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An Automated Feeding System for Soft Shell Crab

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Abstract

Soft shell crab farming has been practiced in south-east Asian countries such as Indonesia. Soft shell crabs are harvested when they have just molted to prevent their shells from being hardened. An issue arises when feeding the crabs. Farmers need to feed the crabs 5% food of their body weight. However, farmers sometimes provide incorrect amounts of food to the crabs. If farmers feed the crab exceeding the required amounts of food, it causes food wastage and dirty water in the crabs' cage. On the other hand, less amounts of food cause slow growth and molting of the crabs. In this study, we developed an automated feeding system for properly feeding of soft-shell crabs. The automated feeding system schedules the feeding time and controls the portion of food using a microcontroller. We also developed a web-based monitoring system to monitor and generate alert message to farmers to make sure that feeding process runs properly.

Keywords*: Automation, Microcontroller, Soft Shell Crab, Feeding, Web-based Application*

1. Introduction

Soft-shell crab is a popular food in the United States, China, Japan, Hong Kong, South Korea, Taiwan, Malaysia and some countries in Europe. Crab commodity is a very promising business sector for the community in Asia, hence, farming of soft shell crab has been practiced in south-east Asian countries such as Indonesia, Thailand, Myanmar, Vietnam, and Philippines. Soft shell crabs are harvested when they have just molted to prevent their shells from being hardened. To growth the crabs, farmers need to feed the crabs with accurate portion of food. When feeding a dry food, farmers need to feed the crabs 5% food of their body weight [1]. However, farmers sometimes provide incorrect amounts of food to the crabs. Such exceeding feed results in food wastage and dirty water in the crabs' cage, hence, the crabs may be sick from drinking the dirty water. On the other hand, if farmers feed the crabs less than the required amounts of food, there will be slow growth and molting of the crabs. Therefore, we need an automation system to feed the crabs properly and accurately based on the required amount of food.

The automation system is a technology that combines the use of mechanics, electronics, sensors and computer application to run a process with less human interference. Automation is basically used to help human beings do the routine, because human being has limitations in terms of precision, unlike machine/computer [2]. There are several studies on automated system for aquaculture and agriculture. References [3] and [4] developed an autonomous robot for agriculture. Reference [5] proposed a PI-based and fuzzy logic-based control system for measuring and controlling the light levels for the indoor hatcheries and nurseries in aquaculture. Reference [6] designed fish feeder system using PIC Microcontroller and it is operated by inputting the desired time the fish will be fed. Reference [7] developed a fish feeder using PIC microcontroller allowing the fish to be fed at the right cycle time as predefined by the user. Reference [8] developed an automatic feeding control for dense aquaculture fish tanks.

In this study, we developed an automated feeding system for soft shell crab using microcontroller. This paper describes the hardware and software design of our proposed automated feeding system. Furthermore, we also evaluated the performance of our automated feeding system.

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2. System Design

We have designed an automation feeding system for soft shell crabs that can schedule the feeding time and controls the portion of food using the microcontroller. Figure 1 shows the design of the feeding system. It is built from a hanging rail and a food container that can feed five crabs in cages. The food container moves to every cage and drops the required amounts of food in the cage. Before the food is dropped, system measures the amounts of food using FSR and drop the food based on predefined amounts of food. If dry food is used, the user sets the amounts of 5% food of crabs' body weight. For instance, if the body weight of crab is 70 grams, then farmers must set the amount of 3.5 gram foods. The system controls the moving of food container using DC motor and properly drops the food in the cage using an ultra-sonic sensor. Furthermore, farmers can monitor the amount of food remotely via Ethernet interface attached in the system.

