune the stepper motor speed and acceleration for collecting the items in the shortest possible time with no errors. Considering the limited time available, combining all the concepts learned in the course to design and implement a complex embedded system is indeed a challenging task.

2 Project Timeline

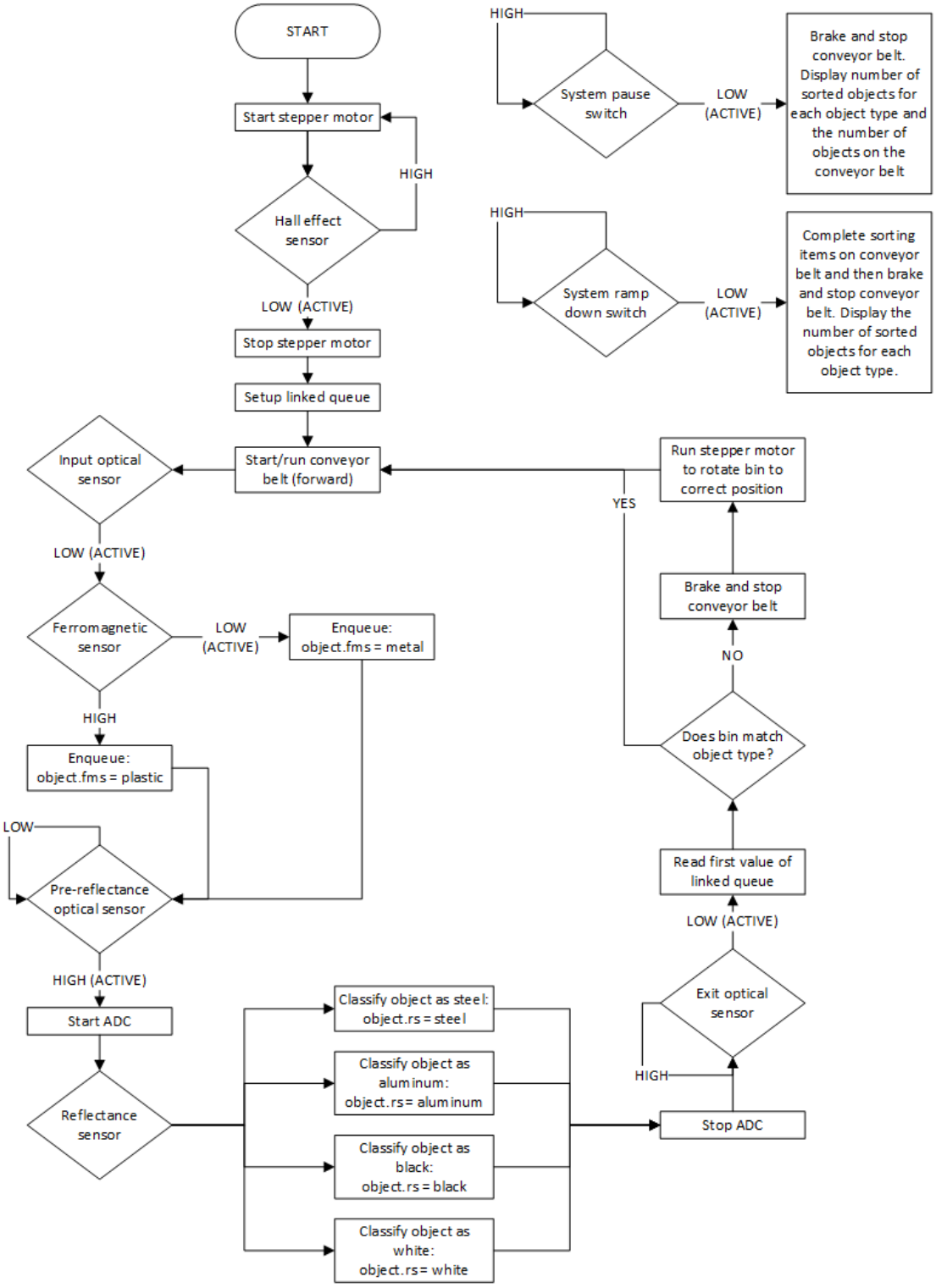


	Task Mode	Task Name	Duration	Start
1		**Design of Sorting System-Mechatronics Final Project**	**27.81 days**	**Fri 3/9/18**
2		Write a pseudo code for the project.	0.81 days	Fri 3/9/18
3		Complete the circuit wiring.	0.81 days	Fri 3/9/18
4		Identify characteristics of each item to be sorted from sensor stations and calibrate the sensors.	1.81 days	Mon 3/12/18
5		Implement linked list for each item on the conveyor.	2.81 days	Wed 3/14/18
6		Implement interrupts to delay ADC.	0.81 days	Mon 3/19/18
7		Set stepper motor home position and define each bin positions.	0.81 days	Tue 3/20/18
8		Configure stepper motor speed and acceleration.	1.81 days	Tue 3/20/18
9		Implement the sorting system with one item on the conveyor. Rotate stepper to the required angle when exit sensor senses the item. Stop the conveyor if required for the bin to positon correctly. Test and debug.	1.81 days	Thu 3/22/18



	Task Mode	Task Name	Duration	Start
10		Implement the sorting system with two items on the conveyor. Test and debug.	2.81 days	Sat 3/24/18
11		Implement the sorting system with four items on the conveyor. Test and debug.	1.81 days	Wed 3/28/18
12		Implement the sorting system with eight items on the conveyor. Test and debug.	1.81 days	Fri 3/30/18
13		Implement system pause function.	0.81 days	Tue 4/3/18
14		Implement system rampdown function.	0.81 days	Tue 4/3/18
15		Test, debug and fine tune the code.	1.81 days	Wed 4/4/18
16		Demonstrate the sorting system.	0.81 days	Mon 4/9/18
17		Prepare final project report.	4.81 days	Tue 4/10/18

