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Design an IoT Application to Manage Aeration System in Fish Aquarium

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Abstract: In recent years, there has been a remarkable growth in fish aquarium. There are not many wireless device control products on the Vietnamese market today, most of the existing products are imported from abroad at high prices. Researching and designing a set of wireless device control products has great significance, helping to increase choices for users. The products are produced domestically so the price is low and contributes to the development of new technologies in an intelligent control system. From there, this research was carried out to design an IoT application to manage the aeration system in an aquarium. The tasks of the project are: learn about IoT system management applications in aquaculture ponds, learn about ESP8266, learn about MQTT protocol, design control model circuits and build software on phones Android, testing, testing and app reviews of theses, control and collect data from devices via wifi. From there, this research builds control software that runs on Android phones. These modules can be combined with each other to expand control objects. The result of the project is a complete system including software and hardware that can be used in aquaculture systems.. The system of applying IoT communication technology does not wake up in accordance with the conditions of fish aquarium. The system works stably and accurately, the data synchronization process of the whole system is 100% accurate.

Keywords: IoT Application, IoT System, Measure and control, Computer, Engineering, Aeration System.

INTRODUCTION

This article presents the research results of building an IoT application to manage aeration system in fish aquarium to support freshwater fish farming. The goal of the project is to communicate with the phone application via WiFi (data transmission and reception) [Eshchar, M. *et al*., 2003; Vinci, B.J. *et al*., 2020; Bullock, G. *et al*., 2000; Dang, H. T. T. *et al*., 2021]. Control LED with buttons on the controller or with an app on your phone. Set a timer on the phone and send the appointment to the device: when the scheduled time comes, the device automatically turns ON/OFF according to schedule without needing to connect to the phone. Control 3 independent relays to turn the aerator on and off independently. There is a RESET button to reset the controller to its original state. There is an additional toggle mode according to user habits. The system uses sensors to measure water quality in aquaculture ponds, and the results are transmitted to the wifi wireless communication standard monitoring system. The system can integrate many parameters such as conductivity, salinity, turbidity, pH, dissolved oxygen content in water, nitrate content...etc [Eshchar, M. *et al*., 2003; Vinci, B.J. *et al*., 2020; Bullock, G. *et al*., 2000; Balakrishnan, S. *et al*., 2019; Kiruthika, S. U. *et al*., 2017]. The slave node collects the indicators of the water source to transmit back to the parent node via wifi. From the root node, the data is sent directly to the Firebase database of the internet and sent to the computer for processing [Dutta, A. *et al*., 2018; Adnyana, G. P. S. S. *et al*., 2018]. The system can automatically control water pumps, oxygen aerators and other devices that can change the environmental indicators of the water. When the monitoring indicators exceed the allowable threshold level, which can affect aquatic products, it is necessary to have timely solutions. Monitoring parameters, operating status of systems are displayed and monitored on software built on computers and smartphones.

2. Build System Design

2.1 Research Facilities

Water quality for aquaculture plays a very important role for the aquaculture industry fish aquarium to support freshwater fish farming. Poor water quality causes slow growth of aquatic products, generates many pathogens, and can cause mass death of aquatic products, causing great damage to people. The quality of the water source must be ensured according to the national technical regulations of freshwater fish cage/raft farming establishments according to QCVN 02-22:2015/BNNPTNT shown in (Table 1).

Table 1: Water quality to ensure freshwater in fish aquarium

No.	Parameter	Unit	Limit Value
1	Dissolved Oxygen (DO)	mg/l	≥ 4
2	Total suspended solids	cm	≥ 30
3	Alkalinity $CaCO_3$	mg/l	60-180

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2.2. Hardware System Design

2.2.1 System Block Diagram

The IoT application system manages the aeration system in an aquaculture pond with 5 blocks connected together in many block directions as follows, creating a stable operating system shown in the diagram Figure 1.

The block diagram of aeration system in fish aquarium is depicted in Figure 1. The system will include the following blocks: source block, central processing block, aerator, and phone application programming block.

- Power module: responsible for supplying power to the entire operating system.

Central processing unit: This block has an ESP8266 microcontroller, has the function of connecting to the internet, MQTT server, receiving data from the control block on the mobile application. The microcontroller used in the system is ESP8266.

Aeration machines: Aerator controlled by central processing unit via button or application on Android smartphone.

