Development of an Automated Drinking System Using Microcontroller for Broiler Production

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Abstract
Although the broiler industry is one of the fastest growing industry in the Philippines, it still lacks the process of automation. Thus, this study sought to develop an automatic drinking system for broiler production that can monitor, control, record water quality and environmental data parameter. An automated drinking system was designed using the Arduino microcontroller and other electronic components for initial and actual field testing. The initial testing included the calibration and functionality of the system. After which, the system was tested for brooding and near harvest stage at a small broiler house set-up in San Rafael, Bulacan. Water quality parameters, such as the temperature, pH, and turbidity were measured in the study. Results showed that the annual cost difference of broiler production favored the utilization of the automated drinking system, rather than of manual labor. The study recommends that the automated drinking system be tested to larger broiler houses, with an additional alarm system through GSM. Furthermore, monitoring and recording via the internet can improve the automated system.

Keywords: Arduino, Automated Drinking System, Broiler Drinking System, Microcontroller

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Introduction

The Philippine Statistics Authority (PSA) stated in 2014 that the Philippine population is projected to increase to about 142 million by around 2050, according to Census-based population projections. This rapid population growth produced a big challenge, especially to the agricultural sector, and this is to raise the overall food production enough for the growing population. The Bureau of Agricultural Statistics (BAS) and PSA (2018) data showed that poultry is one of the most progressive animal enterprises recently in the Philippines. From January to December 2018, poultry production increased by 5.75 %. It expanded by 6.99 percent during the last quarter of 2018 and contributed 16.18 percent to the total agricultural output. It is one of the major and rapid producers of meat in the country. It has been a significant contributor to the country's agriculture sector and crops, livestock, and fisheries.

Without considering the large poultry business sectors, the development of technology was used to the conventional methods of supplying drinking water. In the present situation, galloners were the source of drinking water in the poultry industry, especially in broilers. The main problem with this method is that it requires a lot of manual labor, and the water supply is not guaranteed to be in ample amount and of good quality. Maharjam and Watkins (2016) stated that maintaining drinking water quality for poultry is an important nutritional aspect as they consume water twice the level of feed. Checking and monitoring the water on the broiler farm should be done regularly to ensure that adequate water quality and quality are available.

To handle the problems in production development, an automated drinking system for broiler production was developed. Specifically, it aimed to design and develop the monitoring, recording, and control system for the water quality parameters, design and develop the monitoring and recording system for environmental parameters, and determine the developed automated drinking system's performance.

Body

An automated drinking system for broiler production that considered a small conventional broiler house for broilers from Day 0 to harvest stage was designed, as shown in Figure 1. This was composed mainly of the following: the water sources (the primary source and secondary or emergency water source), the water quality monitoring, controlling, and recording system (Arduino, LCDs, and other electronic components), the alarm system (buzzer and LEDs), the nipple drinkers, the environmental parameter monitoring and recording system.

Temperature, pH, and turbidity were the water quality parameters that were considered. Individual sensors and alarm systems were assigned to each parameter. For the environmental parameters, relative humidity and temperature were considered. The mechanism of the automatic flow of water to the nipple drinkers was shown in the flowchart in Figure 2.

Initial testing and actual field testing were conducted. Initial testing included calibration of the sensors and the functionality testing considering different conditions and water samples. On the other hand, actual field testing included the 24-hour dry run and testing on broilers at the brooding and near harvest stage for four days each.

