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Autonomous Aquaculture Farming System

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Abstract: Aquaculture industry has been developed rapidly in recent decades. Farmers need to monitor the conditions in the breeding tank 24/7 to ensure everything works well. This is a serious inconvenience and financial affect to the owner of the farm. Thus, an autonomous breeding system for aquaculture is built to help to solve the problems faced by the farmers. A cost-efficient autonomous farming system is built to combine with the present aquaculture technology and knowledge in order to increase the productivity of the industry. The main purpose of this project is to study more on the proper habitat for the freshwater prawn or Macrobrachium Rosenbergii, develop a fully functional autonomous farming system which can provide a good living habitat for freshwater prawn farming and equip the autonomous system for prawn farming system with auto detection function to improve the success rate of the freshwater prawn for harvesting. Autonomous breeding system can improve the job efficiency of the farmers and upgrade the whole industry in terms of technology to a new era.

Keywords: Autonomous, Aquaculture, Cost-Efficient, Auto Detection

1. Introduction

The request for seafood has increased over these years, technology has enabled us to breed food in coastal marine waters and the open ocean. This study is mainly about the autonomous aquaculture farming system for freshwater prawn or Macrobrachium Rosenbergii. As an aquaculture farmer, we need to make sure the water in the best situation in order to make sure the prawn grow healthily. [2] The condition of water may keep changing depend on the surrounding condition. This may bring inconveniences to the farmer because they need to monitor the tank to make sure everything works well. We are working on a fully autonomous farming system which can detect all the parameters of the water and send alert or notifications to the breeders to warn them without having them nearby.

This project is mainly about the studies of the proper habitat for freshwater prawn or Macrobrachium Rosenbergii. A development of a fully functional autonomous farming system which can provide a good living habitat for freshwater prawn. There are also auto detection system in this project to improve the success rate of the freshwater prawn for harvesting.

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1.1 Low productivity in traditional monitoring method

Farmers need to monitor the tank situation 24/7 to make sure everything works well. [1] This brings huge inconveniences to the farmers as they cannot do other things except monitoring the water tank condition. Hiring a person to monitor the tank may look to be the best solution for this problem but it also increases the cost of freshwater prawn farming. This solution is failed in the aspect of financial.[2] Next, if the parameters of the water cannot be monitor properly, farmers might not provide a good environment to produce good quality of freshwater prawn.

1.2 Scope and expected outcome

This project is carried out to study the proper habitat for freshwater prawn and develop an autonomous monitoring system. An autonomous aquaculture breeding system prototype built to make sure the system is functioning. This project also monitors the parameters of the proper habitat requirement for freshwater prawn. For example, water parameter, food and so on. The parameters, sensor used and equipment needed for this system will be listed in this project. For example, ultrasonic sensor, relay module, Arduino UNO and DC water pump.

The expectation of this project is a system that suits the habitat for freshwater prawn. When the condition of the water tank change, the system can maintain the living habitat or requirements of the prawn. This system is also expected to increase the rate of successful of the freshwater prawn to survive.

2. Material and Methods

This section is about the project methodology. Arduino UNO act as the MCU for the microcontroller, which is the main part of the project. Sensors and relay module are connected to Arduino UNO to make sure all of them function well as expected.

2.1 Materials

Table 1: Component specifications

Component	Specification
Arduino UNO [5]	• Processor: ATmega328P • Dimension: 68.6mm*53.4mm • Operating Voltage: 5V • Digital I/O Pins: 14 (6 provide PWM output) • Analog Input Pins: 6 • DC Current per I/O Pin: 20mA • Flash Memory: 32 KB (0.5KB used by bootloader) • SRAM: 2KB • Clock Speed: 16MHz • LED_BUILTIN: 13 • Price: RM 24.00
DC-12V Pneumatic Diaphragm Water Pump Motor R365 [12]	• Voltage: 12V DC • Max Flow Rate: 2-3 litre per min • Maximum Suction: 2 meters • Price: RM 15.00
Ultrasonic Ranging Module SN-HC-SR04 [10]	• Voltage: 3V – 5.5 V DC • Current: 2.2mA • Measuring Range: 2cm – 450cm

