Automated Chicken Weighing System Using Wireless Sensor Network for Poultry Farmers

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Automated Chicken Weighing System Using Wireless Sensor Network for Poultry Farmers

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Abstract. In recent years, in the quest for cost-effective operations, slower than expected chicken growth has become a big issue for the poultry farmers in Malaysia. To be profitable, the chickens need to reach 1.8kg in only 38 days from hatching. At present, the farmers manually check the weight of chickens twice a day, in the morning and evening, to monitor the growth rate of chickens. However, the workers in such farms do not weigh the chickens according to an established SOP, which in turn results in inaccurate growth-rate data obtained. This paper describes the development of an automated chicken weighing system using wireless sensor network (WSN) for poultry farmers to replace the manual approach. The weighing scales are equipped with wireless data transfer system to enable automatic data transfer to the Cloud using a Wi-Fi module. The data collected are then compared to the expected growth rates and used to monitor of the growth rate of chickens. The proposed growth rate monitoring system enables them the daily monitoring of the chicken development rate and enables the rectification of problems as soon as any discrepancies are detected. Problems such as insufficient or poor distribution of feed and the occurrence of disease can be rectified at an early stage.

1. Introduction

Poultry meat is one of the most popular and cheapest protein based-food among Malaysians as the meat is socially and religiously acceptable [1]. Malaysians consumed 51.2kg/year of poultry meat in 2016 [2] and has been steadily increasing over the years.

Poultry meat has recorded the highest self-sufficiency ratio (SSR) among the livestock commodities which is 98.0% in 2016 [2], produced 305,058,206 of chickens and 10,655,926 of ducks [3]. According to the federation of livestock famers' associations of Malaysia, there are approximately 2,676 chicken farms in 2015 which produced 725 million of broilers a year [4]. There are about 15,010 tons of chicken meat and 52.71 million of live chickens were exported a year, mostly to Singapore [4]. This shows that poultry farming is an important agricultural industry in Malaysia.

However, poultry farmers in Malaysia follow a strict schedule to maximize profits where the broiler chickens need to reach 1.8kg in 38 days from hatching and be harvested immediately. This is to allow time for the farmers to clean the poultry house and new batch of chicks to come in. Since the chicks are pre-ordered one month earlier before harvest, and will arrive on time, there is no empty room for delays. If the broiler chickens are unable to reach 1.8kg in 38 days, the farmers have to sell the livestock for a fraction of the price to other poultry farms, and hence incur losses. In addition, the margin between broiler chickens' production cost and sales is quite small which results in reduction of revenue to the farmers [1].

There are several factors which cause the retardation of broiler chickens' growth. One of the most important factors is the uneven distribution of broiler chickens themselves in the coop. The broiler chickens should be intensively reared in the coop at all times where the poultry farmers can only place one animal at every $0.80ft^2$ to $1ft^2$ [5]. However, some of the poultry farmers overstock the coop beyond the standard operating procedure. This results in the broiler chickens not having proper access to the food and water due to overcrowding. In addition, the broiler chickens will gorge each other when the food is available which can impact both feed conversion and body weight gain.

Another important factor is that sometimes the broiler chickens experience suboptimal temperature which is caused by the environmental control system of the farms. Heat stress in the coop can cause the broiler chickens to reduce its feed intake by around 16.4% [6, 7, 8] and increase the water consumption [7]. This could result in the body weight of the broiler chickens to be lower by 32.6% [6, 8] and increased the feed conversion ratio by 25.6% [6].

The goal of the proposed project is to enable the farmers to monitor the development of their chickens wherever and whenever using an automated weighing system which utilising wireless data transmission method or IoT. The robust weighing scale was developed using aluminium plates and 5kg load cell which able to transmit the weight data to the workstation through wireless transceiver module. The wireless transceiver module of the weighing scales will transmit the data wirelessly to the workstation every 15 seconds. The collected daily weight values will be averaged and compared to the reference weight values and used to detect any discrepancies or variations. The current average weight along with the reference will be transmitted to the Cloud through Wi-Fi in real time. These values will show the growth rate of the chickens, and any differences between the recorded and reference values to provide an indication of a possible problem.

2. Problem Statement

The general scenario and associated problems with poultry farmers have been introduced above. At present, to monitor the broiler chickens' growth, the farmers in Malaysia have to manually weigh the livestock twice a day, in the morning and evening by using the analogue or digital weighing scale. However, the workers in the poultry farms do not weigh the broiler chickens according to any established standard operating procedure (SOP), which in turn results in inaccurate growth-rate data obtained.

Therefore, this research proposed the development of an automated chicken weighing system to replace the manual approach with a more accurate data collection approach. The system is equipped with wireless sensor network (WSN) that enables daily monitoring of the chicken development. Equipped with growth rate reference, the system also enables any problems that may arise to be detected as soon as any discrepancies are recorded. Hence problems such as insufficient or poor distribution of feed and the occurrence of disease can be rectified at an early stage.

