

Design and Implementation of an Automated Feeding System for Poultry Farms

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Abstract

The huge cost and high labor demand associated with the current deep litter system of poultry farming poses a great challenge to poultry farming. These drawbacks which currently threatens this system of farming, have been attributed to the over-involvement of humans in almost all aspects of operation of this farming system. The consequences are increased disease outbreak, weakness and poor bird feeding. To ameliorate some of these challenges, an automated poultry feeding system is developed and presented in this paper. The proposed system mimics the roles of real-life poultry attendants in delivery of feed and water to birds at specified interval of time. The system senses the level of feed and water in the respective trough and intelligently dispense water and feed in response to the sensed levels. The current system is able to effectively sense and predict the level of feed and water in the farm at an accuracy of 98.79% and dispense same within a response time of 50-60ms.

Keyword

Automated Feeding System, Poultry Farm, Microcontroller, Arduino Uno

1. Introduction

Poultry farming currently serves as major source of protein production for human consumption. It has overtime created employment and revenue for stakeholders involved in the business. As such, the need to ensure its proper management cannot be overemphasized (Barcho, 2019; Olaniyi et al, 2014; Adedinsewo, 2004; Arulogun, 2010; Grothmann, 2010). Efficient management of poultry nutrition has been established as a major factor that accounts for the success of the poultry business (Adedinsewo, 2004).

According to (Olaniyi et al, 2014), 75% of production cost in poultry farm is due to feeding. Similarly, the extensive use of human labor in almost all aspect for the daily running of the farm increases the cost of production. The current deep litter system of poultry farming has been established to be characterized by improper administration of feed, wastage of feed, unfavorable weather conditions, stress associated with manual labor, increased tendency of disease outbreak, fatigue and stress (Hung, 2014; Reyes et al, 2015; Duy et al, 2015).

In an effort to ameliorate some of these challenges, technologies have over-time been developed in order to automate several aspects of this system of farming. See section II for details. Though, several technologies have been developed in an effort to automating the feed dispensing system of poultry farms, many of such systems have been inefficient and unstable hence resulting in malnutrition and increase risk of disease outbreak in many farms. Thus, the present study seeks to develop an automated feeding system for poultry farms that cater for these challenges.

To realize the set objective of this study, the remaining sections are arranged thus: section II reviewed the state of the arts in poultry farming automation with a focus on feeding systems, while in section III, present an overview of the proposed system; discussing and developing relevant block diagram and flow diagrams of operation for the system. In section IV, we give a quantitative analysis of the system design and results generated from the developed system as against other systems. Finally, in chapter five, we conclude and proffer recommendations for improvement on the already developed system.

2. Related Works

Several efforts have been made in order to reduce the high capital associated with the cost of production in poultry farming which has overtime deterred investors from venturing into poultry business (Barcho 2019; Kumar et al, 2019.) The high cost associated with poultry farming has been shown to have a strong correlation with the involvement of persons in this farming system. This has in return greatly increase the overall personnel cost associated with this system of farming (Schmitz et al, 2015; Zhang et al, 2000).

Over the years, technological solutions have been developed in a bid to automate many of the functions that make for the enormous involvement of humans and huge personnel cost associated with this system of farming. Also, efforts have been made to improve the efficiency and effectiveness of these developed technologies. Technological solutions have been developed for the different aspects of this system of farming in areas such as Penning and housing, heating/cooling and ventilation, feeding, waste management and handling of farm product to mention but a few (Zhang et al, 2000; Grim, 1994).

In accordance to the delimitation of the current study, we present an overview of some of these technologies (Olaniyi et al, 2014; Adedinsewo 2004; Arulogun et al, 2010), developed technologies to improve the efficiency of feeding systems in poultry farms. However, these systems were characterized by hardware and software limitations such as limited axis of movement for feeders, no feeder level detection functionality. Thus, resulting in wastage of feed. The system also lacked the capacity of notifying users of the situation in the poultry farm.