Application on Android smartphone: The application interface includes 3 buttons that control on/off and timer for the device.

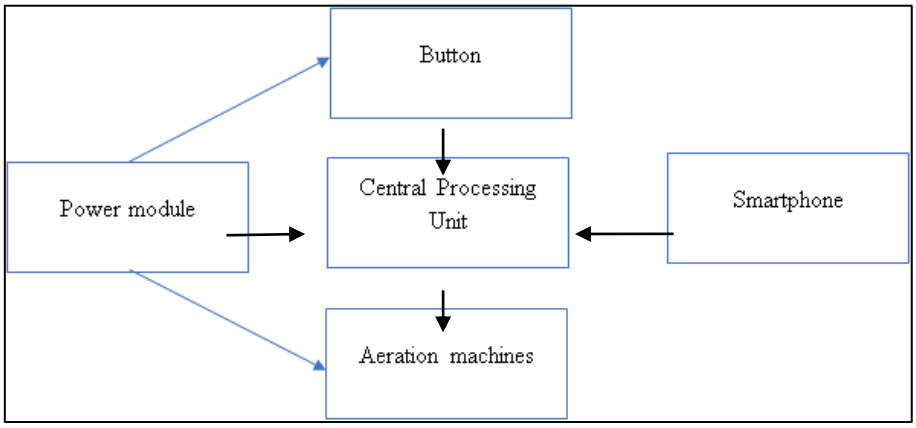

Figure 1: Block diagram of aeration system in fish aquarium

2.2.2 Design Central Processing Unit

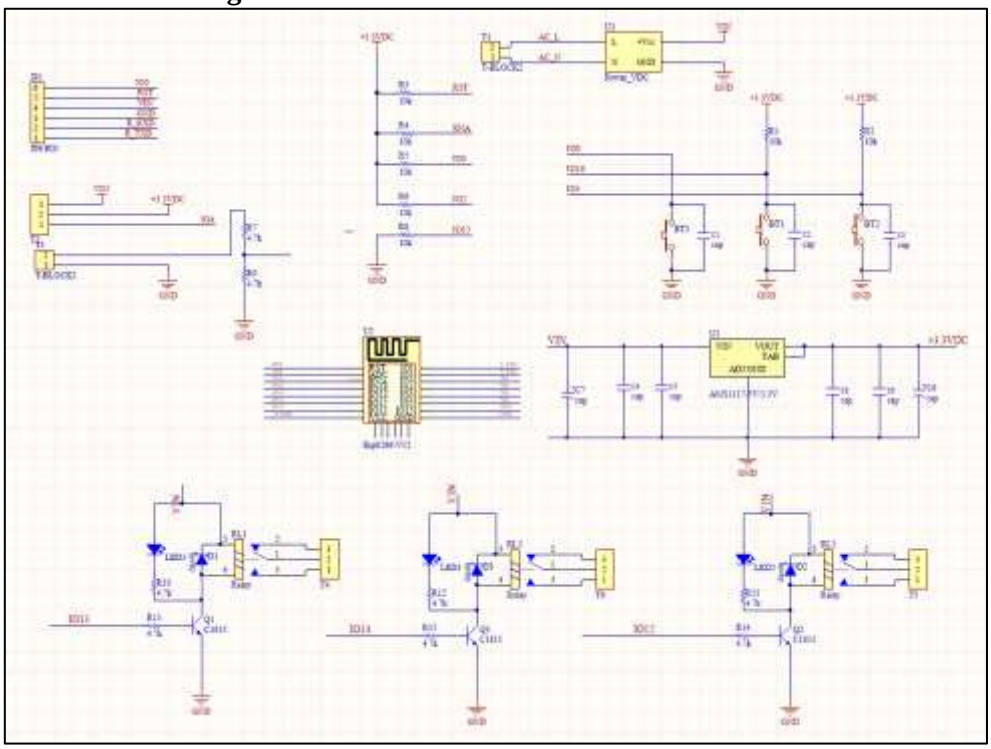

Figure 2: Block diagram of Central Processing Unit

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The central processing block of aeration system in fish aquarium performs many important functions in the system. When powering the device, the powered push button block can turn on/off the aerator and the LED light. The ESP8266 microcontroller in the central processing block will connect to the internet, the MQTT server then receives data from the control block on the mobile application, allowing us to customize on/off control and timer for the steamer/remote aeration and led lights when the smartphone is connected to the internet.

