Object Separation System Based on Height Differences Automatically

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Abstract. Technological advances are now launching the industrial revolution 4.0, where an automation system is an essential tool in the industrial world. In the industrial world, we need a tool that can accelerate and produce processes that can run effectively and efficiently and can improve the quality and needs of production. Therefore a prototype of a high-based object sorting conveyor is controlled by Arduino Uno which controls the automatic item sorting process. This conveyor prototype uses the HC-SR04 Ultrasonic Sensor component with the aim that it can be applied to facilitate the process of selecting objects in the industrial field. Also, Arduino Uno has made a program in advance using a programming language created on specialised software to produce outputs that control the process of sorting objects. This prototype is then programmed to be able to make automatic item selection with a maximum limit of objects that can be accommodated by the conveyor is 200 grams, with variations in the height of the object reaching 1-6 cm. Based on data from the test results, the prototype conveyor has a success rate in selecting objects of ± 92%.

Keywords: Sorting Objects, Conveyors, Arduino Uno, HC-SR04

1. Introduction
An automatic system is very helpful in industrial activities because all production activities that are continuous or momentary are now replaced by engine power. The role of engine power in replacing human labour in terms of the production process so that the production process takes place more effectively and efficiently. In the production process often has difficulty in segregating objects that are categorised in large, medium and small sizes[1]. One of the best solutions in segregating objects to take place efficiently and continuously is to use automation. Automation is meant by using a conveyor that has been equipped with a controller and sorter so that it can quickly maximise production results[2]. The conveyor will move continuously, and the sorting process will work according to the desired program, and with the existence of the system, the sorting of objects can be done as needed. Based on that, the purpose of this study is to develop a prototype conveyor that is equipped with an automatic objects sorter system which can later sort objects based on their size. The size of objects to be sorted is grouped into small (unused), medium and large items, and the method used in the grouping is based on the height of the objects[3].
2. Methodology

The method used in making the simulation of Sorting Conveyors is the testing method. This method focuses on the development and exploration of interrelated matters and is based on integrated data collection. Case studies involve case investigations, which can be defined as an identity or object of study that is restricted or separate for research in terms of time, place, or physical boundaries. After the case is clearly defined, the researcher conducts in-depth research, using several data collection methods, such as interviews, field observations, and documentation. So from the developments that have been carried out, a product is produced based on the objectives to be achieved and indeed can still be developed for further improvement.

2.1. Belt Conveyors

The effectiveness of production in the industry is not merely fulfilled by the existence of an automatic control system that is being intensively applied in the industrial world, saving time and energy when moving objects from one place to another becomes a supporting factor for the effectiveness of the production process. This can be overcome by the existence of a device called a "conveyor", and this tool is designed to be able to distribute production objects quickly to other places by considering the efficient use of energy. Belt conveyor is a means of transportation of objects whose conveyor is made of endless rubber, consisting of several layers hardened with steel fibre (fibre stell) and or steel wire to produce strength to the belt. Belt conveyors can be used to move both unit loads and bulk loads along a straight line (horizontal) or a limited angle of inclination[4]. Belt conveyors or (conveyor belts) have the main components in the form of belts that are above the supporting rollers. A drive motor drives the belt through one pulley, and the belt moves translatively with a flat or tilted pass depending on needs and planning. The material is placed above the belt and with the belt moving in one direction. In the operation of the conveyor belt using a driving force in the form of an electric motor with an intermediate gear that is coupled directly to the driving pulley. The belt which is above the rollers will move across the rollers with speed according to the rotation and pull of the drive.

2.2. Servo Motor

The Servo motor is one type of motor that has three cables. Each of these cables is connected as a power supply, control, and ground. The control cable is used to determine the motor to rotate the rotor in a specific position. This servo motor can rotate up to 180 degrees. Usually used to move a robotic arm or rotate an analogue measuring instrument. Controlling a servo motor needs to be given a voltage source and control signal, and the voltage source depends on the specifications of the servo motor used. Meanwhile, to regulate the rotation of the servo motor is done by adjusting the pulse control with a frequency of 50 Hz with a period of 20 ms and different work cycles. Where to move the servo motor by 90 degrees pulses are needed with a 1.5ms positive pulse duty cycle and to move 180 degrees requires a 2ms pulse width.

2.3. HC-SR04 Ultrasonic Sensor

The HC-SR04 is an ultrasonic sensor that can be used to measure the distance between the barrier and the sensor. This sensor can detect distances without direct touch with high accuracy and stable reading. This sensor is available with an ultrasonic wave transmitter module and receiver. The function of the ultrasonic transmitter is to emit ultrasonic waves with a frequency of 40 kHz then the ultrasonic receiver captures the results of ultrasonic waves that strike an object[5]. The ultrasonic wave travel time from the transmitter to the receiver is proportional to 2 times the distance between the sensor and the reflecting plane. The next stage is the purpose of reading the distance on the sensor to be the height of the object. This is done as a step issued to classify the objects to be sorted, using the ultrasonic signal travel time from the transmitter until it is received back by the receiver is converted into a distance (cm)[6]. The principle of distance measurement using the HC-SR04 ultrasonic sensor is that when a trigger pulse is given to the sensor, the transmitter will begin to emit ultrasonic waves, at
the same time the sensor will produce a transitional TTL output indicating the sensor starts counting the measurement time, after the receiver receives the reflection generated by an object then the time measurement will be stopped by producing a TTL output down transition. If the measurement time is \( t \) and the speed of sound is 340 m / s, the distance between the sensor and the object is calculated using the following Equation 1:

\[
s = \frac{t \times 340 \text{ m}}{2}
\]