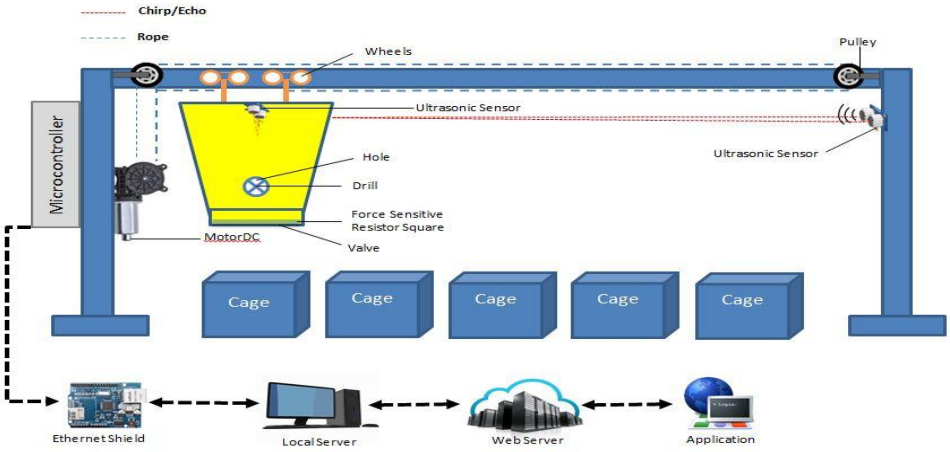

Figure 1. System Design

2.1. Control System

The electronic component of the system mainly consists of a microcontroller (Arduino Mega 2560), ultrasonic sensors, a force sensitive resistor (FSR), a real time clock (RTC), a DC motor, servo motors, liquid crystal display (LCD), buzzer and an Ethernet module as shown in Figure 2. There are two ultrasonic sensors for monitoring the volume of food container to make sure the availability of food in the container and for determining the position of food container to drop the food in the cage. FSR measures the amounts of food before dropping it into the cage. There are two servo motors for moving the drill rod in the container to push the food to feeder valve and to open the feeder valve allowing the food to be dropped. A motor DC moves the food container from a cage to the other cage. Furthermore, the RTC is used for triggering the schedules of the feeding time.

