Component Analysis

Year: \_2021\_\_ Semester: Spring\_ Team: 16\_ Project: Smart Conveyor Belt System\_\_

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Assignment Evaluation:

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| --- | --- | --- | --- | --- |
| **Item** | **Score (0-5)** | **Weight** | **Points** | **Notes** |
| **Assignment-Specific Items** | | | | |
| **Analysis of Component 1** | 1 | x2 |  |  |
| **Analysis of Component 2** | 5 | x2 |  |  |
| **Analysis of Component 3** | 5 | x2 |  |  |
| **Bill of Materials** | 2 | x6 |  |  |
| **Writing-Specific Items** | | | | |
| **Spelling and Grammar** | 5 | x2 |  |  |
| **Formatting and Citations** | 5 | x1 |  |  |
| **Figures and Graphs** | 5 | x2 |  |  |
| **Technical Writing Style** | 5 | x3 |  |  |
| **Total Score** | 74 | | |  |

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

General Comments:

*Good effort! Please pay closer attention to the requirements of the assignment. You clearly put a lot of work into this document, which I appreciate, but there are important oversights. Major electrical components (such as your microcontroller) are missing from your BOM, as well as your passive components (resistors, caps, inductors, etc.). On your BOM, you should specify package type for relevant components (for example SMD 0805 or 1206) I do not see a component analysis in the component analysis section for your barcode scanner. See my comments for more details.*

IMPORTANT NOTE: The Bill of Materials is a separate document and should be downloaded and filled out for another assignment. The Bill of Materials is to be submitted separately, per the course calendar (possibly on a different week), and will be graded collectively with this assignment.

1.0 Component Analysis:

The primary hardware components of our design include a barcode scanner, a conveyor belt surface, microcontroller, servo motors, and DC brushed motors.

The conveyor belt surface is responsible for the movement of boxes through the scanning array and into the sorting mechanism. The scanning array would consist of 4 barcode scanners. Two of the 4 sensors are located above the conveyor belt, with the other two located along the sides of the conveyor belt. The microcontroller will take in the information from all 4 barcode sensors and make a decision as to which sorting compartment the boxes belong to, based on specific, programmable criteria. The microcontroller would output a signal to the motor driver board, which is responsible for controlling the servo motors on the sorting mechanism. The servo motors are responsible for guiding the boxes into sorting compartments. These servo motors would have 2 set positions. One position extends the guide rail out at an angle to guide parcels into the sorting compartment, while the other position would retract the guide rail so that it is flush with the sides of the conveyor belt guard rail, thus allowing parcels to pass through.

1.1 Analysis of Component 1: Barcode Scanner

The barcode scanner is the primary generator of barcode information. Their responsibility is to scan the barcodes located on the sides of moving boxes and send the information to the microcontroller.

One of the sensors above the conveyor belt would be pointing straight down at the belt, which would scan the top of the box as it is passing by. The other top sensor would be pointing towards the belt at a 45 degree angle, which would scan the front of the box (i.e. the surface of the box that is facing towards the direction of motion) while in motion. The last two sensors would be located on the sides of the conveyor belt, which would scan the left and right sides of the box as it is passing by. There would not be any barcodes on the bottom of the box, which is the face of the box that is in contact with the conveyor belt, or any sensors located below the conveyor belt.

When we were looking for different barcode scanners, we were looking for the scanner that was the most cost effective, the quickest scanning time, the ability to scan 2D barcodes, the amount of power needed, and the ability to interface with our microcontrollers.

1.1 Analysis of Component 2: Conveyor Belt Surface

The conveyor belt surface is another important part of our project as it moves the boxes from the beginning of the system, through the scanning array and into the sorting mechanism. When picking our conveyor belt, we wanted the thinnest belt, the most cost effective, and the ability to support the maximum weight. The thinnest belt was preferable because it would be a much easier belt to cut if we needed to make any changes to its length. The belt had to support multiple parcels that may weigh up to 23 kilograms each. During our search we came across different belts made of different materials and thicknesses. All of the belts we discovered were made of Black PVC, Green PVC, and Nylon. The McMaster-Carr website listed some general traits of each material that also aided in our decision making. The biggest factor was having the lowest coefficient of friction. In order to stay within the amount of power being outputted by the DC brushed motors, we had to ideally have the kinetic friction coefficient between 0.4 to 0.7. The plastic-based materials have a static and kinetic friction coefficient of 0.53 and 0.38. This only left us with belts made of PVC materials because of their lower costs and lower coefficients of friction. Although we did discover that the nylon material has a lower kinetic coefficient of fraction at 0.35, there was a significant price increase by about 2.5 times.

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| Product\  Properties | Black PVC | Green PVC | Nylon |
| Thickness (inches) | 0.135 | 0.1100 | 0.120 |
| Weight Supported (N/mm) | 21 | 12.075 | 8.75 |
| Cost ($ per ft.)  [8 inch width] | $3.46 | $6.96 | $8.84 |

1.1 Analysis of Component 3: Microcontroller

For our microcontroller we decided between two candidates: the STM32M0 and the STM32F4. Both are 32-bit microcontrollers made by STM. The F4 has a better DAC, hardware AES encryption and expanded flash memory. The F0 is cheaper and more barebones but still has plenty of memory to store our pwm, our barcode structures and our program. It has plenty of inputs and outputs for the sensors and controls we’re using. We have decided to go with the STM32F0 simply because it meets our basic needs and is cheaper than the STM32F4.

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|  | STM32M0 | STM32F4 |
| Clock Speed | 48 Mhz | 168 Mhz |
| Cost | $14.20 | $40 |
| Extra Features | Limited storage, 2 USART | Improved DAC, Expanded flash memory, 4 USART |

1.1 Analysis of Component 4: Servo Motors

The servo motors are the key components necessary to enable the sorting of the packages. Each servo must be capable of moving a flap very quickly to intercept the packages as they move along the belt, so we need the fastest servos possible for the lowest cost. The flaps that the servos will be actuating are going to be lightweight, so we don't need to be too concerned about the servos capability to handle the load due to accelerating moments. With that said, there are two options: The MG995 and the DS3225. The MG995 is roughly half as powerful as the DS3225, but at a quarter of the cost. Therefore, we will go with the MG995.

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| Motor | Torque | Time to travel 60° | Price |
| MG995 | 12-13 kg-cm | 0.17s - 0.13s | $19 [Qty. 4] |
| DS3225 | 21-25 kg-cm | 0.13s - 0.15 s | $20 [Qty. 1] |

1.1 Analysis of Component 5: DC Brushed Motors

We had a few motors to select from, with our constraints tied to the torque and power output of our motor at a desired rpm. Basically, our motor needs to be able to move a 23kg object down the belt at 30cm/s. To simplify the design process, we decided to use a 12V Brushed DC motor with a gearbox attached. With a roller of 1.9 in diameter, we either need an RPM of roughly 120, or a motor with similar speed and a torque high enough to enable the desired speed after applying an external mechanical advantage via pulleys or gears. With this in mind, we were caught between two options: PN01007-10038 (torque of 3 Nm at 100 RPM for $65), and 2709K17 (torque of 2.6 Nm at 161 RPM for $295). Between these two options, the PN01007 is the clear winner for the price.

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| Motor | Torque | RPM | Price |
| PN01007-10038 | 3 Nm | 100 | $65 |
| 2709K17 | 2.6 Nm | 161 | $295 |

2.0 Sources Cited:

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