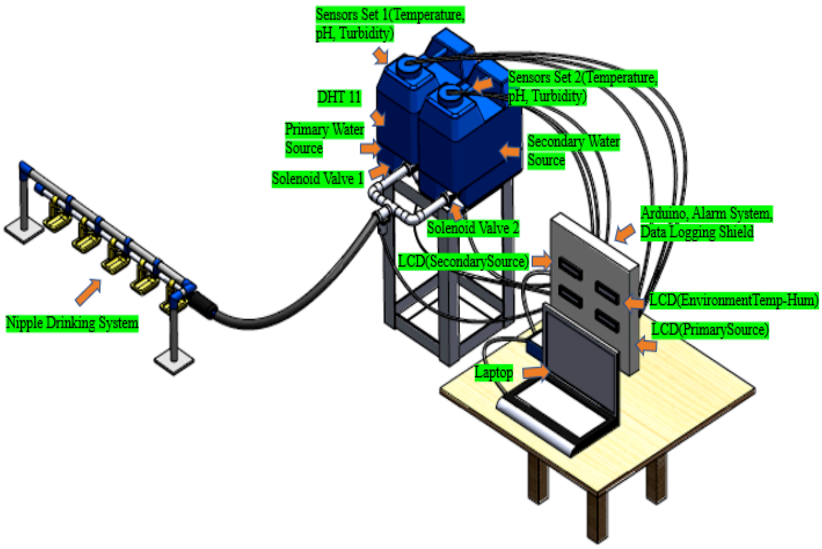

Figure 1: Component of the developed automated drinking system

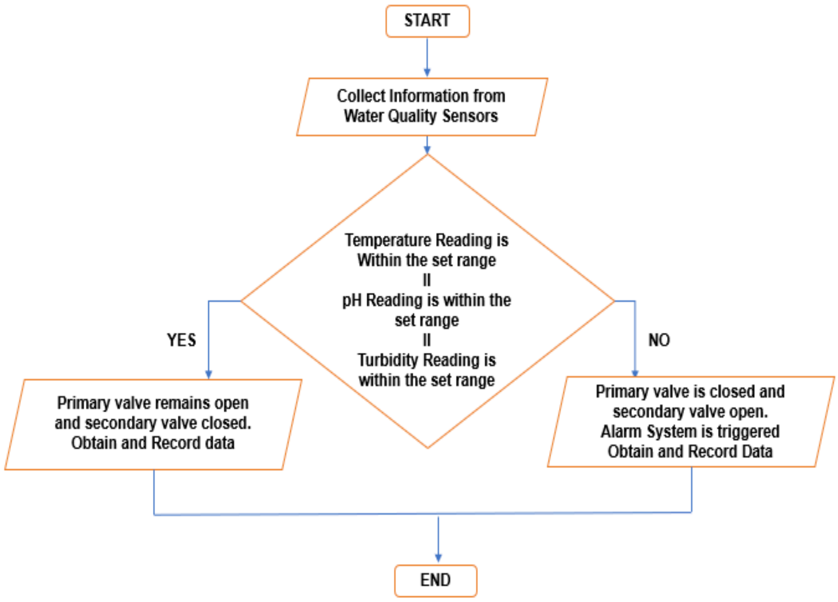

Figure 2: Mechanism of flow of water from sources to nipple drinkers

Initial tests were completed prior to the actual field tests. As per results and obtained parameter values during the calibration and testing of the sensors, the systems functioned properly. This indicated the go signal for the actual field test. A small conventional broiler house setup at San Rafael, Bulacan was chosen as the area for actual field test. The monitoring system was able to display water quality and environmental parameter values. The data logger of the system was able to record pertinent data. Figures 3 to 6 showed the per minute graphs of the obtained water quality data during the brooding stage and near harvest stage for both the primary and secondary source. The maximum recorded temperature was 31.12 ^{o}C. The minimum and maximum pH values recorded were 5.92 and 7.99, respectively. The minimum recorded voltage value for turbidity sensors during the brooding stage was 3.50 V and for the near harvest stage was 3.60 V. The values observed and recorded were within the set limits. During the brooding stage, the set acceptable parameters were the following: less than 36 ^{o}C for temperature, 4 – 8 for pH, and greater than 3.40V for turbidity. During the near harvest stage, the set parameters were the following: less than 36 °C for temperature, 4 – 8 for pH, and greater than 3.50 V for turbidity. The summary of the minimum, maximum, and average water quality data during the entire actual field testing were tabulated in Table 1. No discrepancies and alarms reported during the field test at San Rafael, Bulacan. Considering the recorded water quality parameter data, good quality water was supplied to the broilers during brooding stage and near harvest stage.