The principle circuit design diagram includes: Power module, central processing unit block, button block, relay and led.

Power module

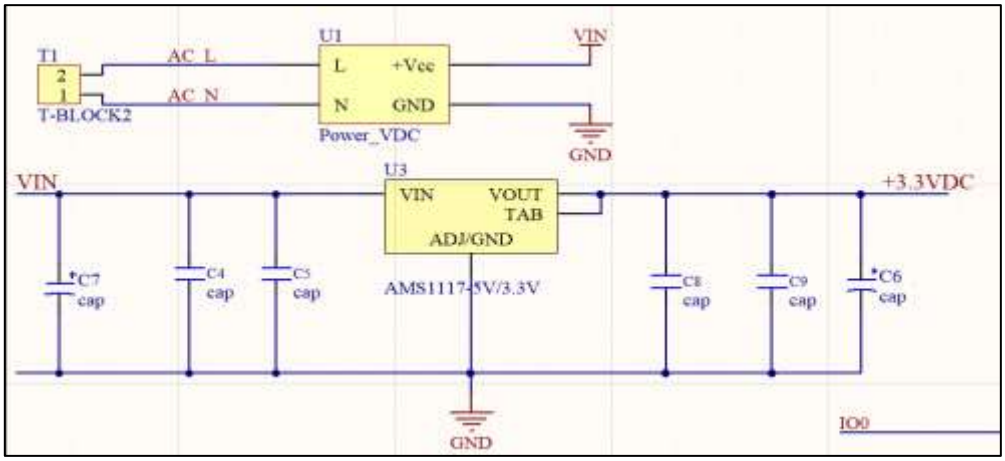

Figure 3: Power module

The power supply block has 1 AMS 1117 low-voltage IC for output voltage at 3.3V-5V, 6 capacitors with noise filtering function for the source. The power block has the function of providing power to the entire system.

Central processing unit Block

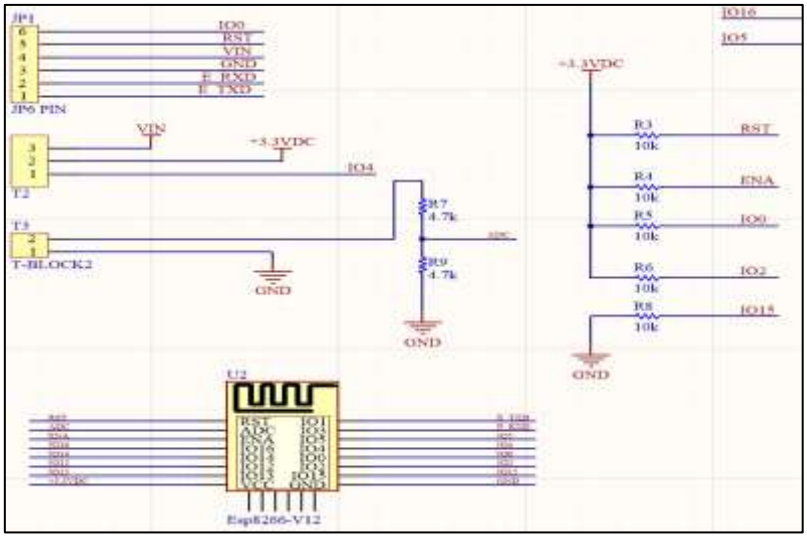

Figure 4: Central Processing Unit

ESP8266 central processing block: used to process input signals and output signals, controlling all system activities.

Button block

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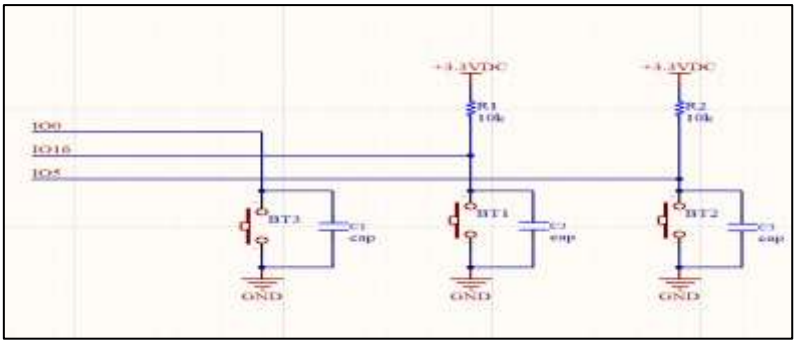

Figure 5: Diagram of button block

The circuit principle diagram of button block: push buttons allow users to control relays directly on the circuit instead of through the phone application. The push button requires a power source of +3.3V.

