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Sorting objects based on weight using the Internet of Things (IoT)

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ABSTRACT

This research aims to design and implement a goods sorter based on weight using Arduino Nano, equipped with a web-based monitoring system. The system uses a load cell sensor to detect the weight of items and classify them into three different categories. The Internet of Things (IoT) concept is applied to enable real-time monitoring through Google Sheets, where the sorting data is automatically sent and stored on the web. The test results show that this tool successfully improves efficiency and accuracy in the process of sorting goods in the industry. Additionally, this tool can reduce costs typically incurred for procuring checkweigher devices and ensure compliance with quality standards regulated by consumer protection laws. Based on the analysis of the test data, this system can function well according to the specified requirements, with several recommendations for improving accuracy and further developing monitoring features.

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1. INTRODUCTION

In the modern industrial world, goods sorting tools provide a reliable solution to ensure that the weight of production results is in accordance with the specified product information [1]. By using this tool, the goods sorting process can be carried out automatically and accurately, ensuring that each product has a weight that is in accordance with the set standards. This helps maintain consistent product quality and provides consumers with confidence in the products they need. Goods sorting tools using conveyors with scales have become a key component in increasing production efficiency and optimizing manufacturing processes [2]-[5]. Conveyors with scales are systems that integrate conveyors, material transfer tools, with weighing devices that allow real-time measurement of the weight of goods as goods are moved through the conveyor system [6]-[10].

In previous studies, goods sorting tools have been conducted by other reseacher [11]-[17]. The results of the first study only focused on the color of the goods and in subsequent studies the sorting tool can weigh the weight of goods on the conveyor but there has been no data collection from the results of the sorting carried out. This is still a problem due to the lack of information on the products produced which ultimately impacts the consistency of product quality. This study presents an innovative solution where there is a difference from the tools that have been made previously. This study will use the concept of the Internet of Things (IoT) which is utilized to be able to monitor remotely. The website design is carried out so that the sorting system that works based on the weight of the goods can be monitored in real time by the operator. The web in question is in the form of data that will be automatically sent and stored on the Google Sheet web. Through this spreadsheet, the operator can find out the amount of sorting that has been done. Thus, this research is expected to contribute to the development of goods sorting tool technology so that the products produced can meet the quality standards that have been set and provide confidence to consumers about the products they need

2. METHOD

The method used to design and develop this device system is the experimental method. The system design stage is part of the planning process carried out before the device is made. The purpose of designing and developing this system is to determine the components that will be used so that the final result is as expected. An explanation of the block diagram, the working principle of the circuit, and the design of hardware and software in this system serves as an initial guide to ensure that the research results are in accordance with the planned and expected system.

In this system, the Arduino Nano microcontroller with the ATmega328 chipset controls the entire operation. This system is made concisely by using only one sensor for the entire mechanism. Load Cell is used as the main sensor and is equipped with the Hx711 module to convert weight data into digital data which is then displayed on the LCD. In addition, the MG996R servo motor with metal gears is also used in this system. A servomotor is a particular kind of motor made to precisely control acceleration, velocity, and angular or linear position. Servomotors are frequently utilized in robotics, CNC machines, and automated manufacturing systems applications where precise motion control is essential. The JGY-370 DC motor functions as the main drive of the conveyor. A DC motor is a type of electric motor that produces mechanical energy from direct current (DC) electrical energy. According to the electromagnetism principle, motion is created when a current-carrying conductor interacts with a magnetic field. Because of its simplicity and controllability, DC motors are widely utilized in a variety of applications, from small household gadgets to industrial machinery. A more detailed explanation of the system schematic can be seen in Figure 1.