3 System Flowchart



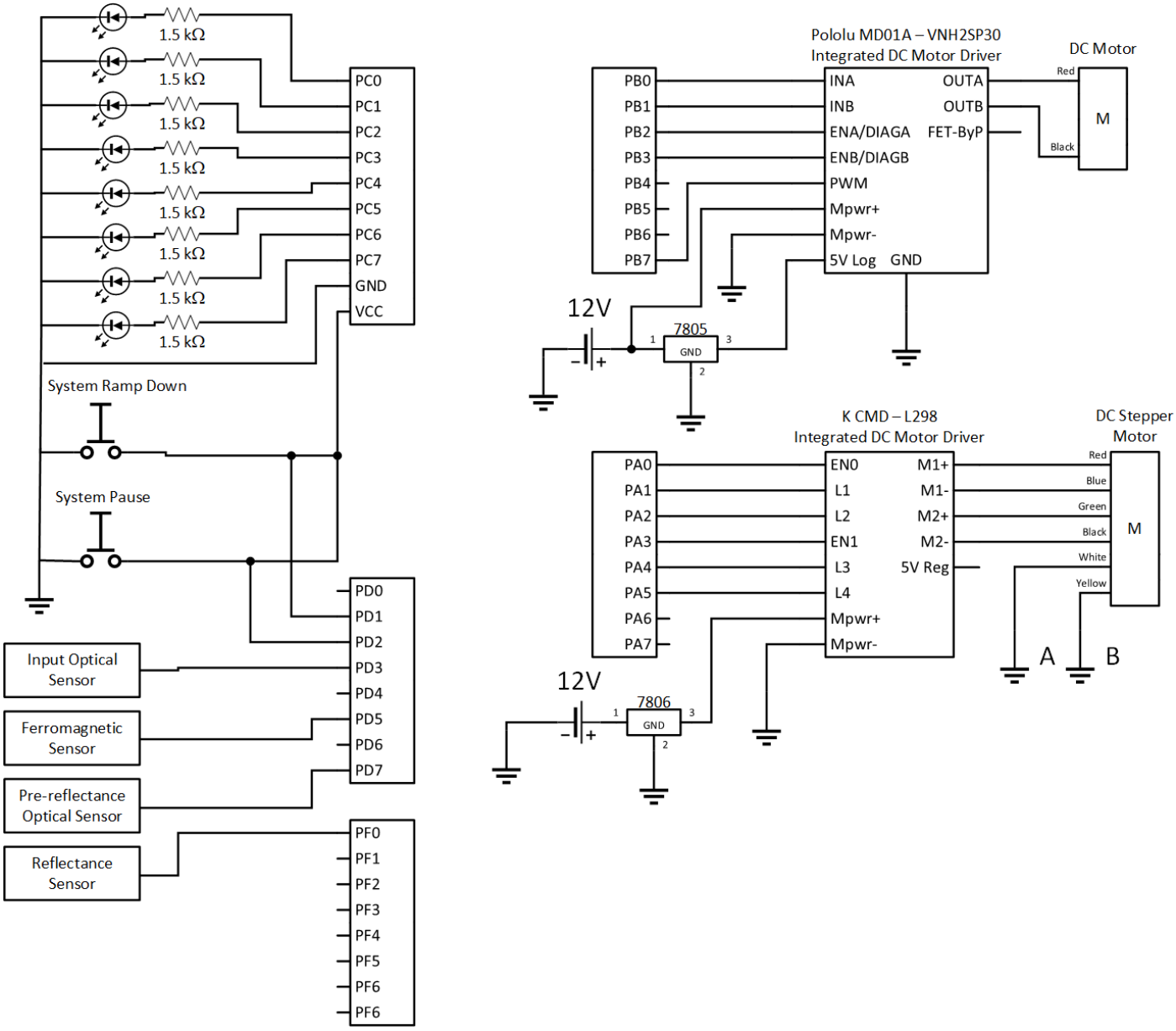
4 Discussion

The program begins with setting up the home position of the stepper motor using a hall effect sensor. Then stepper motor is stopped and an empty linked list is initiated to store the items that moves through the conveyor. Conveyor belt is now started and items are loaded. When the first input optical sensor detects an object, ferromagnetic sensor is activated to identify if the item is metallic or nonmetallic. Then the item is detected by the pre-reflectance optical sensor and it triggers an ADC at the reflectance sensor. Combined with the readings from reflectance sensor and ferromagnetic sensor, the type of item on the conveyor is now precisely identified and enqueued in the FIFO linked queue. ADC is stopped if the pre-reflectance optical sensor detects no item on the conveyor.

As the items travel further on the conveyor and the exit optical sensor detects an item at the end of travel, the first item in the linked list is read and the bin position of the stepper motor is compared. If the bin is appropriately positioned to collect the item, the conveyor is continued to run and the item is allowed to fall into the respective bin. The collected item is dequeued from the linked list. If the respective bin is not positioned, conveyor is stopped and the stepper motor is turned to position the bin correctly as per the item at the end of travel. Once the stepper is in its position, conveyor is started and the item is allowed to fall into the bin and collected item is removed from the linked list.

Two switches are provided for system ramp down and system pause. When the system pause switch is activated, it will stop the conveyor and stepper motor and display the number of each items sorted and also the number of items on the conveyor belt. When the system ramp down switch is activated, it will sort all the items on the conveyor and then stop the belt and display the number of each items sorted.

5 System Circuit



END OF REPORT