The temperature and humidity of the environment were also monitored and recorded during the actual field testing. There was an Average of about 160 heat index value during the actual field testing, thus, environmental parameters during the study were optimum and suited for the broiler production. Figures 7 and 8 showed the environmental parameter data during the brooding and near harvest stage.

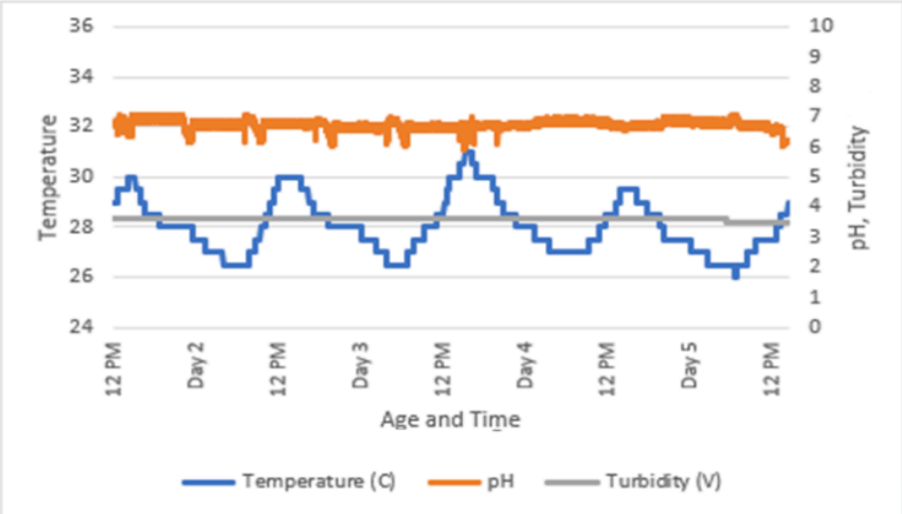

Figure 3: 4-day primary source water quality data during brooding stage

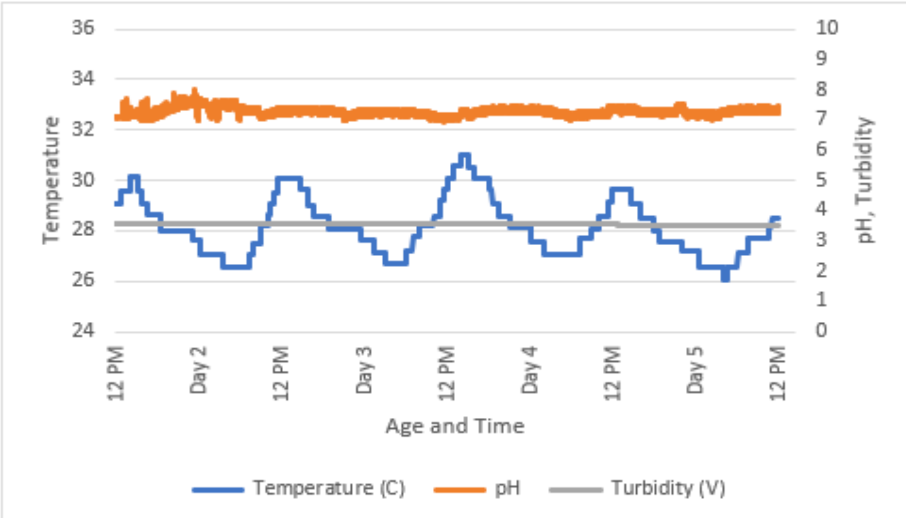

Figure 4: 4-day secondary source water quality data during brooding stage

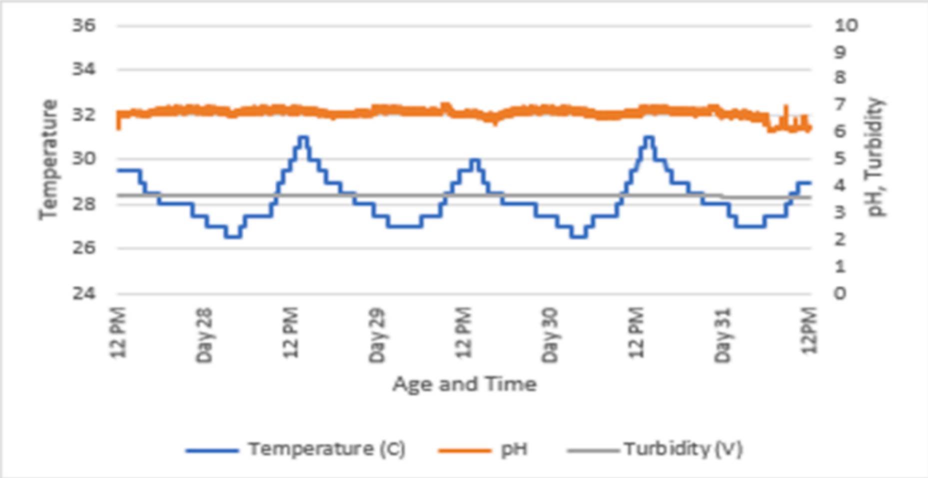

Figure 5: 4-day primary source water quality data during near harvest stage

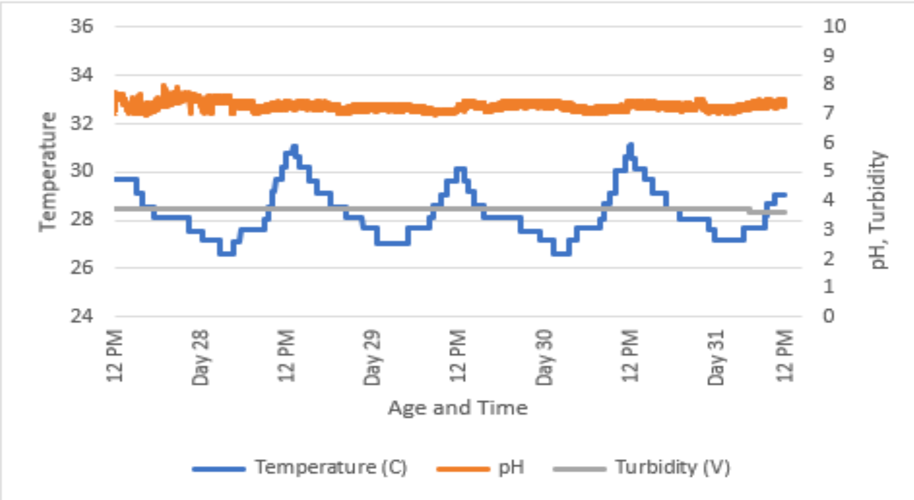

Figure 6: 4-day secondary source water quality data during near harvest stage

ACTUAL FIELD TEST	TEMPERATURE (^{O}C)			PH			TURBIDITY (V)		
	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
Primary Source: 24-hour dry run	26.50	30.50	27.98	6.41	7.05	6.76	3.70	3.80	3.72
Secondary Source: 24-hour dry run	26.37	30.94	28.06	7.00	7.22	7.11	3.70	3.80	3.71
Primary Source: Brooding Stage	26.00	31.00	28.03	5.92	7.09	6.74	3.50	3.60	3.59
Secondary Source: Brooding Stage	26.07	31.03	28.14	6.93	7.99	7.27	3.50	3.60	3.58
Primary Source: Near Harvest Stage	26.50	31.00	28.18	6.04	7.04	6.74	3.60	3.70	3.69
Secondary Source: Near Harvest Stage	26.58	31.12	28.29	6.94	7.97	7.26	3.60	3.70	3.69

Table 1. Summary of minimum, maximum, and mean values during the actual field test