Relay and led

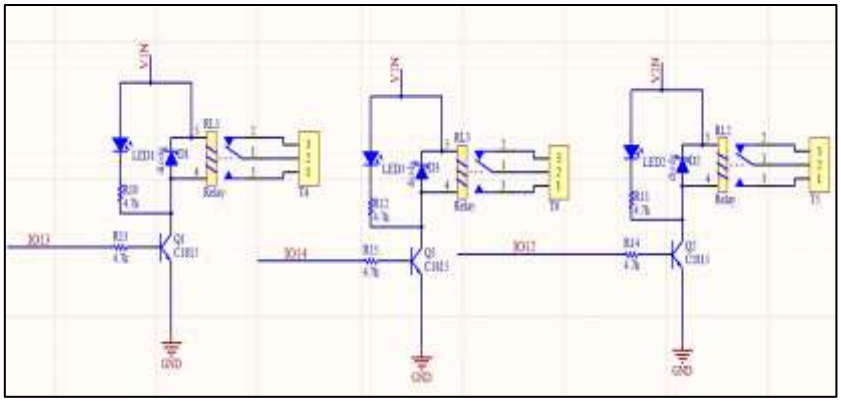

Figure 6: Relay and led

Relay and LED block: controls the output voltage for the load and signals the status. (Figure 6).

2.3 Software Design

2.3.1 Algorithm Flowchart

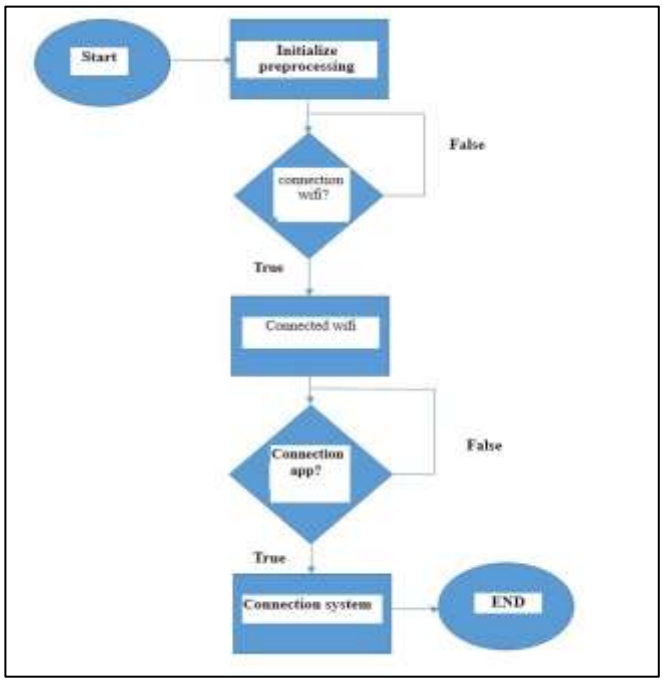

Figure 7: Algorithm flowchart

When starting, the system will stop creating the preprocessor and start checking the wifi connection. If the Wifi connection is successful, when pressing a button on the device, the LED

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corresponding to that button will light up and the Relay will be turned on. Conversely, if the Wifi connection is unsuccessful, the system will recheck the Wifi connection. . After successfully connecting to Wifi, the system will continue to check the connection between the hardware and the application on the Android mobile phone. If the connection is successful, the application will notify that the connection has been successful and the device can be controlled through the application on the phone. When connecting to the application on the phone fails, the system will recheck the connection.

2.3.2 Algorithm Flowchart of Button

At the beginning, after initializing preprocessing, the system begins to consider conditions for button S1. If the value of button S1 equals 1, then device 1 will be turned on, if that value is false, device 1 is still in the off state. This condition is also checked by the system at button S2 and S3 similar to button S1.