Similarly, in an effort to ensure promptness in the dispensing of feed in poultry farm (Arulogun et al, 2010; Olaniyi, 2015), developed an intelligent mobile dispensing system for poultry feed. The system uses microcontroller with PID Controllers respectively, allows for remote control of feeding trough. However, the system failed to make provision for the sensing of feed levels thus encouraging wastage. The system also could not cater for the simultaneous feeding of large number of birds; it also didn't cater for the supply of water to the birds.

Also, (Sinduja et al, 2016) developed an automatic control system for poultry farms. Their system which is founded on a wireless sensor network (WSN), is capable of measuring variation in environmental parameters such as temperature, food and water level using an Aurdino ATmega2560 microcontroller. It is also able to analysis and present this information in a graphical user interface (GUI) to users.

In an effort to cater for some of these limitations outlined in the reviewed studies, we propose a system that is capable of hygienic simultaneous dispensing of feed and water. The system uses an Arduino controller as its controller for intelligent sensing and dispensing of water and feed as the birds consume them.

3. Overview of the Proposed System

Our proposed system is designed with a view of optimizing the entire system performance. In this regard, the systems hardware is made up of subsystems that are interconnected as shown in Fig.1. Similarly, the software and hardware are optimally integrated for its operation. While the software module includes several programs and applications that help a user issue commands, the hardware part takes care of the controllers and interfaces that connect directly to the devices to be controlled. A description of the different subsections of the system is thus presented.

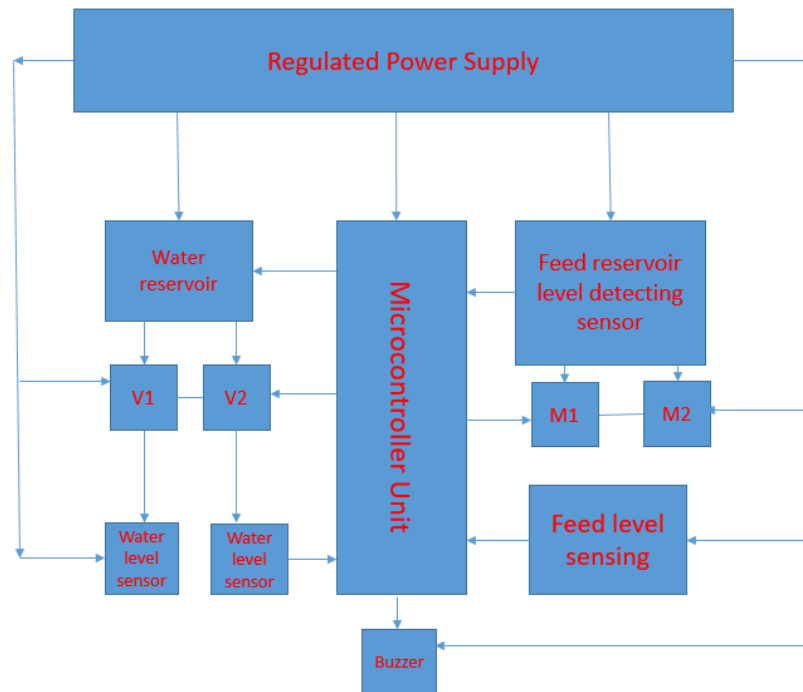


Figure 1. Block diagram of the proposed system

3.1. Hardware Description

The hardware of the proposed automated feeding system basically consists of the following subsystems: L298N motor driver, ultrasonic module, buzzer, solenoid valve, voltage regulator circuit, switching system, 12V power adapter, stepper motor. We thus describe each:

