



Design of Arduino Uno-Based Automatic Object Sorter Belt Conveyor System Using Ultrasonic Sensors

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ABSTRACT

Belt conveyor is a fairly simple equipment used to transport load units or bulk materials with a large capacity, the tool consists of belts that are resistant to the transport of solid objects. The sabuk used in this Belt Conveyor is made from various types of materials, for example from rubber, plastic, leather or metal which depends on the type and nature of the material to be transported.

The testing process of this tool starts by turning on the Conveyor Belt, the rotation on the Conveyor Belt is constant at a speed of 3.1 m / min and there is no speed setting, the speed of the Conveyor Belt can be known using the Tachometer tool and can be calculated manually using the formula $v = s / t$ where v = speed, s = distance and t = time. When the object is attached to the Conveyor Belt the object will run and pass through the Ultrasonic sensor, when the position of the object is directly under the sensor, the sensor will detect the object based on the height or distance between the sensor and the object, so that *Arduino Uno* can carry out the work process of the object falls into category A, B or C.

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1. INTRODUCTION

The improvement of production technology is always offset by the improvement of transportation technology that is increasingly developing. One of them is to use the belt conveyor system as a means of transportation that plays a role in the process of transporting its production results. Belt conveyor has been widely used in industry. There are so many benefits obtained from the use of belt conveyor, according to calculations that have been done, the transportation system with belt conveyor will be more efficient compared to trucking transportation.

Currently some small medium industries still use conventional means of transporting goods that have been packaged to be stored into warehouses manually pulled using trolley and stored based on packaging of different sizes. In addition, the process of sorting packaging manually will also take time, cost, and the operator's own power. To overcome this problem, there needs to be an automatic object sorting machine based on the height of the product or packaging size, so that workers no longer sort the packaging conventionally to be stored into gudang manually, workers only standby in the storage area to arrange or arrange packaging that has been sorted through belt conveyor.

Belt conveyor is a fairly simple equipment used to transport load units or bulk materials with a large capacity, the tool consists of belts that are resistant to Transportation of goods, belts used on conveyor belts are made of various types of materials, for example from rubber, plastic, leather or metal depending on the type and nature of the material to be transported. Transport hot materials, the belt used is made of heat-resistant metal. There are several advantages of using a conveyor belt, namely: (1) Can operate horizontally or obliquely

with an angle up to 1800; (2) Sabuk disproved by roller plate to carry material;(3) High capacity; (4) Can operate continuously; (5) Versatile; (6) Easy maintenance

Belt conveyor consists of belt, frame, idler, drive unit, take up and hardware. In general, the belt consists of three main parts, namely the top cover, carcass and bottom cover. The belt layer serves to protect the kakas from wear and damage during operation. Carcass serves to pass the voltage on the belt at start and during moving the charge. In addition, kakas can also absorb the impact force of the load due to the speed of the belt so that it remains stable. A good belt should have high strength, light weight, high hygroscopic, flexible and durable. Judging from this requirement, then a belt consisting of several layers of cotton and rubber is a good type. As for some of the conditions of the belt among them; (1) Resistant to Tensile loads; (2) Shock load resistance; (3) Low tenacity; (4) Must be flexible; (5) Does not absorb water; (6) Light

2. METODE

The design of this automatic object sorting system based on Arduino Uno-based height using Ultrasonic distance sensors, this tool will automatically sort objects passing under ultrasonic sensors through the Conveyor Belt based on the size of the distance between the Ultrasonic sensor and the object. In this design, the simulation is carried out using box as an object that will be sorted based on height automatically through the Belt Conveyor, using 3 box with different sizes, including box A with a height of 12 cm, box B with a height of 15 cm, and box C (Reject) with a height of 10 cm. In the process of working, the object sorter is also supported by a servo motor that serves as a sorter of the object based on the container that has been made. In designing this series of automatic object sorting tools, it is combined from several main components such as Arduino Uno as a microcontroller, Ultrasonic sensor, servo motor, and Belt Conveyor drive system. To build this automatic object sorting tool, starting from preparing the necessary tools and materials, starting from the design of the tool both from the programming process and assembling the tool, then conducting tool testing, to the final analysis in the form of finishing and data processing.