	• Working Temperature: 0 ℃ to 70 ℃ • Measuring Angle: 15 degree • Dimension: 45 mm * 20 mm * 15 mm • Cost: RM 6.00
Toyogo Storage Box (20 series) [4]	• Size:510 mm x 360 mm x 200 mm • Capacity:42 liters • Price: RM 32.00
Aquarium Pipe [7]	• Size: 8 mm x 1 m • Price: RM 2.00
Water Solenoid Valve 12V DC [9]	• Voltage: DC 12 V • Power: 15 W • Current: 1.25A • Inlet and Outlet Thread Diameter: G ½ • Price: RM 24.90
5V Relay Module [8]	• Operating Voltage: 5 V • Maximum load: AC 250 V/10 A, DC 30V/10A • Price: RM 7.20
Water Flow Sensor [6]	• Allowing Pressure: 1.75 Mpa • Operating Temperature: <80 ℃ • Working Voltage Range: DC 5-8 V • Price: RM 15.00
12V AC-DC Power Adapter [11]	• AC input: 100 V to 240 V • DC output: 12 V 2.0 A • Cable length: 90 cm

2.2 Method

There are many detail steps during designing the system. These included component selection, programming platform, schematic design of components, hardware integration for the prototype and software development. Software development is all about the coding arrangement and simulation. The project prototype was built before the software simulation. This is to ensure the progress goes well after the coding upload and run in the Arduino UNO. The project report has been updated from time to time to avoid any progress did not follow the timeline of the project.

The sensors such as ultrasonic ranging module and water flow sensor have been installed to collect the data from the hatching tank. All the collected data will then send to the microcontroller unit which is Arduino UNO. Data will be process by the Arduino IDE coding. Then, instructions will be given by the microcontroller unit to the equipment such as water pump and solenoid valve. At the final stage, all the data collected from the sensors and equipment can view on Arduino IDE serial monitor.

Figure 1 shows the data transmission block diagram. It shows how the data transmission this autonomous farming system. Figure 2 shows the device operational flowchart which shows how the equipment work together in this system.