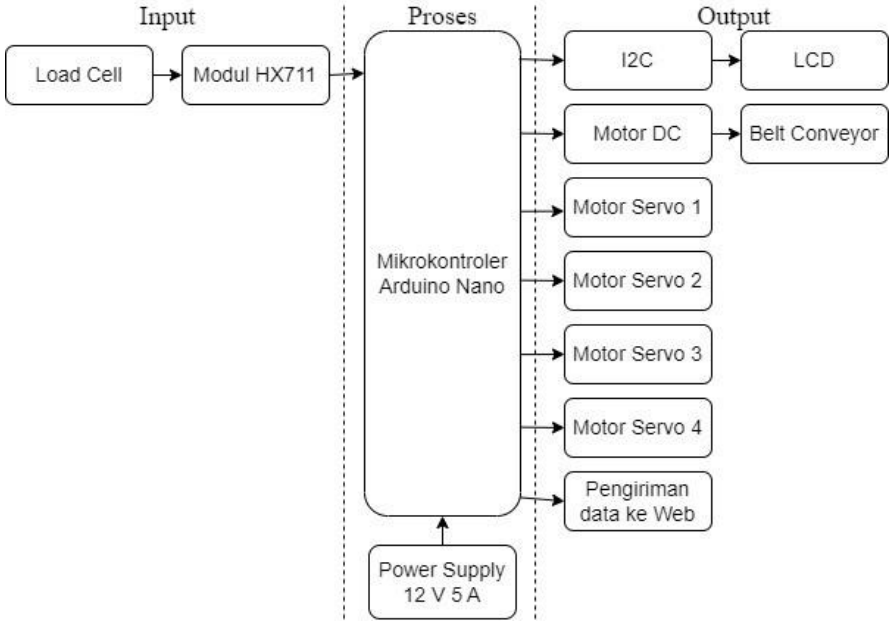

Figure 1. System Design Block Diagram

This system is designed using a block diagram that details the function of each component to carry out the object sorting process. Load Cell functions as a sensor that detects the weight of the object to be sorted. Weight data from the Load Cell is converted to digital format by the HX711 Module, which acts as an intermediary to display information on the LCD. Arduino Nano is tasked with processing input signals from the sensor and sending the results of the processing to the output components according to the system workflow. The power supply provides DC voltage to operate all system components efficiently. LCD and I2C are used to display the readings from the microcontroller, providing a clear visual display of the weight of the object being measured.

The DC motor functions to drive the conveyor belt that sends objects in the sorting process. Furthermore, servo motor 1 acts as an object pusher after the weight measurement is complete, while servo motors 2 to servo 4 are tasked with pushing the load according to its weight categorization, ensuring that objects are placed on the correct path based on their weight. By integrating these components, the system can sort objects by weight with high efficiency and accuracy. All components needed in the system design process are collaborated into one to produce a system that functions according to the design. The system workflow is arranged according to the system's objectives and is illustrated in a flowchart as in Figure 2.

