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Rice Stock Monitoring: A Smart-home Based System

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ABSTRACT

Monitoring systems have undergone numerous developments and improvements. Smart-home monitoring is one of the categories of monitoring systems which can be accessed remotely. Rice monitoring is one type of smart-home based monitoring that can be performed. In order to prevent households from experiencing a sudden lack of rice stock, it is essential to closely monitor the stock of rice. The Smart-home Based Rice Monitoring Design is an innovation created by earlier researchers for the benefit of the community, particularly households. This system is constructed with a microcontroller and a load cell sensor. To operate this device, user enters the weight of the rice using the keypad, and presses the fence button to release the rice from the container. In the meantime, pressing the star button on the keypad will delete or clear the entered numbers. The servo will then operate to open the valve, allowing the rice to fall, and close the valve when the weighing process is complete. A load cell sensor will perform the weighing process, and a 16x2 LCD will display the rice weight output process. All data processed through ESP32 will be transmitted to Firebase. The development of the application was planned using the MIT App Inventor website. To create applications on MIT App Invertor and Realtime Database on Firebase, an internet connection and an active email address are required.

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1. INTRODUCTION

Smart-home based system is one of the home control systems that offers homeowners the convenience of controlling electronic devices using a smartphone. The concept of a smart house refers to a system designed for home convenience and capable of remote monitoring [4]. The purpose of this research is to design a prototype to monitor the stock of rice in a container. Rice is a staple cuisine for the majority of Indonesians and people from other nations. The annual consumption of rice traded in Indonesia is rising [7]. In order to prevent abrupt rice shortages, it is essential to closely monitor rice supply availability.

As technology developed and based on the background above, an initiative emerged for the author to create a system **"Rice Stock Monitoring: A Smart-home Based System".** With this device, it is envisaged that households would always be able to monitor their remaining rice supply. With the load cell sensor's keypad input, the rice-weighing procedure may also be performed more efficiently. In addition, this rice monitoring gadget can be connected to a smartphone in order to check the remaining rice supply in refillable containers.

A load cell sensor serves as the weight sensor and a hx711 amplifier serves as the weight sensor's amplifier module in the technology utilized to construct a Smart-home Based rice monitoring tool. The keypad is used as input or to enter the rice weight value, and a 16x2 LCD is utilized as output to display the keypad-entered action.

A load cell sensor is a transducer that converts weight-induced pressure into an electrical signal. Load cells can give precise force measurements. The metal load cell utilized for strain conversion is given to data variables [1].

Servo Motor is a motor with a closed feedback system where the position of the motor will be informed back to the control circuit inside the motor. Servo motors can operate cloakwise clockwise (CW) and counter cloakwise (CCW) counterclockwise. Servo motors usually only move to a certain angle. The direction and angle of motion of the motor can be controlled by setting the PWM signal duty cycle on the control pin. Servo motors also have a series of electronic controls and internal gears that are used to control the speed and angle of motion [8].

Adapter or Power Supply is a hardware component that provides electricity and power to other devices for operation. The primary purpose of the power supply is to provide electrical current to all correctly installed computer components. As indicated previously, the electric current supplied by the power source will be AC (alternating) current that will subsequently be converted to DC (unidirectional) current because the computer components themselves cannot accept AC type electric current and can only receive DC type electricity [10].

The regulator's job is to give a DC output voltage with a set voltage value that is unaffected by variations in input voltage, output load current, and temperature. During the excitation procedure of a synchronous generator, the regulator is a vital component [5]. LM2596 DC-DC Regulator is utilized as the regulator. The LM2596 regulator is a Stepdown converter that converts DC input voltage to DC output voltage [2].

Google's Firebase is a mobile platform that enables developers to create high-quality applications fast and precisely. Firebase is comprised of complementing functionalities that can be coupled as required. In addition, Firebase has the benefit of being user-based and able to generate revenue. The Google-developed platform Firebase is deployed since its capabilities are sufficient for use in multiple applications.

2. RESEARCH METHOD

The methodology using in this research is based on software engineering. The first step is to review existing literature related to smart-home based system, and the second step is to analyse current system, then design and implement the prototype.

2.1. Hardware Design

In the hardware planning of this system, there is a whole ESP32 Microcontroller planning such as Block Diagram, Flowchart and System Network. The Block Diagram is a basic description of the system to be designed. Each part of the system block has its own function for the process of running a well-built system. In the Figure 3.1 there is an input block, namely a 4x4 matrix keypad as a rice weight input button. The keypad button is pressed according to the desired weight value. Apart from the keypad buttons, the other input blocks are load cell sensors for weight sensors and the HX711 amplifier as a module for rice weight sensor amplifiers. The process block there is an ESP32 which is a microcontroller that is used to process and process input. Among them are load cell sensors, HX711 amplifier and 4x4 matrix keypad. Input that has been processed will be output (output). In Figure 3.3, there is an output or output block, which consists of a 16x2 LCD as an output to display the rice weighing process, a servo as an actuator to open the valve (lowering rice) and close the valve on the rice container once the weighing process is complete, and an Android or smartphone as a monitoring applications tool.