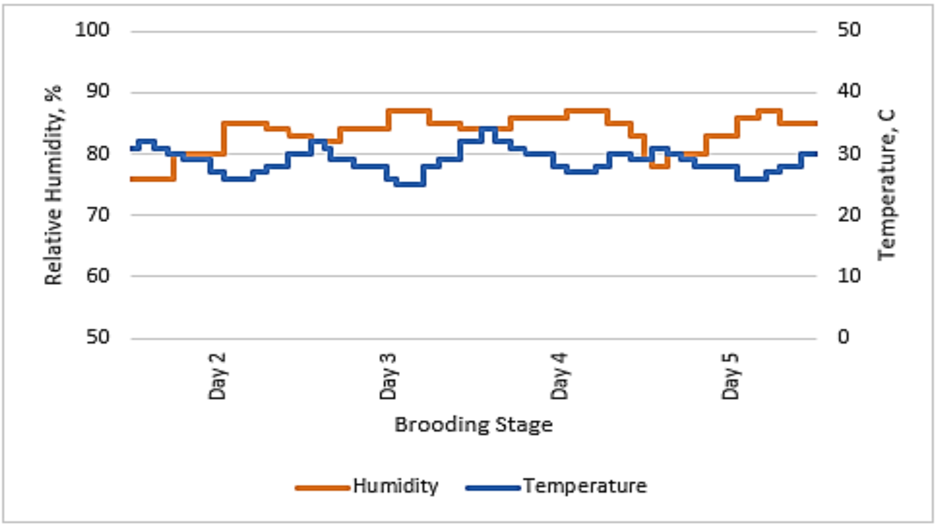

Figure 7: Environment temperature and humidity during brooding stage

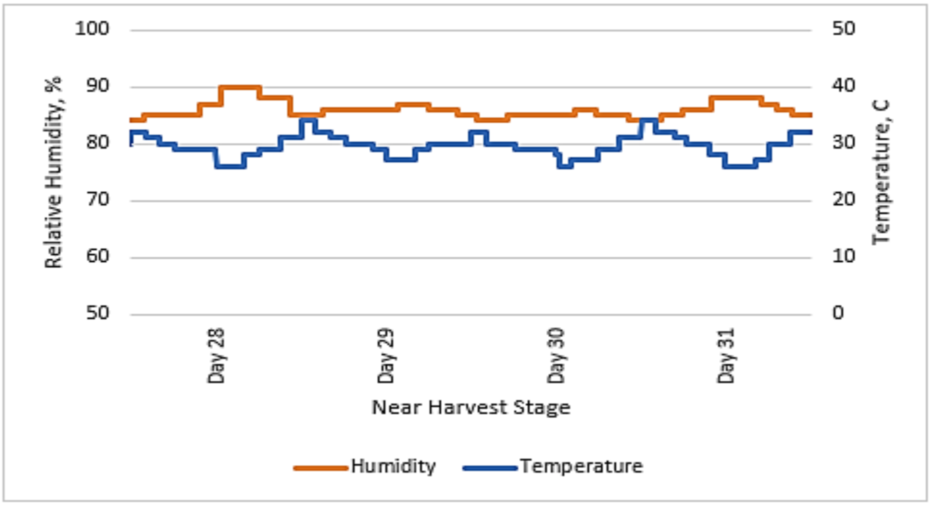

Figure 8: Environment temperature and humidity during near harvest stage

The drinking system was financially evaluated to determine if it could contribute to economic welfare. The total cost of producing the automated drinking system was PhP 43,340.00. The total yearly small conventional broiler production costs using the developed automated drinking system and conventional manual labor were computed and compared. A difference of about PhP 94,752.00, which favored the automated drinking system, was obtained.

Conclusion

The developed automated drinking system was able to monitor and record water quality data during the initial and actual field tests with no discrepancies and alarms, hence, water quality data were within the expected and set limits. The environment temperature and humidity data were monitored and recorded as well. The annual cost difference of broiler production favored the automated drinking system over the conventional system, thus, the use of automation could be considered in small broiler production in the Philippines. To further improve the study, it is recommended that the automated drinking system should be tested on bigger broiler houses.

Furthermore, an additional alarm system through GSM could also be considered. Lastly, monitoring and recording thru the internet could help improve the system.

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