With:
- \( s \) = Distance of sensor to object (m)
- \( t \) = Time of ultrasonic wave travel from transmitter to receive

2.4. Arduino
Arduino Uno is a microcontroller development board based on the ATmega328 chip where there are main components, a microcontroller chip with AVR type from the Atmel company. The chip or IC (integrated circuit) can be programmed using a computer. The purpose of embedding the program in a microcontroller is so that the electronic circuit can read the input, process the input and then produce the desired output[7]. Microcontroller functions as the brain that controls the input, process, and output of electronic circuits.

2.5. Flowchart of The Tool
The conveyor process flowchart can be described as follows, where the conveyor is first turned on before carrying out research. This is done so that the process runs smoothly. When the conveyor is working correctly, the object is placed on a moving converter. The next SRV sensor will read the height of the object passing through it, and the servo motor will work opening and closing the bar in accordance with the results of the sensor reading/sorting process, with variations in object height 5-6 cm servo 1 opening, object height 3-4 cm servo 2 opening, and objects with height 1-2 will reject, and if the sorted object does not match the programmed program, then re-install the object to be measured until it is in accordance with the programming. This process continues until the items to be sorted have been used up.

![Figure 1. Flow Chart of The Workings of The Conveyor Sorting Objects](image-url)
3. Result and Discussion
The design of the converter can be seen in Figure 2, and wiring design on sorting conveyors can be seen in Figure 3.

![Figure 2. Design of Sorting Conveyors (left, and right side view)](image1)

![Figure 3. Design of Wring in Conveyor Automation](image2)

3.1. Working Mechanism of Sorting Conveyors
The working mechanism of the conveyor is designed to sort objects based on their size randomly. The classification in determining the size of objects is divided into three, namely: large objects, medium objects and small objects (reject). The objects to be sorted are box-shaped with a length and width of 5 cm but with varying height. This is intended so that later sensors can focus on grouping objects based on height and no longer concerned about the length and width because of the same size.

![Figure 4. Items to be Sorted](image3)
Table 1. Qualification of Objects

| Height  | Size  | Remarks |
|---------|-------|---------|
| 1 – 2 cm | Small | Reject  |
| 3 – 4 cm | Medium | Compatible |
| 5 – 6 cm | Large | Compatible |

Based on Table 1. It can be seen that the height of objects in 5-6 cm and 3-4 cm by the qualifications of the desired object, while the height of objects 1-2 cm does not match the qualifications of the desired item, so it becomes a rejecting object.

3.2. Conveyor Test Results

The following is table of results of the testing of objects sorting conveyors based on their height.

Table 2. Test Results for Sorting Conveyors

| No. | Objects | Number of Repetition | Level of Success | Height of Object | Size  | Remarks |
|-----|---------|----------------------|------------------|-----------------|-------|---------|
| 1   | A       | 5 times              | 100 %            | 1 cm            | Small | Reject  |
| 2   | B       | 5 times              | 80 %             | 3 cm            | Medium| Compatible |
| 3   | C       | 5 times              | 100 %            | 4 cm            | Medium| Compatible |
| 4   | D       | 5 times              | 80 %             | 5 cm            | Large | Compatible |
| 5   | E       | 5 times              | 100 %            | 6 cm            | Large | Compatible |

Based on Table 2, states that each item that passes through the conveyor is done five times with a relatively similar success rate. The success rate is one example when the item "D" passes through the conveyor five times, four times successful and once failed. This shows that the conveyor has not been able to sort objects correctly because there must be some mistakes that prevent the conveyor from being able to detect or sort objects properly.

To get an average level of success, conveyor in sorting the objects are as follows:

\[
\frac{\text{Total number of items successfully sorted}}{\text{Overall total testing}} \times 100\% = \frac{23}{25} \times 100\% = 92\%
\]

So the average success rate of conveyors in sorting objects is 92% which means that the conveyors have exceeded the predetermined initial standard of $\geq 75\%$.

While the level of failure or error in conveyor testing is:
Overall total Tests – items successfully sorted

\[ \frac{25 - 23}{25} \times 100\% = 0.08 \times 100\% = 8\% \]

So the average error rate on the results of testing the conveyor in sorting the objects is equal to 8%. Of course, the testing process is inseparable from an error or failure, and this affects how well a tool can be applied in the real world. The smaller the error value on a device, of course, the more accurate the tool.

4. Conclusions

Based on the analysis and testing of objects sorting conveyors, the following conclusions are obtained when the conveyor carries the objects and passes the sensor, and the sensor will automatically detect the objects passing through it. If the item detected matches the specified item size, the servo motor would move at once to sort the item. The higher the DC voltage input value is given to the DC Motor, the higher the conveyor speed in carrying objects. The greater the load carried by the conveyor, the slower the conveyor will be to carry the load. The maximum limit that can be accommodated by the sorting conveyor based on this height is 200 grams. Based on data from the test results, conveyors have a success rate in sorting objects by ±92%. KW.

5. References

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6. Acknowledgements

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