- i. **Motor Driver Module (L298N):** L298N is a dual H-Bridge motor driver that allows simultaneous speed and direction control of two Direct Current (DC) motors. It can drive DC motors of range 5-35V, with maximum current of 2A. Two inherent features that makes for excellent control of motor speed and direction of rotation are responsible for the choice of L298N. It has two terminals used to connect the two DC motors as shown in Fig.2. It also uses the Enable A and B pins to enable and control the speed of the motors. Similarly, the pin 1 and pin 2 of the Logic Input are used to control the rotation direction of the motor A. On the other hand, pin 3 and pin 4 are also utilized in controlling motor B. The basic logic of operation of this module is: When input 1 is LOW and input 2 is HIGH, the motor moves forward and when input 1 is HIGH and input 2 is LOW, the motor moves backward. Whenever both inputs have the same level, the motor stops. Same logic applies to pin 3 and pin 4 for motor B.
- ii. **Ultrasonic Module:** HCSR04 ultrasonic sensor was adopted owing to its excellent and high accuracy non-contact range detection. It also offers stable readings in an easy-to-use package. It has transmitter and receiver sub-modules and uses sonar in establishing the distance to an object. Its operation is thus described: A sound signal at high frequency is sent through the transmitter trig pin. If the signal finds an object along its path, the signal is then reflected by the object. The transmitter through its echo pin receives the reflected signal and instantly determine the object distance.

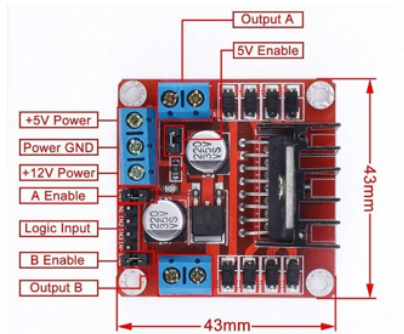


Fig. 2. Integrated power Supply unit



Fig. 3. HC-SR04 Module

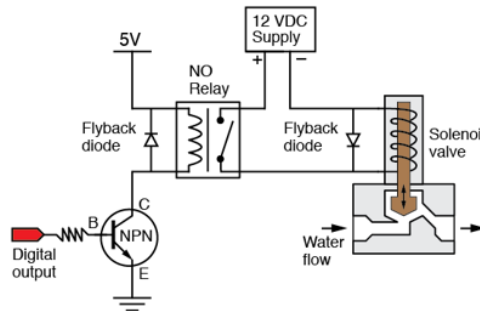


Fig. 4. Solenoid Valve

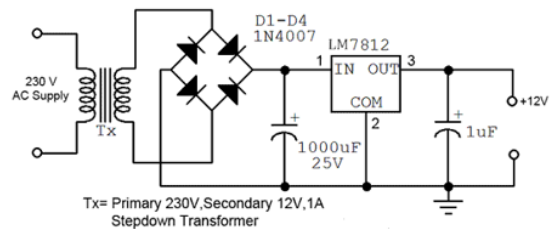


Fig. 5. Power Supply unit

- iii. **Buzzer:** The buzzer used in this study is a piezo buzzer as shown in Figure 3. It operates using a DC power supply of range 4-9V. A simple 9V battery can also be used. When the input pins receive DC voltage, it results in oscillating signals due transistors and resistors. The induction coil is used to amplify the oscillating signals. The application of high voltage alternating signals to the piezo ceramic disc results in mechanical expansion and contraction in radial direction causing a bend of the metal plate in opposite direction. Continuous bending and shrinking of the metal plate in opposite direction produces sound waves in the air.
- iv. **Solenoid Valve:** A 12V DC electric Solenoid Water Air Valve Switch was adopted for controlling the flow of fluid in the system. The valve which uses a solenoid coil opens when 12 V dc is applied its terminals thus allowing for the flow of fluid. It is also able to stop the flow of fluid when its terminal dis-energized as shown in Figure 4.
- v. **Power Supply Unit (PSU):** Our system utilizes a 12V Direct Current (DC) power supply. Usually, 12V DC power supply is obtained from a 120V or 240V AC input using a combination of diode rectifiers, transformer, filter capacitors and transistors as shown in Figure 5.
- vi. **Switching System:** The switching system is made up of a 2 channel relays used in switching the connected valves as shown in Fig.6. The relay is connected to the Solenoid valve while the ground of the relay is connected to the ground of the microcontroller. The control of the switching involves setting the particular pin to be used as an output pin and then set the value of the pin to HIGH. The microcontroller gives an output voltage of 5 volts when a pin is HIGH. This is used to trigger a transistor which switches the relay.