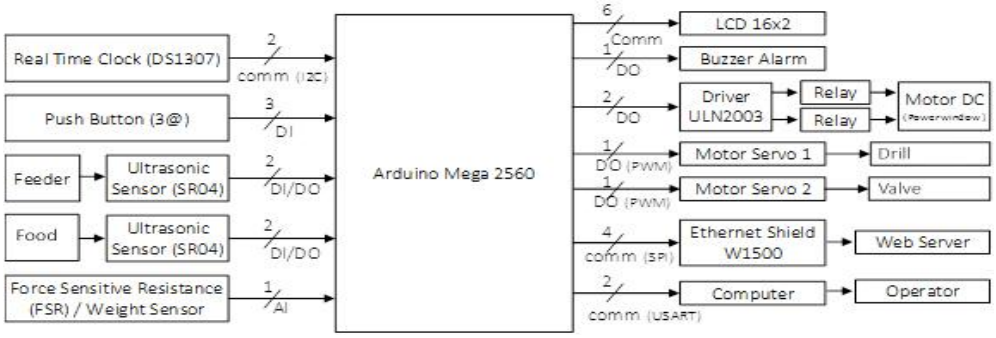

Figure 2. System Block Diagram

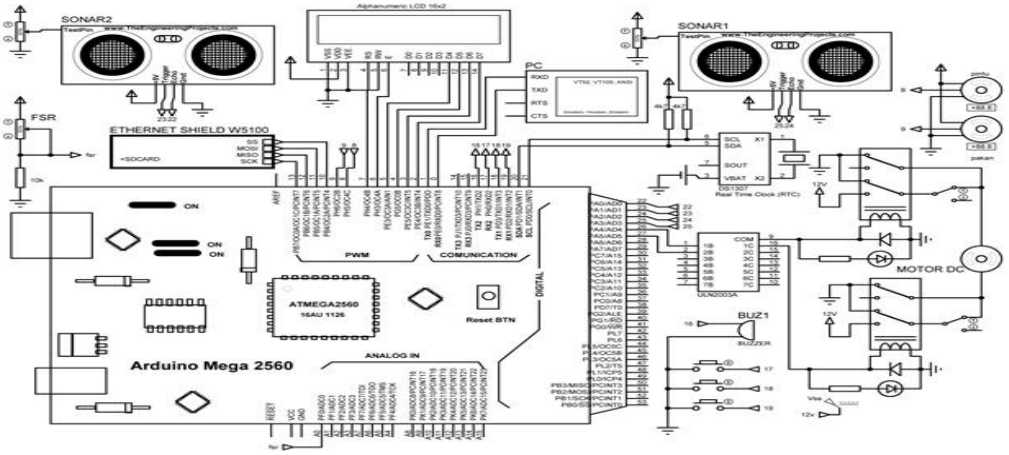

Figure 3. Electronic Schematic Diagram

```
FUNCTION LOOP:

    FUNCTION ServoFeeder(Direction* direction) THEN
        IF (direction == proceed) THEN
            SERVO.CCW    ⟵ 1000
        END
        ELSE IF (direction == retreat) THEN
            SERVO.CW     ⟵ 1900
        END
        ELSE
            SERVO STOP
        END
    END FUNCTION

    FUNCTION ServoValve(Rotate* rotate) THEN
        Open  ⟵ 74 Degree
        Close ⟵ 0 Degree
        IF (rotate == TRUE) THEN
            Open
        END IF
        ELSE THEN
            Close
        END
    END FUNCTION

    FUNCTION GetWeight(Weight* weight) THEN

        IF (weightFood == predefinedAmountOfFood) THEN

            SET FUNCTION ServoValve(TRUE)

        END IF

    END FUNCTION

END LOOP
```

Figure 4. Feeding Algorithms

2.2. Feeding Method

Figure 4 shows the algorithm of feeding embedded in microcontroller. The algorithm works as follow. The function of *GetWeight()* measures the amounts of food based on predefined amount of food set by farmers through a web-based application (explained in the next section) before food is dropped into the cage. If the weight of food reaches the predefined amounts of food, i.e., 5% of crabs' body weight, then the system calls the function of *ServoValve()* to open the feeder valve allowing food to be dropped into the cage.

2.3. Web-based Monitoring System

We developed web-based application for monitoring the feeding process. The application provides information regarding the duration of farming, feeding frequency and duration, and last time of feeding in every five crabs in the cage as shown in Figure 5 and 6. The application also provides information regarding details condition of 5 crabs in every cage and allows farmers to input the weight of crabs and the application generates the required amount of foods based on the weight of crabs. The application sends all input information to the microcontroller. In addition, the application can generate an alert message via the SMS to farmers when a food container is almost empty.