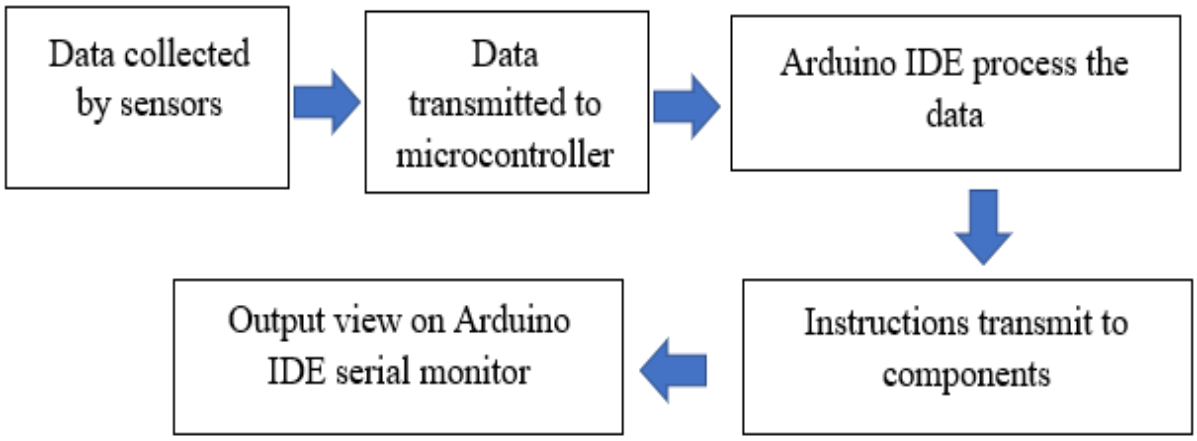

Figure 1: Data transmission block diagram

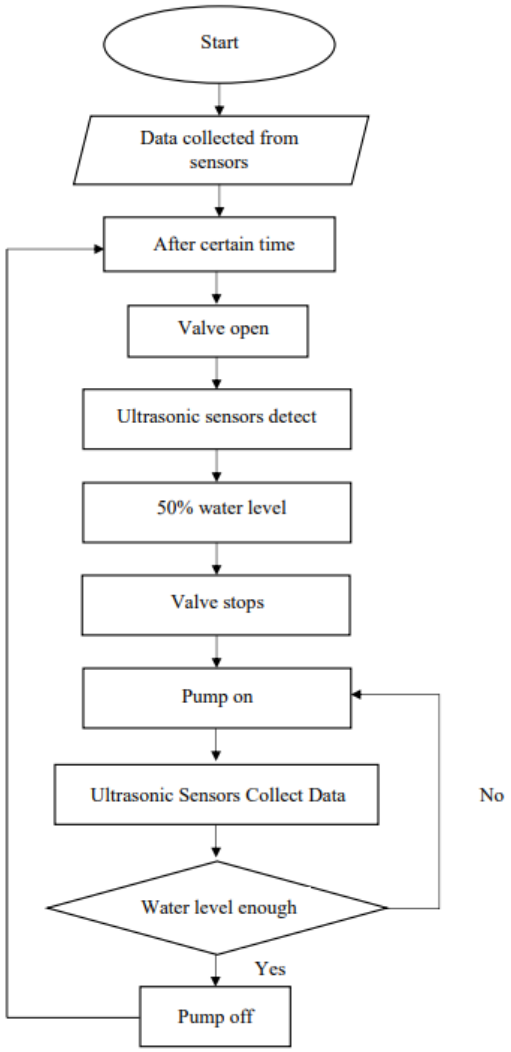

Figure 2: Device Operational Flowchart

3. Results and Discussion

This project aims to build an autonomous aquaculture breeding system which can control and monitor the condition of the hatching tank without wasting time and human power. A prototype of the system has been built to show the result of the software integration with it.

3.1 Results

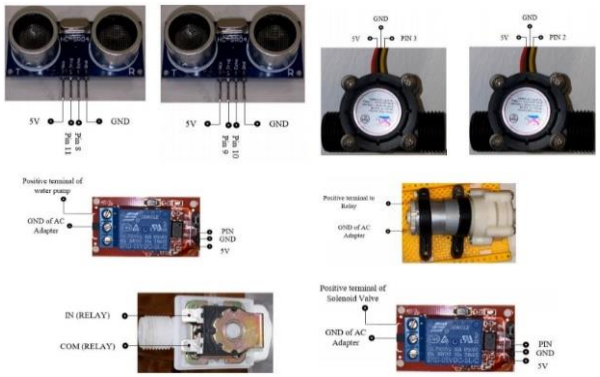

Figure 3: Component Connection Diagram

Figure 3 shows the independent schematic diagram of the connections of the equipment to build the autonomous system. All the components were connected to the Arduino UNO with jumper wire or single core wire. AC to DC adapter is used to provide enough power for the water pump and solenoid valve as Arduino UNO only has a maximum of 5 V output.