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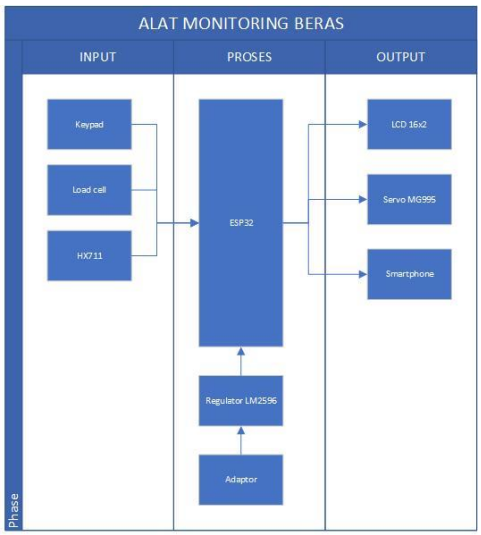

Figure 1. Tool Planning Block Diagram

In designing a system, it is necessary to consider how the system will be implemented on the instrument. In order to design the system, it is important to create a flowchart. Each chart in a flowchart contains specific symbols that describe the detailed sequence of processes and the link between processes (instructions) in a program.

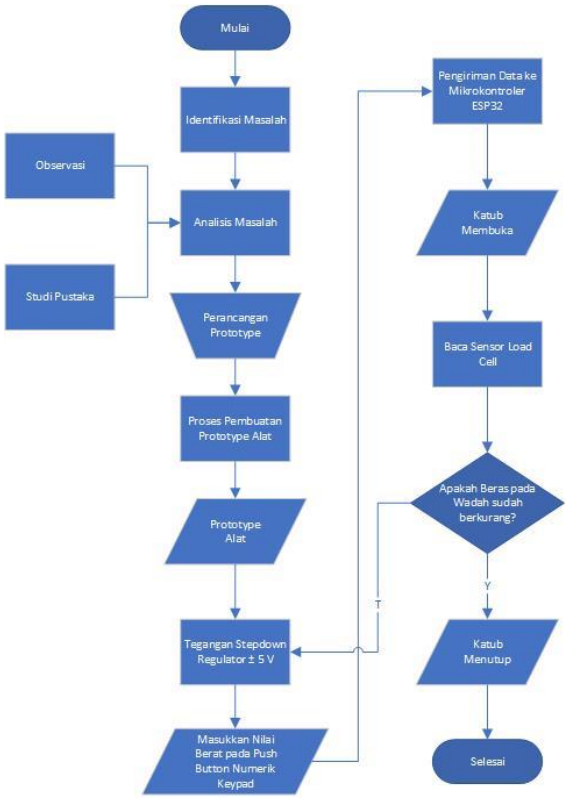

Figure 2. Tool Design Flowchart

The flowchart figure above shows the process of the tool starting from identifying and then analyzing the problem. After the analysis was carried out by means of observation and literature study, the design of the tool began to be made until the results of the prototype design were completed. The tool is given a voltage of ± 5V then input the desired weight value on the 4x4 matrix keypad. After entering the weight value, the servo will open the container valve then the weight of the rice that drops will be read by the

load cell sensor. If the weight of the load is appropriate and the rice in the container has decreased, then the servo will close the valve on the container.

2.2. Entire Network of Tools

Figure 3. is a schematic diagram of the entire network of rice monitoring devices. This network consists of Sensor load cell network, 16x2 LCD network, 4x4 matrix Keypad network, LM2596 Regulator network and Adapter and MG995 Servo Motor network.

a. The load cell sensor circuit is used as a transducer, namely the force acting due to mechanical stress. The load cell is responsible for converting the mechanical force into an electrical signal. The load cell requires the HX711 amplifier module as a signal amplifier module as well as an ADC (Analog to Digital Converter) module. HX711 functions to condition the analog signal from the load cell sensor while at the same time converting the analog signal into a digital signal.
b. The communication used for the LCD in this design is 12C communication. The 16x2 LCD circuit to ESP32 has a fairly simple wiring process. ESP32 has default pins for 12C namely SDA (GPIO 21) and SCL (GPIO 22). The ESP32 Ground (GND) pin is also connected to the Ground pin on the LCD.
c. The keypad series is used as input for the weight value to be sent to ESP32.
d. Regulator circuit is used to regulate the output voltage. The regulated output voltage is the voltage of an adapter (power supply), so that the effect of increasing or decreasing the adapter voltage becomes stable.
e. The MG995 Servo Motor series is used for actuators or actuators that require precise motor rotation positions. This electronic component is a motor that has a feedback system to provide information on the actual motor rotation position which is forwarded to the ESP32 microcontroller control circuit.