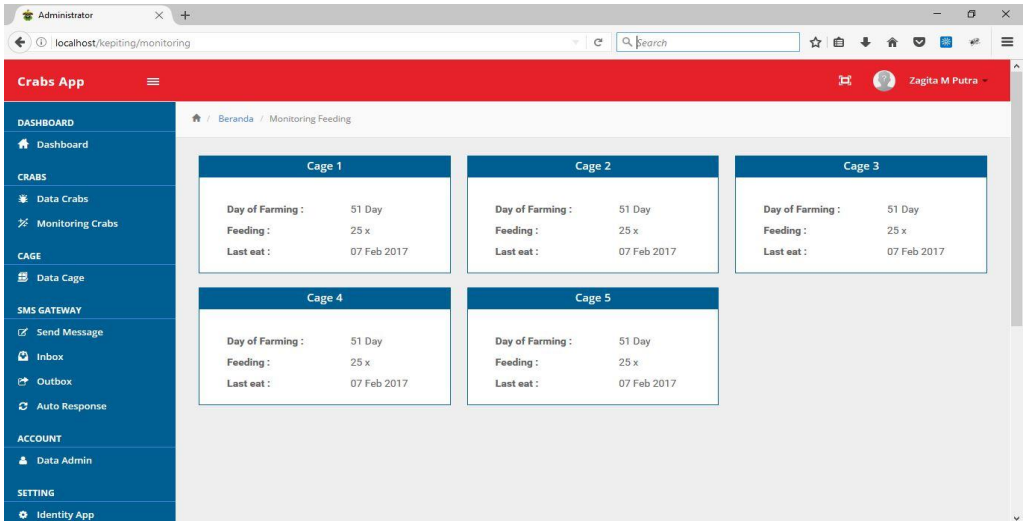

Figure 5. Main Web Interface

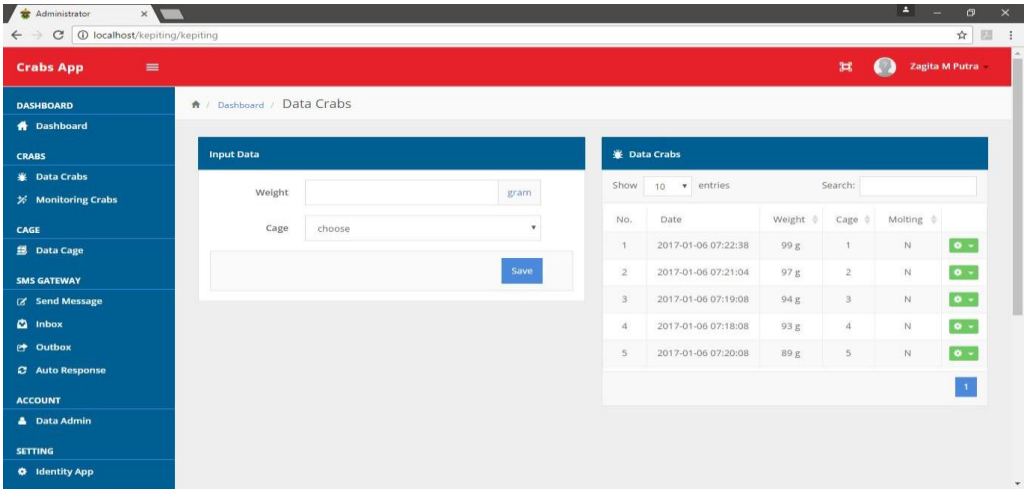

Figure 6. Web Interface for Details of The Crabs

3. Performance Evaluation

We evaluated the accuracy of the automated feeding system by measuring the food dropped in the cage to make sure that the system drops the predefined amount of food properly, i.e., the amount of 5% food of crabs' body weight. In this evaluation, we set the five different crabs' weight, i.e., 99, 97, 94, 93, and 89 grams and the application calculates the required amount of 5% food of crabs' body weight. We validated the accuracy of our automated feeding system by comparing the difference between predefined and dropped amount of food in the cage. As shown in Table 1, the amount of difference between them ranges from 0.05 to 0.1 gram.

Table 1. Predefined vs. Dropped Amounts of Food

No.	Crabs' Weight (gram)	Predefined Amounts of Food (gram)	Dropped Amounts of Food (gram)
1	99	4.95	5.10
2	97	4.85	4.90
3	94	4.70	4.80
4	93	4.65	4.70
5	89	4.45	4.50

4. Conclusion

This paper presents the design of an automated feeding system for soft shell crab. The system aims to feed the crab based on the predefined amounts of food properly, i.e., the amount of 5% food of crabs' body weight, in order to accelerate the growth of the crabs and avoid food wastage, which results in dirty water. The system was built from the hanging rail and a food container that can feed five crabs in cages. The food container moves to every cage and drops the required amounts of food in the cage according to the program fed into a microcontroller. The experiment shows that our system can feed the crabs with predefined amount of food. The amounts of difference between predefined and dropped amount of food ranges from 0.05 to 0.1 grams.

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