This design is carried out using design methods, automation manufacturing and testing of belt conveyor operating systems using arduino uno as a controller and sorting objects based on height. The following outlines the working system of tools and the relationship between components with each other. Explanations can be poured in the form of block diagrams as follows:

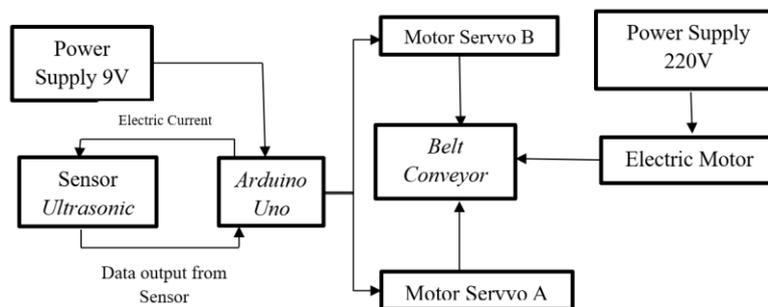


Figure 1. Tool Block Diagram

2.1 Automation Improvement

After the design process has been prepared, the next stage of automation manufacturing for servo motor rotation and ultrasonic sensor readings that function to instruct servo motors to rotate 0° - 90° and 90° - 0° . As shown below is a program from Arduino Uno.

```
#include <Servo.h>
#define trigPin 13
echoPin 12 #define
Servo tasks;
Arm servo;
int Barang1 = 1;

void setup()
{
Serial.begin (9600);
```

```
pinMode(trigPin, OUTPUT);
pinMode(echoPin, INPUT);
arm.attach(6);
task.attach(10);
}

void loop()
{
int duration,distance;
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
digitalWrite(trigPin, HIGH);
delayMicroseconds(100);
digitalWrite(trigPin, LOW);
duration = pulseIn(echoPin, HIGH);
distance = 14 - (duration/2) / 29.1;

if (distance >= 1 && distance <= 3)
{
Serial.print("Quality A to : ");
Serial.print(Item1++);
Serial.println(" ");
Serial.print(distance);
Serial.println("12cm");
task.write(15);
delay(50);
arm.write(90);
delay(3000);
arm.write(15);
delay(3000);

}

if (distance >= 4 && distance <= 6)
{
Serial.print("Quality B to : ");
Serial.print(Item1++);
Serial.println(" ");
Serial.print(distance);
Serial.println("15cm");
arm.write(15);
delay(50);
task.write(90);
delay(5000);
task.write(15);
delay(5000);
}
if (distance >=7)
{
Serial.println("Reject Item");
task.write(15);
arm.write(15);
delay(500);
}
delay(1000);
}
```

Figure 2. Program Arduino Uno

2.3 Parameters

After the design of the arduino-based automatic object sorter conveyor belt is completed, there are several parameters that must be considered so that the design results are in accordance with the desired.

a. Belt Conveyor Parameters

Belt Conveyor design is categorized as correct if there is no slip on the motor and the speed of the object carrier belt is not too fast, because if it is too fast it can interfere with sensor readings. The speed used is the optimum speed, which is not too fast and not too slow.

b. Automation Parameters

Automation manufacturing is categorized as correct if the servo motor moves according to the height conditions of each box level and the servo motor response does not slip at the turn.

3. RESULTS AND DISCUSSION

From the design of the Belt Conveyor, arduino uno-based automatic object collector using Ultrasonic sensors, which have been completed, we can know on the table, as follows:

Table 1. Conveyor Belt Specifications

No	Spesification	Distance (cm)	Speed (m/min)	Height (cm)
1	Speed Belt Conveyor	-	3,1	
2	Length of Track	98	-	-
3	Distance from start point to sensor	18	-	-
4	Distance sensor to belt	23,5	-	-
5	Distance Sensor to Box A	11,5	-	-
6	Distance Sensor to Box A B	8,5	-	-
7	Distance Start Pont to cross cutting A	46	-	-
8	Distance Start Pont to cross cutting B	73	-	-
9	Distance Sensor to cross cutting A	28	-	-
10	Distance Sensor to cross cutting B	54	-	-
11	Height Box A	-	-	12
12	Height Box B	-	-	15
13	Height Box C	-	-	10

From the analysis and trials that have been carried out from the design of the Arduino Uno-based automatic object sorter belt conveyor, it can be known the results of the design of the tool as it has been made in the Arduino Uno software program, the results of experiments that have been carried out are presented in the form of table 2 below:

a. Box Experiment A

In the experiment box A starts at a distance of 5 cm to 50 cm, can be known the distance continue on box A.