Fig. 6. Relay Module

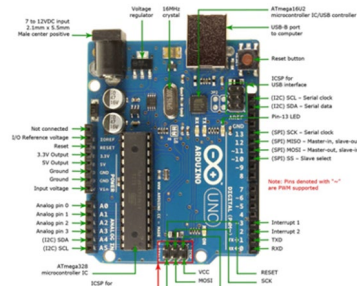


Fig. 7. Arduino-Uno Layout

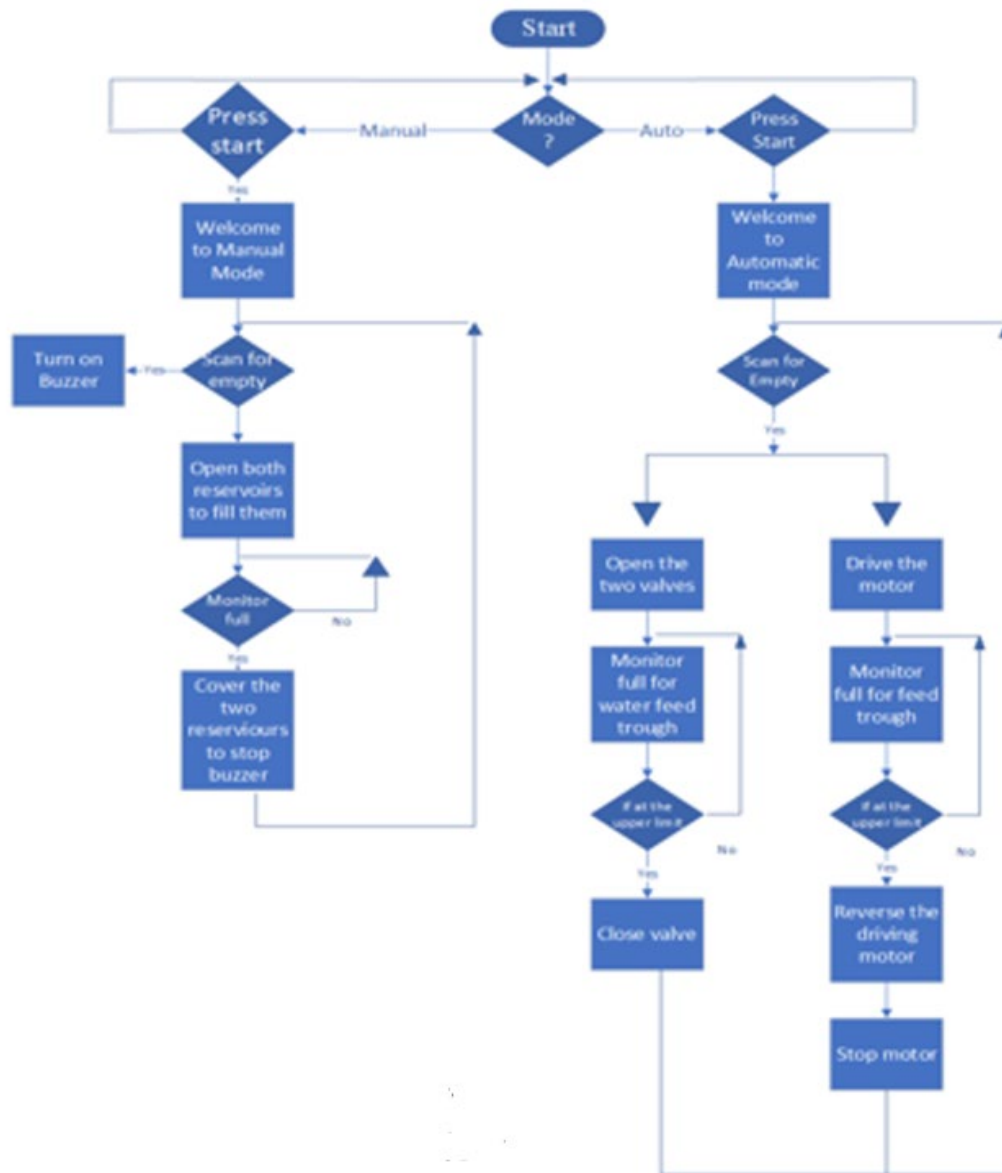


Figure 8. System Operations Flow

3.2. System Communication and Control Description

Communication between the hardware's was realized through a program written on a controller. For this study, we adopted the Arduino Uno (Chinaeke-Ogbuka, 2019, Amadi, 2019) based on the Microchip ATmega328P microcontroller as shown in Fig 7. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The ATmega328 on the board is preprogrammed with a boot loader thereby allowing the upload of new codes to it without needing external hardware programmer. While the Uno communicates using the original STK500 protocol, it is different from all earlier boards because it does not use the FTDI USB-to-serial driver chip. Rather, it makes use of the Atmega16U2 programmed as a USB-to-serial. For this task, a C-language program was written on a computer using the Arduino Integrated Development Environment (IDE) for controlling the working of the system. The program was uploaded to the microcontroller through a serial port interface from the programming circuit of the microcontroller to the serial port of the computer with the aid of the Arduino. The program flow diagram is as shown in Fig.8.

4. Implementation and Testing of the Design

The overall circuit of the design comprises of the different sub-circuits of the individual units (Modules) all connected to the microcontroller via the Arduino Uno. The functions of these individual units were harmonized through a written program on the ATmega328P microcontroller. The prototype design was implemented physically as shown in Fig. 9. The individual components that make up the entire system were tested separately before integrating them together. All the interfacing units were tested separately as well to ensure closer specifications required for proper functioning of the system, and also to check the continuity of the connections that link the individual components. Reliability testing for the system was carried for 3-days and a mean reliability value of 0.5064 was obtained.



Figure 9. The prototype of the automated feeding system for poultry farms

5. Conclusion and Recommendations

