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SMART BIRD CAGE BASED ON STM32 FOR TURTLEDOVE BIRD USING SOLAR PANEL

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ABSTRACT

Background: One type of bird that is widely bred and maintained is the turtledove. At turtledove breeding, bird cage maintenance is still done manually for cage lighting, feeding and drinking. Manual maintenance of the cage will make it difficult for farmers who have a fairly busy schedule or often leave the house.
Aim: For that reason, the authors decided to make a Smart Bird Cage.
Method: In this study, the authors used STM32F4 Discovery and ESP8266 as control centers via smartphones. The sensors that will be used are the temperature sensor and the Light Dependent Sensor (LDR). The outputs are 5 volt dc motor, 5V dc pump motor, buzzer and exhaust fan using on/off control with internet of things (IoT). While the control system for heating the cage uses the PWM control method on the AC module control for the brightness level of incandescent lamps.
Findings: The results of this study are the temperature in the bird cage is controlled with a heating lamp that turns on when the temperature is below 30°C and with the IoT system used by farmers, they do not have to worry about managing bird cage consumption when outside the city.

KEYWORDS *Microcontroller STM32F4, Internet of Things, Smart Bird Cage, Turtledove Bird*

INTRODUCTION

Keeping turtledoves is not only a hobby favored by bird lovers because of its beautiful chirping sound and distinctive beautiful feathers. Turtles belong to a group of small birds (females 19-21 cm and males 20-24 cm) weighing between 60-70 grams. Body color is dominated by brown with a slightly long tail. The color on the head is gray with a brown back. The neck and sides are smooth. The back is brown with black fur edges. Besides being kept, turtles are also bred by some people because they have a lot of fans and a fairly high selling value. One of them is the tough turtle turtle bird farm located in the city of Sidoarjo. Based on interviews with livestock owners in breeding, there are several phases such as the post-hatching phase of 0-14 days, the tiller phase of 1-12 months, and the phase of birds that are ready to be brooders over 12 months (Nuasa-Baru.com, 2021).

In maintaining turtle doves to grow optimally, giving feed, drinking, temperature and turning on room lights on a regular basis is something that must be done by breeders. This is done so that the turtledove does not lack nutrients which can result in the death of the turtledove. The obstacles that commonly occur in the maintenance of turtledoves are irregularities in the timing of feeding and drinking and sometimes forgetting to turn on the lights at night to keep the temperature of the cage from getting too cold. This can happen because the management must be done manually by farmers and the activities of farmers are dense so that they cannot visit the bird cage.

With the development of increasingly sophisticated technology, Research on animal cage colony automation is of concern to researchers to be developed (I.S.A. Razak, 2018). Applications for monitoring and automatic control systems in animal cages need to be done to reduce the workload of humans in the process of raising animals (P. Suksaengjun, 2015). Development of automatic control methods using microcontroller hardware and software as well as several decision making methods became a research topic (K.S.Ng, P. -Y. Chen, 2017). Automatic control systems on houses, animal cages, environment, highways have become the object of research developed until now (Y.S.Thakur, 2018). An automatic control system requires a monitoring system that can monitor the condition of the object at any time (S. Yammen, 2019). Remote monitoring technology becomes an alternative choice if the object being monitored has a great distance from the control center (G. Prasad, 2017). Internet of Things is one form of application that cannot be separated at this time with an automatic control system. Through a wireless network all activities can be monitored and controlled remotely (Herman Yuliandoko, 2018). It is possible to create a system for bird nests that can make it easier for breeders to care for turtle doves. This final project designs and builds a bird cage management system called Smart Bird Cage. Smart Bird Cage is a bird cage management system that can help breeders in caring for turtledoves through the farmer's smartphone. The Smart Bird Cage is designed using the STM32F4 Discovery and the ESP8266 module as the control center. Thus, the smart bird cage load can be controlled and monitored remotely. With this tool, the author hopes that this tool can help bird breeders work in caring for and monitoring the needs of bird cages when they are outside the home.

METHOD

Rapid Application Development RAD is a model of software development processes that are classified as incremental (Multilevel) techniques. RAD emphasizes short, short, and fast development cycles. Short time is an important limitation for this model. RAD uses an interactive (Repetitive) method in developing a system where the working model of the system is constructed at the beginning of the development stage with the aim of determining the user's requirements. The RAD model can be seen in Fig. 1.