Table 2. Box A experiment

No	Distance between box (cm)	Height of Box (cm)	Distance box to sensor (cm)	time of box A1 (s)	Result	Time of Box A2 (s)	Result	Time of Box A3 (s)	Result
1	5	12	11,5	8	✓	-	✗	-	✗
2	10	12	11,5	8	✓	-	✗	17	✓
3	15	12	11,5	8	✓	-	✗	18	✓
4	20	12	11,5	8	✓	-	✗	18	✓
5	25	12	11,5	8	✓	-	✗	19	✓
6	30	12	11,5	8	✓	17	✓	23	✓
7	35	12	11,5	8	✓	18	✓	27	✓
8	40	12	11,5	8	✓	19	✓	31	✓
9	45	12	11,5	8	✓	21	✓	34	✓
10	50	12	11,5	8	✓	23	✓	37	✓

From table 2 can be known the results of the experiment box A from the distance between box 5 cm to 25 cm, not all box managed to enter the cross section because the distance is not in accordance with the work step process, while at a distance of 30 cm or more, box can all enter the container A, from the results of the experiment can be known the minimum distance so that the box can enter all into the cross section, namely at a distance of 30 cm, it can be seen as figure 3.

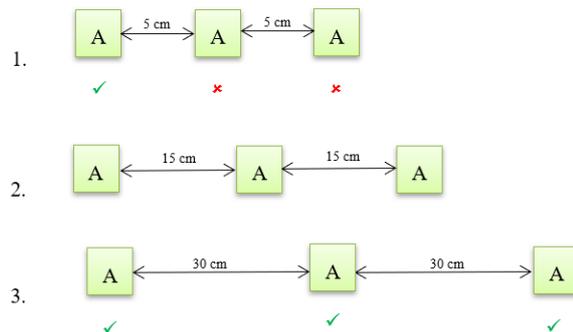


Figure 3. Distance Continue Box A

In figure 3 can be known in figures number 1 and 2 does not include the distance continue because not all box can enter the cross-section while in figure number 3 is the distance continue for box A because all box can enter the cross-section at a distance of 30 cm.