In this study, we designed and implemented an effective, user-friendly automatic feeding system for poultry farms with a view of remedying the current challenges associated with poultry farming especially as it regards the high cost associated with personnel. The developed system also improves power management in the farm. The system

controls the dispensing of poultry feed (liquid and solid) through a program written on ATmega328P microcontroller via the Arduino Uno. Compared with other conventional methods, this system shows excellent performance with its advanced digital technology and it is more effective as it saves both time and energy. Overall, it greatly reduces personnel cost. While the current system is only designed to automate the feeding systems for subsistence poultry farms, the present study failed to cater for other section that could incur man power cost such as health, waste management and ventilation systems. It is hoped that further studies will explore a cross- platform approach to these areas.

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Biography

Ifeanyi Chinaeke-Ogbuka was born in Nsukka Nigeria on 14th September 1989. She obtained her Bachelors of Engineering (B. Eng) in Electronic Engineering and Masters of Engineering (M. Eng) also in Electronic Engineering Department of the University of Nigeria, Nsukka. She currently serves as a Lecturer II in the same Department. Her research interests are in

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Cosmas Ogbuka holds the following degrees from the Department of Electrical Engineering, University of Nigeria Nsukka, where he has attained the rank of Associate Professor: B.Eng. (First Class Honors), M.Eng. (Distinction) and Doctor of Philosophy (Ph.D.) obtained in 2004, 2009, and 2014 respectively. His research interests include Electrical Machines, Drives and Power Electronics. He is an International Faculty Fellow of the Massachusetts Institute of Technology (MIT) USA and had also undertaken a postdoctoral research visit at the Chair of Electrical Drives and Actuators (EAA) Universitaet der Bundeswehr Muenchen Germany. He is currently the Director of the Computer Communications Centre of the University of Nigeria