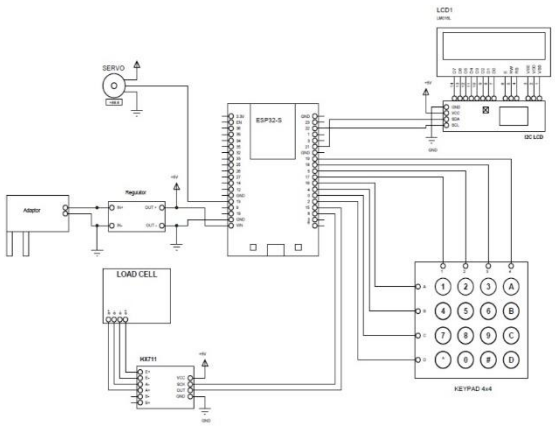

Figure 3. Entire Network of Tools

2.3. Software Design

In building applications related to Android, a decent design is needed as an overview, planning and drawing of multiple independent aspects. This is done in order to make all the elements into a single element. In creating this system leveraging the availability of Google Firebase and MIT App Inventor. The input that originates from an android application produced using the MIT App Inventor utilizing a block-based programming language. In the process this program takes a database that comes from firebase. Meanwhile, the output is provided to the tool which will read the data arriving from the firebase database. The link contained in firebase is included in the MIT App Inventor, in the image below is the final design of the application running process.

3. RESULTS AND ANALYSIS

3.1. Hardware Design Results

This series of automatic rice monitoring tools designed on the basis of a smart home uses an ESP32 microcontroller and a load cell sensor. This tool is assembled on a plywood board with the help of other hardware components. Hardware components consist of Hx711 Amplifier, LM2596 Regulator, Adapter, 4x4 matrix keypad, ESP32, 16x2 LCD, MG995 Servo. All tools and materials are combined using rainbow cables to form a series. The connected cable must match the available pins, both input pins and output pins. The hardware design results for the entire tool can be seen in the image below.

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Figure 4. Display Results of the Rice Monitoring Tool

The load cell sensor is evaluated based on its ability to dispense rice in response to keypad inputs that have been configured using the Arduino IDE software.

Smart-home Based rice monitoring application built with Google Firebase and the user's mobile device. The rice monitoring application requires an internet connection to function. This rice monitoring program is used to determine how much rice remains in the container.

The description of the results of the application display on the user's smartphone consists of two blocks, namely: There is a 'RICE STOK' block, which is to find out or monitor the remaining rice stock in the rice container. When the remaining rice is running out, new rice can be put into the container for further use.

The system works by initialize or prepare all input and output components, as well as the program, before proceeding. Because it has received an electric current voltage, when the adapter from the tool system is plugged into the power, the electric current voltage will continue to flow. All components will be provided with electric current so that they can function efficiently and ideally. In addition to receiving an electric current, the gadget must also receive an internet network connection (Wi-Fi) in order to connect to the application and display the remaining rice stock in the rice container. After making all the necessary preparations, the first step is to press the required number on the keypad. If you wish to enter the weight of rice in decimal format, use the full stop key. The dot button on the keypad is used to convert the weight of rice into decimal format. To process the scales, press the equal symbol button (=) to enter and cause the rice to fall. To remove or wipe data, press the slash (/) button. After the data is transferred to the ESP32 microcontroller, the load cell sensor, hx711 amplifier, and mg995 servo motor read the rice's weight. After the rice-weighing procedure has concluded and the servo has closed the valve, the ESP32 sends the data to firebase. The supplied data will be received and evaluated by Firebase to determine whether the weight of the rice has decreased. If the rice's weight has decreased, Firebase will send data to the mobile application. The rice tracking application will display the amount of rice remaining in the container. If the weight of rice in the container is not recognized or is not reduced, it is required to recheck the source code in the Arduino IDE programming software. Once the application has been verified, it can be uploaded to ESP32.

4. CONCLUSION

Based on the results of the hardware and system design as well as the tests and trials carried out, it can be concluded that a Smart-home Based rice monitoring tool using a load cell sensor has successfully weighed rice according to the keypad value input. This device can weigh rice with an Internet-accessible application for monitoring rice stockpiles. This tool's valve is equipped with a servo motor that allows it to open and close.This tool is equipped with a 4x4 matrix push button keypad and can input the numerical value of rice weight in decimal form. This device has a 16x2 LCD screen that can show orders and the weighting of rice in progress. The resulting instrument has been useful in monitoring the availability of rice stocks based on smart homes.

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