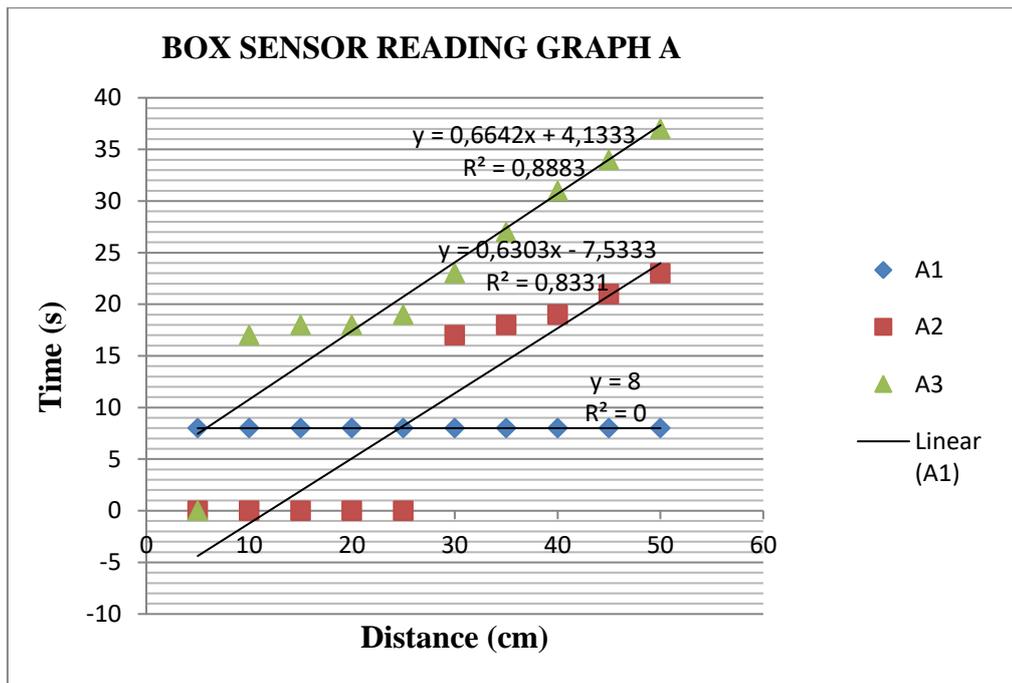


Figure 4. Box Reading Graph A

From figure 4 can be seen the graph of box work reading A, where for the work process of box A1 from a distance of 5 cm to 50 cm, the time needed to enter the cross-section A is constant, which only takes 8 seconds, because box A1 is in the front position so that the work step or sensor reading starts from box A1, while for box A2 at a distance of 5 cm to 25 cm is on line 0 or box is not readable by the sensor and only read at a distance of 30 cm and takes 17 seconds to enter cross-section A, because for box A1 and A2 requires a minimum distance so that box A2 can be read or detected by Ultrasonic sensors, and for A3 box at a distance of 5 cm is not readable by the sensor and only read by the sensor at a distance of 10 cm and so on. when the A2 box fails to be read by the sensor, the reading continues on the A3 box.

b. Box B Experiment

In the experiment box B starts at a distance of 10 cm to 100 cm, can be known the distance continue on box B.

Table 3. Experiment of Box B

No	Distance Between Box (cm)	Height of Box (cm)	Distance Box to Sensor (cm)	Time of Box B1 (s)	Result	Time of Box B2 (s)	Result	Time of Box B3 (s)	Result
1	10	15	8,5	14	✓	-	✗	-	✗
2	20	15	8,5	14	✓	-	✗	-	✗
3	30	15	8,5	14	✓	-	✗	31	✓
4	40	15	8,5	14	✓	-	✗	33	✓
5	50	15	8,5	14	✓	-	✗	35	✓
6	60	15	8,5	14	✓	-	✗	37	✓
7	70	15	8,5	14	✓	28	✓	43	✓
8	80	15	8,5	14	✓	30	✓	48	✓
9	90	15	8,5	14	✓	32	✓	52	✓
10	100	15	8,5	14	✓	34	✓	56	✓

From table 3 can be known the results of the box B experiment from the distance between 10 cm to 60 cm box, not all box managed to enter the shelter because the distance is not in accordance with the work step process, while at a distance of 70 cm or more, box can all enter the cross section, from the results of the

experiment can be known the minimum distance so that the box can enter all into the shelter, namely at a distance of 70 cm, It can be seen as figure 4.3.

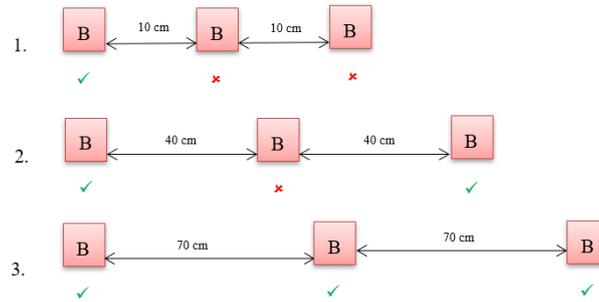


Figure 5. Continuous Distance Box B

In figure 5 can be known in figures number 1 and 2 excluding the distance continue because not all box can enter the cross-section while in figure number 3 is the distance continue for box B because all box can enter the cross-section, namely at a distance of 70 cm.