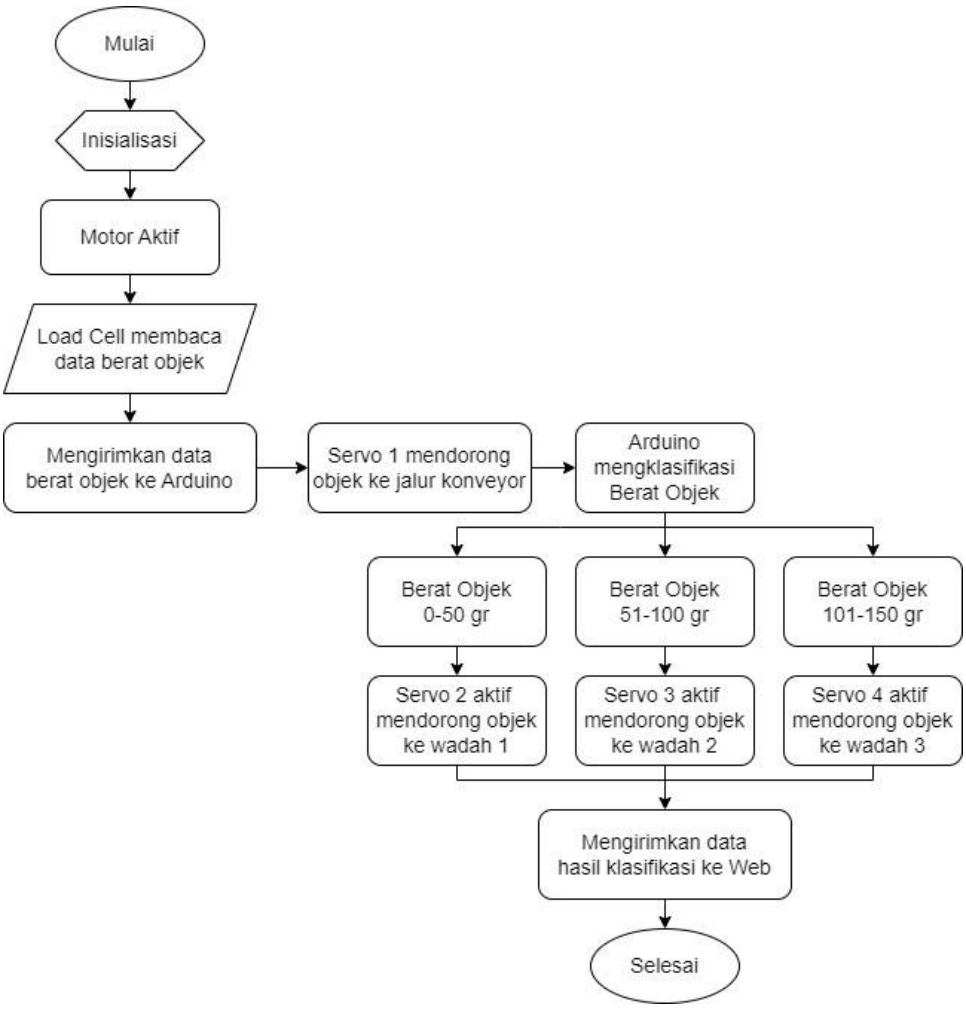

Figure 2. Flowchart of proposed system

To run the system according to the initial plan, an electrical system schematic design is required which can be seen in Figure 3.

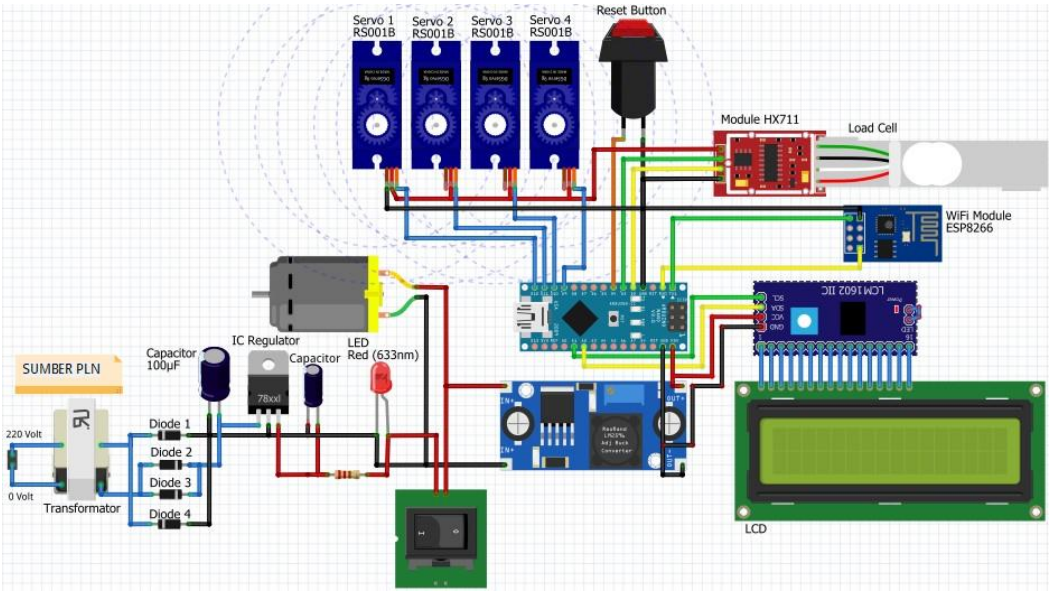

Figure 3. Circuit sheme

Four servo motors are utilized, as seen in Figure 3. One of these is the RS001B type, a high-performance robotic servo motor that is frequently utilized in industrial automation, robotic arms, and humanoid robots. ROBOTIS, a business renowned for producing cutting-edge robotics components, makes it. An outline of the RS001B servo can be found here. The 3-dimensional schematic design of the system that has been designed can be seen in Figure 4.

