Functional Specification

Year: \_2021\_ Semester: \_Spring\_ Team: \_16\_ Project:\_Smart Conveyor Belt\_\_\_\_\_\_\_

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Assignment Evaluation:

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| **Item** | **Score (0-5)** | **Weight** | **Points** | **Notes** |
| **Assignment-Specific Items** | | | | |
| **Functional Description** | 3 | x3 | 9 | You need to be specific when you compare your system. You cannot compare it against ‘them’ and vaguely claim better results without having data for your performance or the performance of existing devices on the market. |
| **Theory of Operation** | 5 | x3 | 15 |  |
| **Expected Usage Case** | 5 | x3 | 15 |  |
| **Design Constraints** | 5 | x3 | 15 |  |
| **Writing-Specific Items** | | | | |
| **Spelling and Grammar** | 5 | x2 | 10 |  |
| **Formatting and Citations** | 5 | x1 | 5 |  |
| **Figures and Graphs** | 0 | x2 | 0 | Missing functional block diagram. Please see https://engineering.purdue.edu/ece477/Course/Assignments/Example/FunctionalSpecificationEx2.pdf |
| **Technical Writing Style** | 5 | x3 | 15 |  |
| **Total Score** | 84 | | |  |

5: Excellent 4: Good 3: Acceptable 2: Poor 1: Very Poor 0: Not attempted

General Comments:

*Good work! Please see my comments for additional instruction. Most specifically, please do not make hand waving comparisons with no data. Also, please be sure to include all information required by the homework, in this case the functional block diagram that describes your project’s operation.*

1.0 Functional Description

The smart conveyor belt system is capable of sorting parcels at higher than average speed while operating with fewer moving components. The system uses omnidirectional barcode scanners to communicate with the microcontroller, which uses this information to decide which sorting compartment that parcel belongs to. In addition, the microcontroller interfaces with the motor driver of the multiple sorting flaps, allowing the microcontroller to adjust flap positions in order to sort correctly.

2.0 Theory of Operation

The theory of gravity and friction for moving packages specifically F = mgCos(Theta)\*u.

Barcode scanners rely on how light reflects off of surfaces that are white vs being absorbed by surfaces that are black. By shining a laser against a barcode and measuring the light being reflected back we can construct binary code based on this pattern and use it for information.

3.0 Expected Usage Case

The conveyor belt smart sorting system will be used in a warehouse/transportation station setting where mixed packages would need to be sorted while maintaining regular operation speed. Due to the need of warehouses and transportation baggage services, the system would need to withstand a decent amount of weights. The environment would mostly be static, but our part of the belt could be moved to sort different tracks (the next baggage claim belt for example). The user could be warehouse employees who loads parcels from the sorted compartment into the next locations. Their age would be around 25-50 for the majority of the employees are within this age range. Our product sorts the parcels by itself so our user base could just connect their parcel line to our sorting system before they start running the belts and continue their production flow.

4.0 Design Constraints

4.1 Computational Constraints

We need to have 4 pins reserved for pwm signals to control the servo motors. In addition we will need multiple interrupts for retrieving information from our barcode sensor and ir sensor (barcode needs highest priority). We have a short space between the time our barcode is read and the shifting of all the motors and in that time we need to look up in memory, the path to direct the package and output the pwms to the servos quick enough to direct the package before it reaches the end.

4.2 Electronics Constraints

The major components the Smart conveyor belt will utilize are as follows: A microcontroller (MCU), Servo motors, Brushed DC motors, and a Barcode scanner.

The servos will need to be controlled by PWM signals, so we will need 1 PWM-capable GPIO pin on the MCU for each servo being controlled, which translates to 3 GPIO pins. If we go with servos that require more than 3.3V to be controlled, then we will need to use a level-shifting circuit to convert 3.3V logic to the voltage necessary for running the servos.

For the Brushed DC motors, we don’t need more than unidirectional, on/off control, meaning each DC motor will need a single GPIO capable of outputting a ‘1’ or ‘0’. The MCU’s GPIO will interface to an isolated circuit through a simple transistor.

The barcode scanner needs approximately 5 gpio lanes to transmit info. USART should be sufficient for data transfers, however we may need to integrate with ps/2 pending a barcode scanner purchase.

4.3 Thermal/Power Constraints

The Smart Conveyor Belt is intended to be used indoors and stay in one place, so we will be powering it using a couple of DC power adapters: one to power the motors, and the other to power the MCU and barcode scanner. The MCU and barcode scanner will be consuming a small amount of power, so their thermals can be ignored.

As for the motors, there will be significant power consumption, but the max we are willing to draw is 150 watts. We should shoot for a maximum temperature of either 50°C or whatever the max temperature of the brushed DC motor is, whichever is lower.

4.4 Mechanical Constraints

Our motors will only be able to move so much weight without shorting or breaking; we estimate a max of two 8 pound packages at once on our current designed conveyor belt so our motors will need to be able to move both of those with no issues. It needs to not be susceptible to dust in particular as it is meant for an industrial setting.

4.5 Economic Constraints

The smart conveyor belt System is essentially an optimized version of existing products. It has some original features, but there are obviously some competitions in the market such as [1],[2]. To keep our product competitive, it should be appropriately priced slightly above a functional but slower solution, and below an overcomplicated product. By investigating general market price, a price range of $2000-$2500 per unit would be the most profitable while staying competitive in the field.

4.6 Other Constraints

5.0 Sources Cited:

“Smart CONVEYOR BELT, move the items in any direction!,” *Insoltech*, 01-Feb-2019. [Online]. Available: https://insoltechllc.com/2019/01/30/smart-conveyor-belt-move-the-items-in-any-direction/. [Accessed: 30-Jan-2021].

“Chameleon™ - Parcel Sorting Automation,” *Engineering Innovation*, 26-May-2020. [Online]. Available: https://www.eii-online.com/equipment/parcel-automation/chameleon-parcel-processing/. [Accessed: 30-Jan-2021].