3. Proposed System

The development of the automated chicken weighing system using wireless sensor network (WSN) consists of two parts which are the weighing scales and a workstation that collects the weight data.

3.1. Weighing Scale

The robust weighing scale was developed using aluminium plates and 5kg load cell where it can handle loads from 500 to 5,000 grammes. The Arduino Microcontroller was used to collect data from the load cell amplifier and transmit it to the workstation through the wireless transceiver module. Two units of 3.7vdc (3.8amp) rechargeable batteries were used as the power supply for the weighing scale. In addition, the weighing scale was designed to be water and dust resistant so that the internal electronic components are fully enclosed. The proposed system architecture of the weighing scale is as shown in the Figure 1.

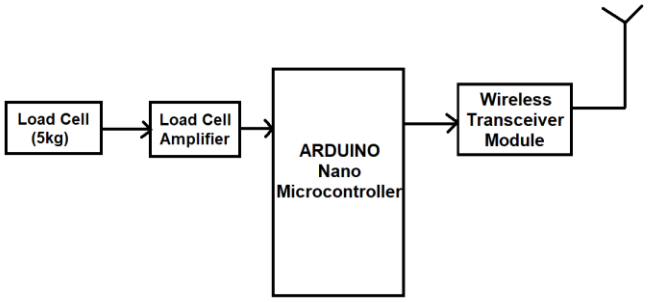

Figure 1. Proposed system architecture of weighing scale.

3.2. Workstation

The wireless transceiver module of the weighing scales will transmit the data wirelessly to the workstation every 15 seconds. The collected daily weight values will be averaged and compared to the reference weight values and used to detect any discrepancies or variations. The current average weight along with the reference will be transmitted to the Cloud. These values will show the growth rate of the chickens, and any differences between the recorded and reference values to provide an indication of a possible problem. This enables the farmers to keep track of the broiler chickens' development by access the daily weight readings and comparisons wherever and whenever. The proposed system architecture of the workstation is as shown in the Figure 2.

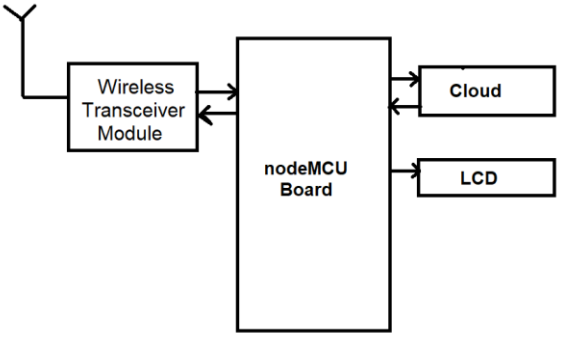

Figure 2. Proposed system architecture of workstation.

4. Real Time Data Collection in Chicken Coops

The proposed system is installed in three chicken coops with different dimensions to perform the real time data collection, designated coop A, B and C.

The chicken coop A which is 200ft long and 80ft wide needs 20 sets of weighing scales and one workstation. The chicken coops B and C, on the other hand, which are 180ft long / 80ft wide and 100ft long / 50ft wide need 18 and 12 sets of weighing scales respectively. The data from each weighing scale are transferred wirelessly to the workstation. To obtain a more accurate weight data, the weighing scale is placed at every 18ft in the coop because the movement of one group of chickens is 3 meters in radius.

These are then averaged to get the daily weight of the chickens in the specific coop. The system will compare the average daily weight of the chickens to the reference values. The differences are evaluated: insignificant deviations correspond to normal growth rate while otherwise may indicate problems. If the latter is detected, a warning is given to the farmer via the Cloud. The farmer may also view the collected data whenever the need arises through an app via mobile phone.

The weighing scale is placed within the three coops for 38 days to obtain and monitor the development of the chickens from day to day. This is to ensure the growth rate of the chickens is as expected.

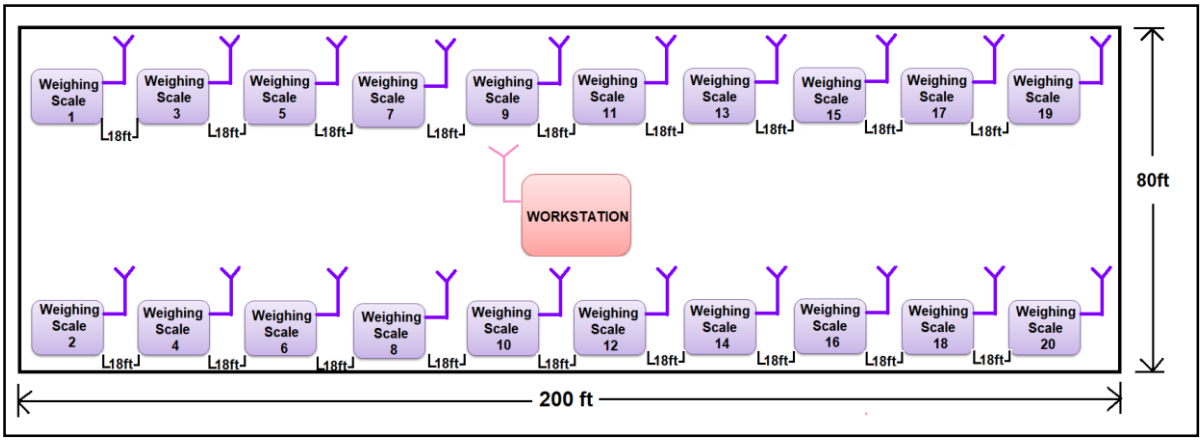

Figure 3. Weighing scale distribution for chicken coop A.