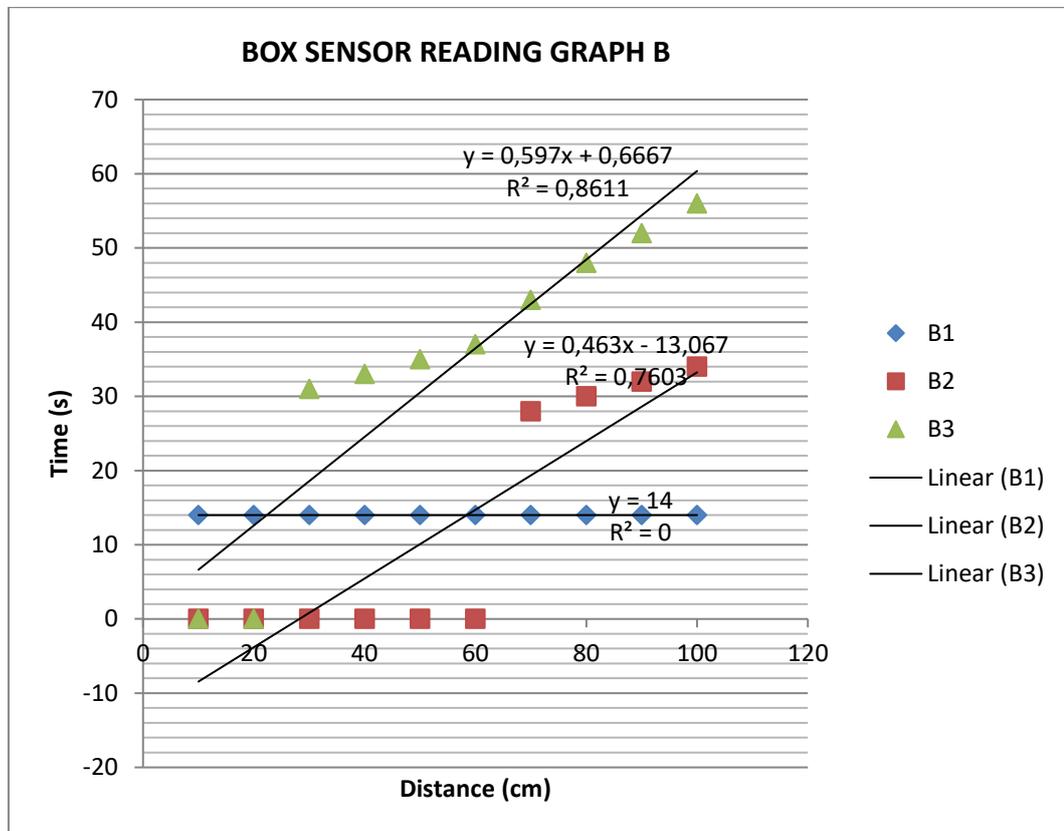


Figure 6. Box B Racing Graph

From figure 6 can be seen the graph of the working reading of box B, where for the work process of box B1 from a distance of 10 cm to 100 cm the time needed to enter the cross-section B is constant, which only takes 14 seconds, because box B1 is in the front position so that the working step or sensor reading starts from box B1, while for box B2 at a distance of 10 cm to 60 cm is on line 0 or box is not read by The sensor and new read at a distance of 70 cm and take 28 seconds to enter the cross section B, because for box B1 and B2 requires a minimum distance so that box B2 can be read or detected by Ultrasonic sensors, and for box B3 at a distance of 10 cm to 20 cm is not readable by the sensor and only read by the sensor at a distance of 30 cm and so on. When the B2 box fails to be read by the sensor, the reading continues on the B3 box.

c. A-C-B Box Experiment

In the A-Reject-B box experiment starting at a distance of 10 cm to 100 cm, can be known the distance continue on the A-Reject-B box.

Table 4. A-C-B Box Experiment

No	Distance between box (cm)	Height of Box A (cm)	Height box A to Sensor (cm)	Height of Box B (cm)	Distance Box B to Sensor (cm)	Height of Box C (cm)	Distance Box C to Sensor (cm)	Time of Box A (s)	Result	Time of Box C (s)	Result	Time of Box B (s)	Result
1	10	12	11,5	15	8,5	10	13,5	8	✓	21	✓	20	✓
2	20	12	11,5	15	8,5	10	13,5	8	✓	23	✓	22	✓
3	30	12	11,5	15	8,5	10	13,5	8	✓	25	✓	24	✓
4	40	12	11,5	15	8,5	10	13,5	8	✓	27	✓	27	✓
5	50	12	11,5	15	8,5	10	13,5	8	✓	29	✓	29	✓
6	60	12	11,5	15	8,5	10	13,5	8	✓	31	✓	32	✓
7	70	12	11,5	15	8,5	10	13,5	8	✓	33	✓	34	✓
8	80	12	11,5	15	8,5	10	13,5	8	✓	35	✓	36	✓
9	90	12	11,5	15	8,5	10	13,5	8	✓	37	✓	39	✓
10	100	12	11,5	15	8,5	10	13,5	8	✓	39	✓	42	✓

From table 4 can be known the results of the A-Reject-B box experiment from the distance between the box of 10 cm or more, the box can all enter the shelter, from the results of the experiment can be known the minimum distance so that the box can enter all into the shelter, namely at a distance of 10 cm, can be seen as figure 7.