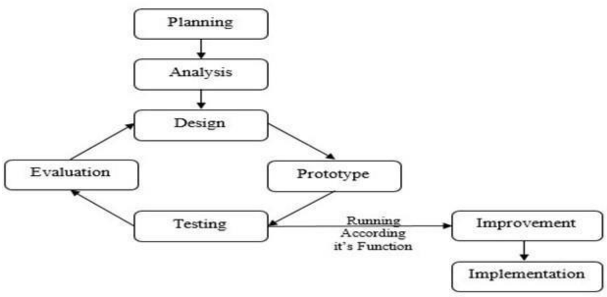

Fig. 1. Rapid Application Development (RAD)

Planning

In this step, a system is planned and also electronic circuits are carried out which includes needs, scope, purpose of making, and restriction area.

Analysis

At this step, an analysis of the needs used in accordance with the planning stage has been carried out, from the results of the needs analysis to be used to complement the components in the program and electronic circuits. This stage discusses ongoing system analysis and the system that will be proposed in this study.

Design

At this, hardware design is carried out which includes the design of electronic circuits, program flow and program algorithms. Designing software, discusses making applications that include application display design, program flow and algorithms used in the program.

Prototype

At this step, an implementation of the design stage is carried out, where at this stage a system prototype is used as material to test the device, the material in question is an Android application and a microcontroller circuit, where the tool has a turtledoves bird cage equipped with sensors and transmitters (Internet). These four stages will continue to repeat so that the system has functioned well, the four stages are the design, prototype, testing and evaluation stages.

Testing

Testing using smartphone will perform to test software in terms of functional specifications. The testing of the design and program code aim is to find out whether the function of the application runs according to the needs or not, the function in question is the sensor readings on the enclosure, internet connection, data transmission and output produced. If there is an error or error in the application, all of that will be recorded as an application evaluation. Tests are also carried out on electronic circuits, whether or not the device is running according to their respective functions.

Evaluation

Evaluation is the process of concluding a data in the form of deficiencies that occur in an application or hardware as a reference for developing applications that are being made and also to complement the functions that are lacking in the application so that the application becomes better.

Improvement

At this step, improvements is made to the application. So that the system can be functionate properly and correctly. Improvements made to hardware are usually located in the position of the sensor used and cabling on the turtledove's enclosure. While in the application software, improvements are made to the appearance and function of the application.

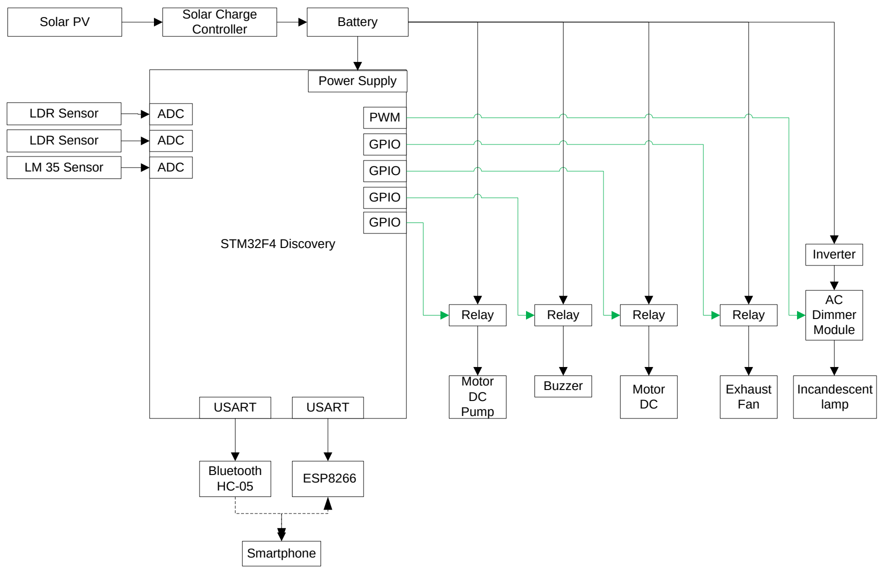

Fig. 2. Block Diagram Smart Bird Cage

In the block diagram of Fig 2, the source used to supply the loads in the Smart Bird Cage is a DC battery which is charged by the Solar Panel. The output of the battery is connected to several relays, each of which is a load. Relay that serves to disconnect and connect the load with the source based on orders from the microcontroller. The smart bird cage uses two communications, namely by Bluetooth and ESP8266. The Bluetooth module will be used as a data logger when measuring the temperature in the bird cage. Then, the recorded data will be used for the learning process on the lighting control method that will be used. The ESP8266 module will be used for the Internet of Things (IoT) feature when the system is operating so that farmers can control and monitor the load on the cage via a Blynk smartphone from anywhere.