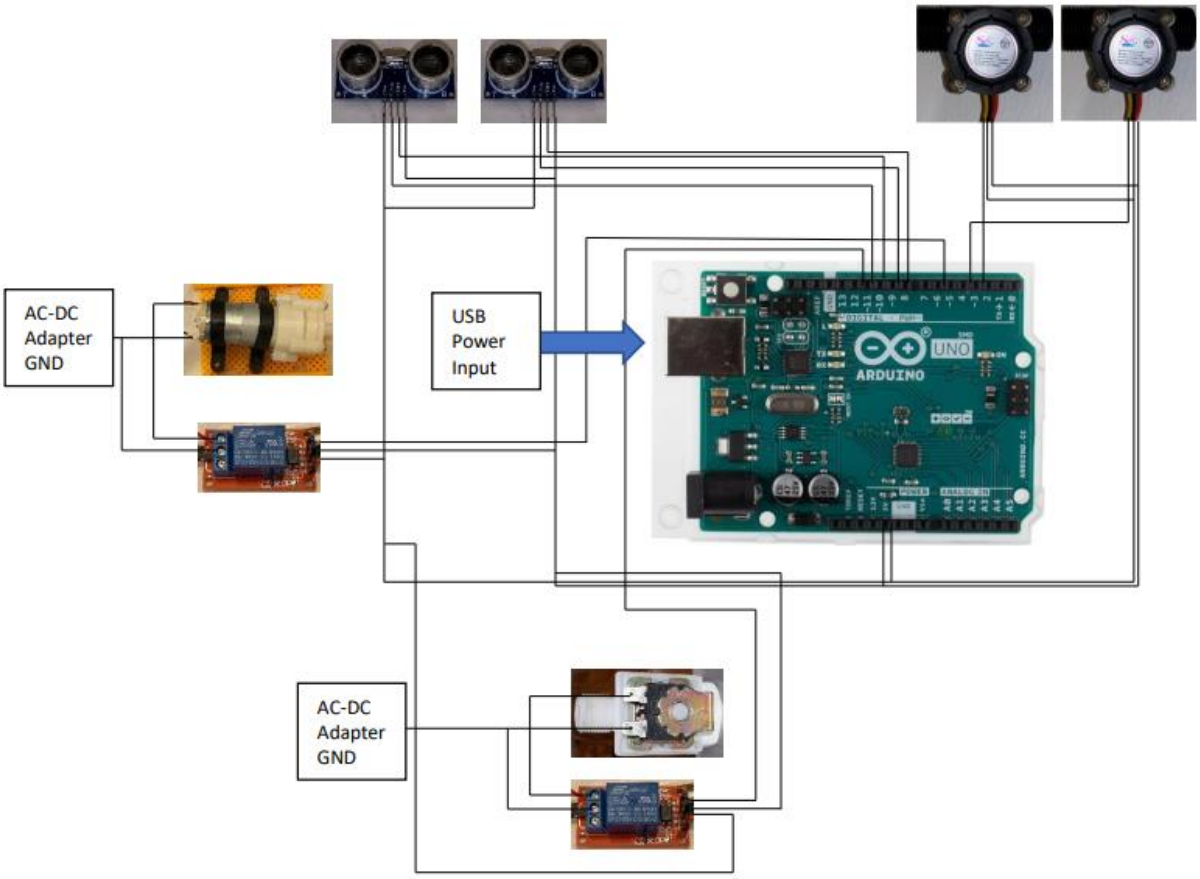

Figure 4: Connection of Prototype

Figure 4 shows the complete connection schematic diagram of the equipment in this system. There are three tanks which are main hatching tank, reservoir tank and also an overflow tank. All the equipment uses strong wire tape to fix it at the proper place.

Figure 5: Serial Monitor after the system run

The result of the system in the serial monitor has shown in Figure 5. The data collected by the sensors and the condition of the equipment can be clearly see in the serial monitor of the Arduino IDE as shown in Figure 5.

3.2 Discussions

All the equipment in this project work simultaneously together with the software. This led to a fully functional autonomous aquaculture breeding system. All the parameters can be detected by the system itself and control the in and out of the water simultaneously.

There are problems with the prototypes too, which is low water pressure of the main hatching tank causing the water did not flow out as we expected. This can simply solve by increasing the pressure of the tank. Inconsistency of the ultrasonic ranging module also a problem of this system.

4. Conclusion

As a conclusion of this project, the Autonomous Aquaculture Breeding System is a great innovation that bring tones of benefits to the aquaculture industry. This project has been built with a reasonable price as it as many electronic equipment as well as sensors. The system can circulate the polluted water by itself which controlled by the microcontroller unit, Arduino UNO which can provide a good living habitat for the aquaculture product especially freshwater prawn. However, there are improvements can be adding into this system. The microcontroller unit can be fix in a water proof container to make sure it works normally even though splash by water. The water pressure of the hatching tank should be increase to make the solenoid valve works normally. The tank can be bigger when it comes to the reality to breed more amount of aquaculture products.

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