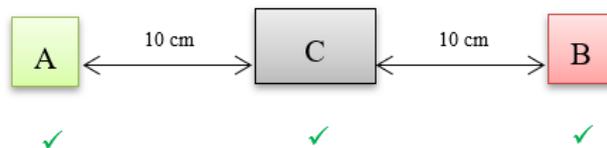


Figure 7. Distance Continue Box A-C-B

In figure 7, it can be known the distance continue on the A-C-B box is at a distance of 10 cm because the A-C-B box can fit all into the cross section.

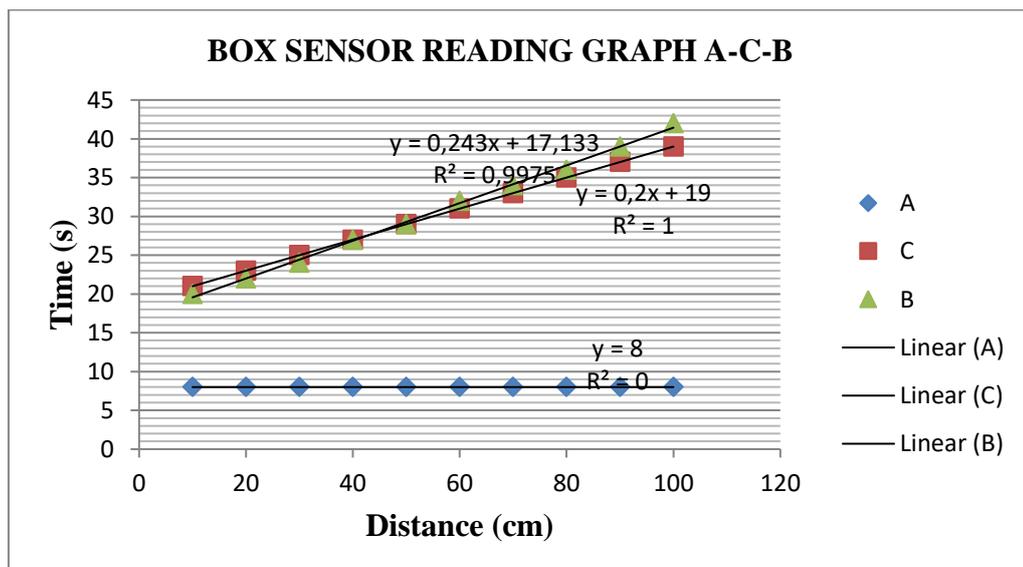


Figure 8 A-C-B Box Experiment Graph

From figure 8 can be seen the graph of the work reading of box A-C-B, for the work process of box A from a distance of 10 cm to 100 cm the time needed to enter the cross-section A constant, which only takes 8

seconds, because box A is in the front position so that the working step or sensor reading starts from box A, while for box C (Reject) at a distance of 10 cm to 100 cm still runs on belt The conveyor gets into the C cross section without any obstacle because the sensor does not read box C, the time it takes for box C to reach cross-section C according to the predetermined distance, and for box B at a distance of 10 cm and so on can be read by the sensor because it exceeds the minimum distance that has been readable by the sensor then the reading continues on box B.



Figure 9. the Arduino Uno-Based Automatic Object Sorter Belt Conveyor System Using Ultrasonic Sensors

4. CONCLUSION

This conveyor belt works to sort objects based on the height of the object, when the object passes then the sensor will read the height of the object and immediately the servo motor will open 90° , when the object approaches the place of sorting then the servo motor will close back to 0° so that the servo motor will push the object is to enter each area of the object based on a predetermined height where there is area A for objects with a height of 12 cm and area B for objects with a height of 15 cm, while objects that are not read the height will run without any obstacles towards area C or area "Reject".

From the results of the Design of the Arduino Uno-Based Automatic Object Sorter Belt Conveyor System Using Ultrasonic Sensors, it can be concluded that the tool can sort objects based on height well. In accordance with the experiments that have been carried out on the tool, so it is known that the distance continues on each box, namely for box A with a distance of 30 cm and for box B with a distance of 70 cm.

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