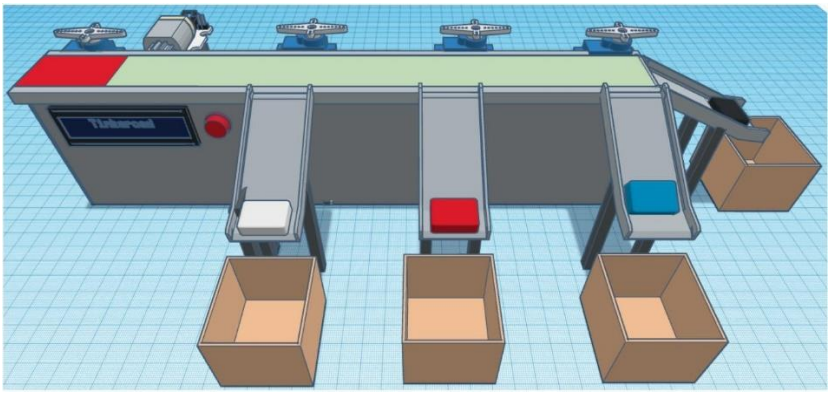

Figure 4. 3D Design of the System

The weight measurement data will later be recorded accurately in Google Sheet using the Internet of Things (IoT) concept which is used to be able to monitor remotely. The website design is done so that the sorting system that works based on the weight of the goods can be monitored in real time by the operator. The use of Google Sheet is supported by the existence of a library to be able to access spreadsheets by the Arduino microcontroller. This can be done by a microcontroller that has an ESP8266-based wifi chip. In the Arduino IDE library, it can be searched for by the library name "ESP Google Sheet Client". The use of spreadsheets is increasingly widespread because in addition to being a medium for recording data, the recorded data, if processing is needed, can be done very easily.

3. RESULTS AND DISCUSSION (10 PT)

Testing the tool comes next after it is completed. Testing is carried out in compliance with accepted experimental protocols. Experimental methods are methodical processes created to conduct an experiment in order to gather information, test a hypothesis, or confirm findings. For this process to be repeatable and guarantee the validity of the outcomes, it must be rationally, clearly, and systematically developed. Testing is carried out with various types of weight of the object to be weighed. Table 1 describes the test results.

Table 1. The experimental results

No.	Object Weight	Experimen	Object Weight Classification	Object Weight Accuracy Level
1.	50 gram	10x	Box 1	100%
2.	75 gram	10x	Box 2	100%
3.	100 gram	10x	Box 3	100%
4.	22 gram	1x	Error	100%
5.	54 gram	1x	Error	100%
6.	45 gram	1x	Error	100%
7.	83 gram	1x	Error	100%
8.	46 gram	1x	Error	100%

4. CONCLUSION

Based on the research that has been conducted, it can be concluded that the Arduino Nano-based goods sorting tool has been successfully designed and implemented to classify goods based on weight. This system uses a load cell sensor to detect the weight of goods and classify them into three different categories. By utilizing the concept of the Internet of Things (IoT), this tool allows real-time monitoring via Google Sheet. Sorting data is sent automatically and stored on the web, making it easier for operators to monitor and analyze. The use of this system increases efficiency and accuracy in the process of sorting goods in the industry. With this tool, the costs that are usually incurred for the procurement of checkweighers can be reduced, as well as ensuring compliance with quality standards set by consumer protection regulations.

Testing of the tool shows that the system can function properly according to the specified specifications. Analysis of test data helps in identifying areas that need improvement and ensures that the tool can provide maximum benefits to users.

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