Each load on the Smart Bird Cage is connected to an LDR sensor, a temperature sensor and a light sensor. The first LDR sensor serves to measure the water content of the cage when the sensor detects that the water is empty, the microcontroller will turn on the dc pump motor to fill the water. The second LDR sensor is used to detect the contents of bird feed.

The temperature sensor serves to measure the temperature in the cage and as an input to the PI control. When the temperature is below the set point of the specified PWM control method, the incandescent lamp will light up brightly or dimly by controlling the PWM on the AC Light Dimmer Module to warm the cage.

At the hardware section the needed components are controller, sensor, bird cage, some of handphone, suitable power supply (e.g. battery cell) to start up the proposed system, and other supporting components.

1) *Controller*

Fig. 3. STM32F4 Discovery Board

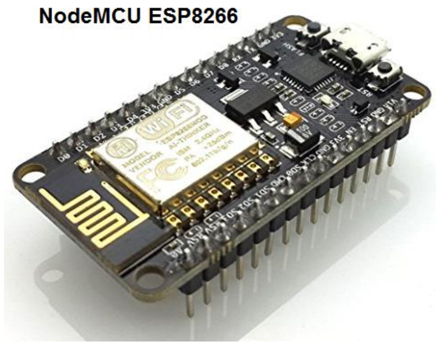

Fig. 4. NodeMCU ESP8266

Fig. 3 presents the STM32F4 Discovery Board. Board will read the temperature value from temperature sensor (LM35 Sensor) then send these reading to Bluetooth HC-05 mobile apps via Bluetooth module (HC-05) for save the data recorded. This board also to control pwm on incandescent lamps on cage. Fig.4 presents The ESP8266 module is a microcontroller that has a wifi connection facility and can be integrated with sensors and actuators via the GPIO pin because it has a processor and memory. This module has features such as supporting the IEEE 802.11 b/g/n standard, can be used for WiFi direct (P2P), AccessPoint soft-AP, has 81 Mb RAM and 1 Mb Flash Memory, speeds up to 160 MHz, and an output power of 19.5 dBm. This esp8266 module will be used as an IoT feature in this proposed.

2) *Sensor*

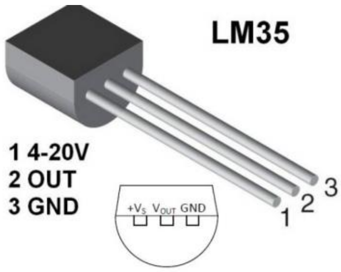

Fig. 5. LM35 Sensor

Fig. 6. LDR Sensor Module

Fig. 5 present the LM35 series are precision integrated-circuit temperature devices with an output voltage linearly proportional to the Centigrade temperature. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 device does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾° cover a full −55°C to 150°C temperature range. Fig.5 present the LDR sensor. LDR sensor is an analog input sensor consisting of a variable resistor whose resistance varies depending on the amount of light falling on its surface. When there is no light in the room, the resistance of the LDR sensor is HIGH (up to 1 M Ohms) and if there is light, the resistance of the LDR sensor is LOW. The LDR sensor consists of two pins. This pin has no positive and negative polarity. The LDR sensor module will read incoming analog data from the LDR sensor and provide digital data in the form of HIGH or LOW as output. The LDR sensor module consists of 4 pins: AO (analog output), DO (Data output), ground, and Vcc. The DO pin will be HIGH in low light and LOW in low light. The sensor module also consists of a potentiometer sensor, which can be used to vary the resistance of the LDR sensor.

3) *Design Box System*

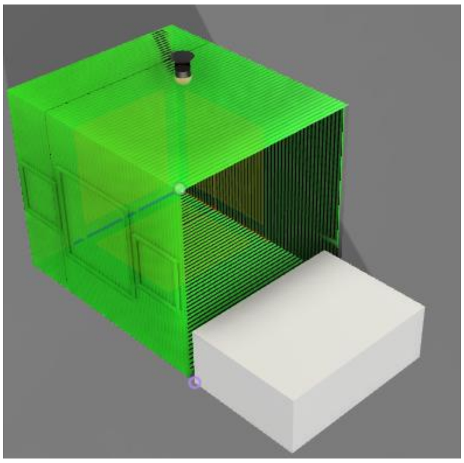

Fig. 5. Smart bird cage design concept

Fig. 6. Smart bird cage implementation design

Fig. 5 present a 3D design drawing of the smart bird cage which is used as a reference for designing the hardware of the smart bird cage. in the picture the smart bird cage controller is designed in such a way in an acrylic box with a width of 29.7 cm, a length of 42.0, and a height of 12 cm. Fig. 6 present the hardware used as a controller container that has been designed for the smart bird cage according to the design that has been made.