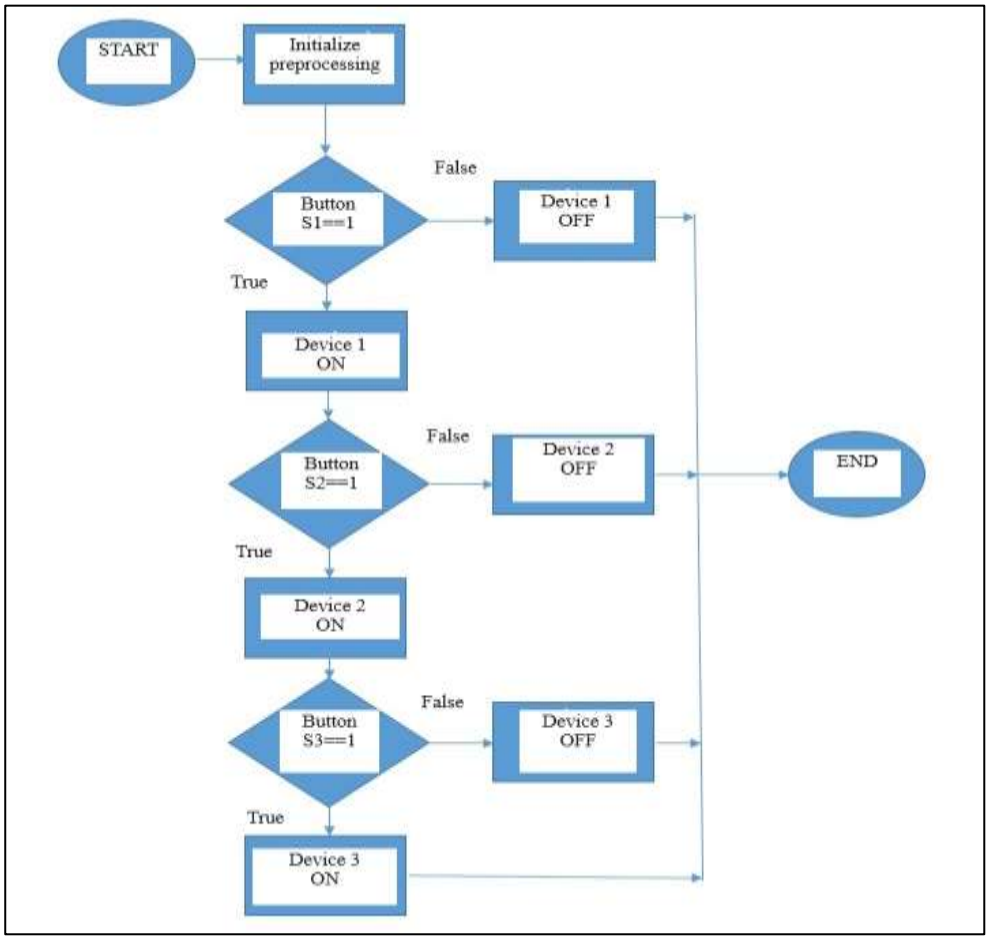

Figure 8: Algorithm flowchart of button

2.3.3. Algorithm Flowchart of Timer Mode

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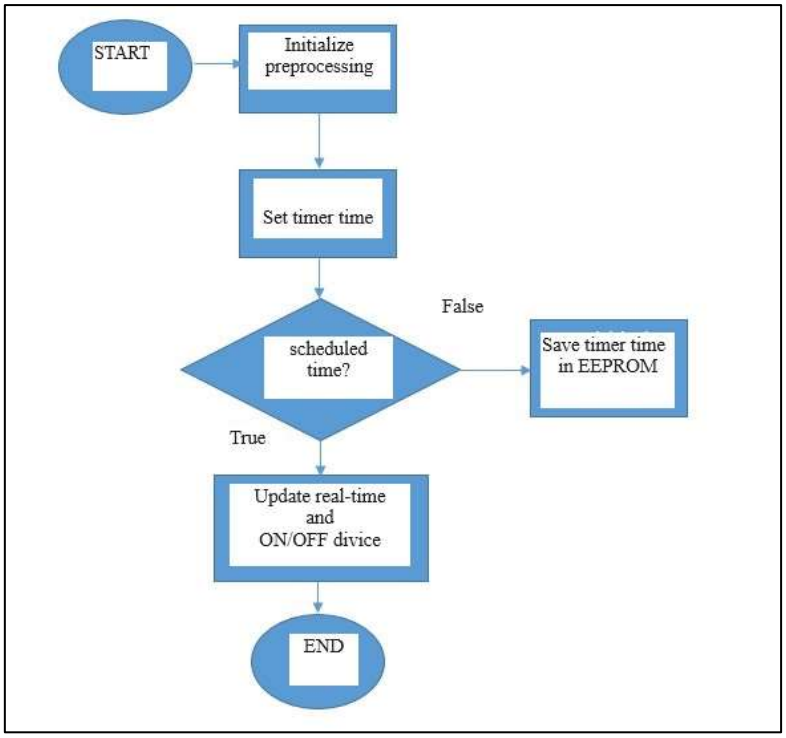