5. Result and Discussion

Based on the real time data collection in three coops as shown in Figure 4, it can be clearly seen that the growth rate of chicken is as expected from day 1 to day 12.

However, starting from day 13, the growth rate of chickens was recorded to be slower than expected. Compared to expected growth rate, the growth of chickens is 3.38% to 12.21% slower which caused the livestock take 40-42 days to reach 1.8kg. This is due to high amount of broiler chickens in one coop.

For coop A which is 200ft long and 80ft wide, the poultry farmer supposedly can only place 15,000 of broilers chickens. However, the poultry farmers placed 16,000 of broiler chickens. This results in the broiler chickens not having proper access to the food and water due to overcrowding. In addition, the broiler chickens will gorge each other when the food available which can impact both feed conversion and body weight.

The coop B and C, on the other hand, which are 180ft long / 80ft wide and 100ft long / 50ft wide supposedly can only place 14,400 and 5,000 of broiler chickens respectively. However, the poultry farmers placed 12,000 and 4,000 of broiler chickens respectively in one coop. This is why the broiler chickens in coop B and C grow well than the those in coop A.

Secondly, the unexpected growth rate of chickens might also due to the poor ventilation system in the coop. When the temperature is high in the coop, the broiler chickens drink more water than they eat the food which resulted in the body weight gain of livestock is lower.

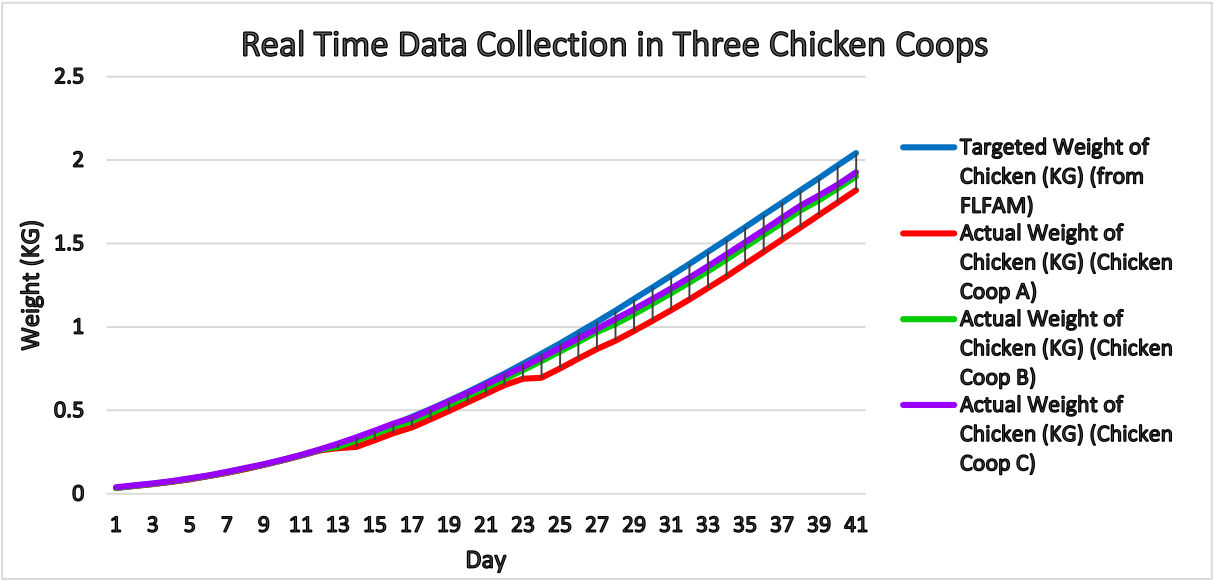

Figure 4. Real time data collection in three chicken coops.

6. Conclusion

Successful development of an automated chicken weighing system using wireless sensor network (WSN) able of collect real-time weight data of broiler chickens has been demonstrated. The proposed system aims to replace the manual approach and assist the farmers to monitor the daily development of chickens such that rapid action can be taken as soon as problems are detected. With the aid of this system, problems such as insufficient or poor distribution of feed, the occurrence of disease and poor ventilation system can be rectified at an early stage.

Further development of the system may include additional sensing modalities, to enable the temperature and humidity zoning within the coop to be monitored and its effects to the chicken growth analysed. This will enable true efficient management of the chicken coops to be implemented.

Acknowledgments

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