4) *Battery Capacity*

The design of this load is assumed when electricity is needed when it will be late at night. Then when the sun shines, the whole load will die. In this final project using a cage with the following loads:

a) Main Illumination Lamp

Lamp Energy = Number of Lamps × Power × Usage Time
= 1 Unit × 25 Watt × 12 Hours
= 300 Wh

b) Motor DC Pump

Motor DC Pump Energy = Number of Pump × Power × Usage Time
= 1 Unit × 1.5 Watt × 24 Hours
= 36 Wh

c) Motor DC 5 V

Motor stepper Energy = Number of Motor × Power × Usage Time
= 1 Unit × 0.6 Watt × 24 Hours

= 14.4 Wh

d) Exhaust Fan

Exhaust Fan Energy = Number of Exhaust Fan × Power × Usage Time

= 1 Unit × 1.8 Watt × 12 Jam

= 21.6 Wh

Total load energy = 300 Wh + 36 Wh + 14.4 Wh + 21.6 Wh

= 372 Wh

Battery capacity = 372/ 12 Volt = 31 Ah

With the calculations, this system can use one battery that has a capacity of 12 Volt / 33 Ah on the market. Fig. 7 shows the battery to be used with a capacity of 33 Ah.

Fig. 7. Battery 12 V/33 Ah

e) UI Smart Bird Cage Using Blynk

Fig. 8. UI Smart Bird Cage Using Blynk

Fig. 8 presents the UI display of the smart bird cage using the blynk application. There are 4 buttons that are used to control the smart bird cage system. The first button is the fan button, this button is used as a controller of the exhaust fan which is used to release heat in the controller box. the second button is the buzzer button, the buzzer button is used to turn off the bauzzer which sounds when feed or drink is empty. the third is the drinker button, the drinker button is used to fill the water in the drinking water container by controlling the dc motor pump.

The last is the feed button, this button is used to feed the smart bird cage by controlling the dc motor.

RESULTS AND DISCUSSION

Application Main Page

The main page application displays the condition of the load being used whether it is in an on/off condition. In fig. 9, shown that when the button is pressed on the application display, the button will change from off to on. So, the fan and motor feeding the birds are on while the drinking water pump and blazer are off. The results of the on/off control are shown in Figure 9.

Fig. 9. The Main Page

Temperature Data Capture

Temperature data capture in the bird cage will be used as data retrieval and decision makers and from the system. Data collection was carried out 720 sampling data from 6 pm to 6 am. From the data it was found that when at 6 pm to 9 pm the temperature was still above 30 degrees Celsius while at 10 pm to 6 am the temperature started to be at is below 30 degrees Celsius. It indicates that the effective hour of the incandescent lamp is 10 o'clock at night until 6 o'clock in the morning. In fig. 10 is the temperature data in the form of a graph.

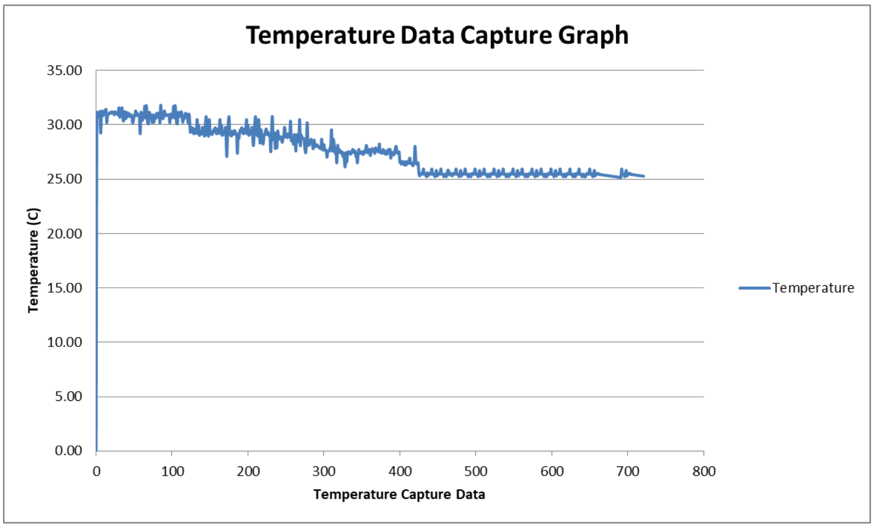

Fig. 10. Temperature Data Capture Graph

Bird Cage Warming System

The test results on the control system can be seen if the system can work according to its function, when the temperature exceeds the minimum limit of under 30 oC, the light will automatically turn on and warm the cage. In fig. 11 shown that the heating system is on when the temperature is below 30^{o}C.