Figure 9: Algorithm flowchart of timer mode

Starting the program, the system will initiate preprocessing and enter the timer time. When the scheduled time arrives, if the scheduled time is correct, the system will update in real time and turn the device on or off. If the scheduled time is wrong, the system will save this appointment in memory EEPROM.

After completing the design of the principle diagram and drawing the 1-layer PCB circuit manually. This is a 3D image of the circuit with 3 relays, 3 push buttons equivalent to 3 LED light bulbs, 1 Esp8266 module used to receive data transmission, 1 mini pump (mini aerator) as the Output.

3. Construction of System Board

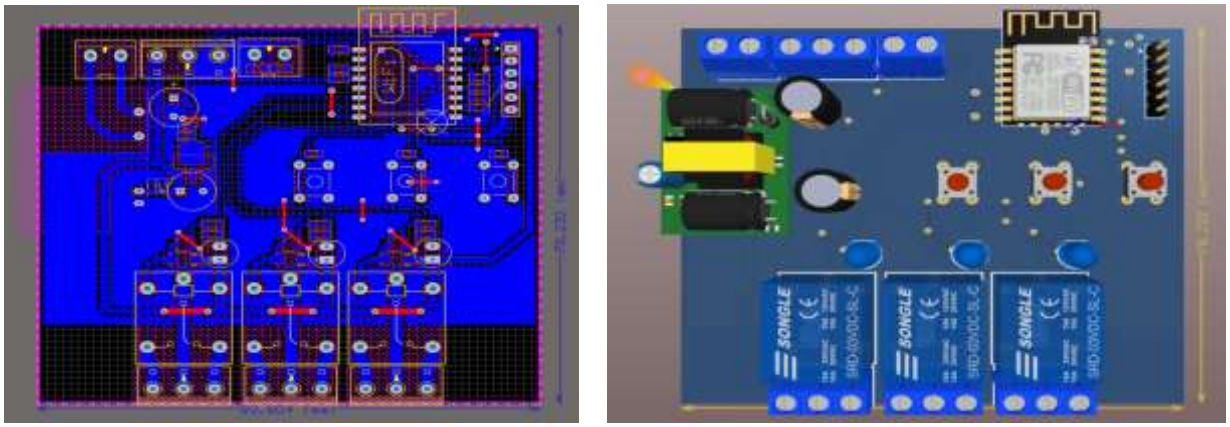

Figure 10: PCD Diagram and 3D Diagram

4. Application on Smartphones

The smartphones application screen will display an interface including 3 general buttons equivalent to 3 push buttons and 3 LEDs on the hardware device board. When not connected to hardware, these 3 buttons have a gray state (Figure 11.a). When the buttons are in the off state and the device has not been started, the above buttons will be displayed in red. When the button is turned on, meaning the hardware device is working, the button will display a green status.

Measurement sample 1: The water source is taken from the aquarium tank

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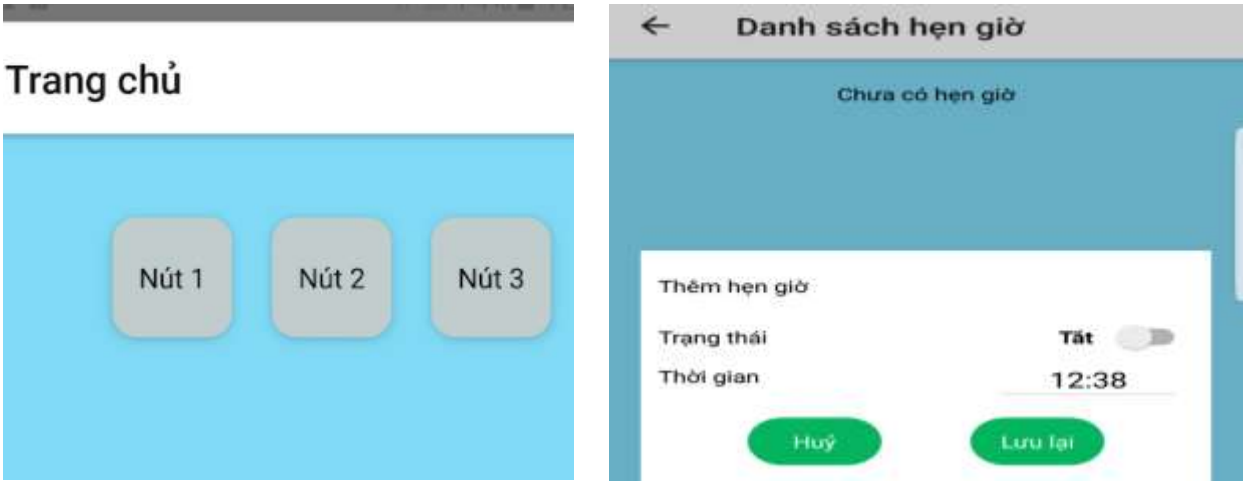

(a) (b)

Figure 11: Application on smartphones

a. Home of application on smartphones b. Timer mode

Figure 11.b is the timer mode, there are 2 function buttons that allow users to customize the on/off timer for the hardware device and there is an additional function button that allows users to delete previously saved data.

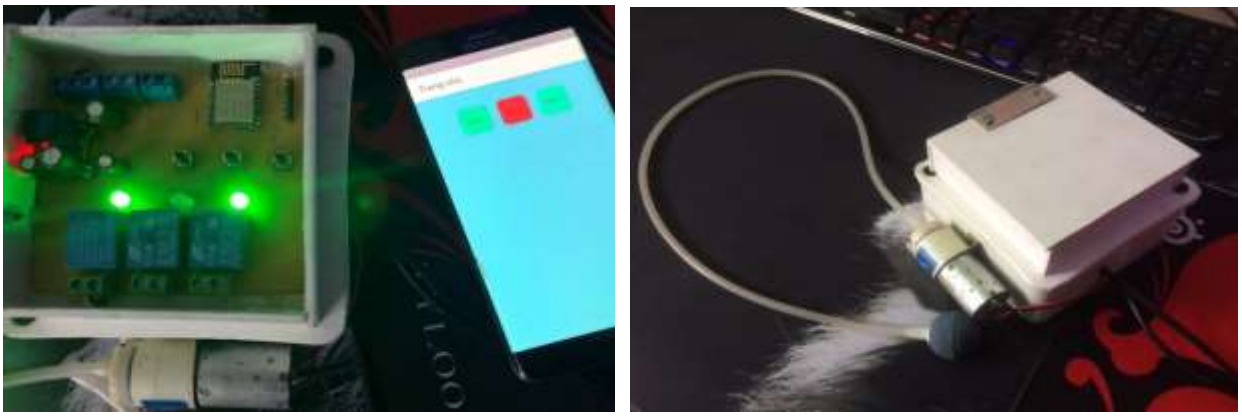

Figure 12: Real aeration system in fish aquarium

Use copper plates to attach devices and components. Use a soldering iron to tightly solder and connect the components together. This is a job that requires a high degree of meticulousness because if the soldered joints are open and unattached, the circuit will not run and will be unsightly. After completing the hardware model, load the program programmed on visual C into the circuit. Ceramic system of devices: Esp8266 wifi module, mini pump (mini aerator), button, Relay, Led, and connecting wires. Then test run the system.

Pure water will have a pH=7.0. If left in the air for a long time, water will come into contact with carbon dioxide in the atmosphere and create a balance. That balance will reduce the pH to about 5, 6. Water holds 4.82 mg/L carbon dioxide at pH 7. However, when use aeration system in fish aquarium then carbon dioxide of water decreased by 20%, O2 of water increased by 30%.

CONCLUSION

With an aquarist, how to adding O2 into my aquarium in order to help fish growth. Research results on building a aeration system in fish aquarium applying 4.0 technology can be applied to aquaculture in general and freshwater fish aquarium. This is a pretty standard practice, the system can monitor environmental indicators that adversely affect the growth and development of fish through the wireless environment, remote monitoring and control via the network and through the remote computer system. . The results of the synchronization process test results between the systems are 100% accurate synchronization, the system operates stably. Test measure times on a measuring sample with small error. From the test

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results on the system can be applied in the field of aquaculture.

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