Fig. 11. Smart Bird Cage Warming System

Feeding and Drinking System

In the feeding and drinking system, the LDR sensor is used as a detector for bird feed and drink containers. Fig. 12 shows the condition when the feed is filled or not. When the feed is filled, the sensor indicator light will turn off, while if the feed is empty, the light on the sensor will light up. In the drinking system, the LDR sensor is used as a detector of the condition of the drinking container in the bird cage. In fig. 13 shown the condition when drinking birds in a filled or empty container. When the container is not filled with water, the sensor indicator light will turn off and turn on when the container is filled with water.

Fig. 12. Smart Bird Cage Feeding System

Fig. 13. Smart Bird Cage Feeding System

CONCLUSION

The results of research and testing that have been carried out it can be concluded that:

1) Remote load control with the Blynk application can run well if the connection used uses a good signal and there is no connection interference
2) The feeding and drinking system works optimally in helping farmers distribute feed and drink for their pet turtledoves.
3) Based on temperature capture data, incandescent lamps can function optimally to warm the temperature of the cage from 9 pm to 6 am.

REFERENCES

Alshahrani, M., Traore, I. 2019. Secure mutual authentication and automated access control for IoT smart home using cumulative Keyed-hash chain. *J. Inf. Secur. Appl., vol. 45, pp. 156–175*.

Biason, A., Pielli, C., Zanella, A., Zorzi, M. 2018. Access control for IoT nodes with energy and fidelity constraints. *IEEE Trans. Wirel. Commun.*.

Chaczko, Z., Klempous, R., Nikodem, J. 2013. Modeling autonomic monitoring and control for IoT systems. In *25th European Modeling and Simulation Symposium, EMSS 2013, pp. 625–631*.

Ng, K.S., Chen, P.-Y., Ting, P.-H. 2017. Smart cage implementation with dependable safety agent for dogs. In *2017 IEEE 22nd Pacific Rim International Symposium on Dependable Computing (PRDC), pp. 2473–3105*.

Nuasa-Baru.com, online website, Wordpress, 14 March 2021, {accessed 8 August 2021}

Prasad, G., Mumtaz, A., Ghildiyal, S. Wireless home appliance control using IoT. 2017. *Int. J. Comput. Appl., vol. 168, pp. 15–17*.

Ramesh, V., Sankaramahalingam, M., Bharathy, M.S.D., Aksha, R. 2017. Remote temperature monitoring and control using IoT. In *2017 International Conference on Computing Methodologies and Communication (ICCMC)*.

Razak, I.S.A., Zaky, N.K.B.Y., Rodzi, N.I.B., Bin Zakaria, M.R. 2018. A smart cage monitoring system using internet of things. In *International EUREKA Innovation Exhibition 2018 (i-EIE 2018)*.

Suksaengjun, P., Thanapatay, D., Chinrungrueng, J., Nobuhiko, S. 2015. Smart cage using object detection. In *6th International Conference on Information and Communication Technology for Embedded Systems, IC-ICTES*.

Thakur, Y.S., Joshi, P. 2018. IOT Based Smart Temperature Controller. *Int. J. Eng. Trends Technol., vol. 66, no. 2, pp. 78–80*.

Wilhelm, J., Blackshire, S., Lanzone, M. 2017. Energy-Neutral Data Collection Rate Control for IoT Animal Behavior Monitors. *Appl. Sci., vol. 7, pp. 1–18*.

Yammen, S., Tang, S., Vennapusa, M.K.R. 2019. IoT based speed control of Smart Fan. *In 2019 Joint International Conference on Digital Arts, Media and Technology with ECTI Northern Section Conference on Electrical, Electronics, Computer and Telecommunications Engineering (ECTI DAMT-NCON)*.

Yuliandoko, H., Subono, S., Wardhani, V.A., Pramono, S.H., Suwindarto, P. Design of Flood Warning System Based IoT and Water Characteristics. *TELKOMNIKA 2018, Vol.16, No 5 ISSN:1693-6930, e-ISSN: 2302-9293*.