Remote Monitoring and Control System for Poultry Feed Dispensing

Olayemi M. Olaniyi, Umar U. Buhari, Theophilus O. Kaa
Department of Computer Engineering
Federal University of Technology, Minna, Nigeria
mikail.olaniyi@futminna. edu.ng, Nigeriabuhariumar@futminna.edu.ng, theophilus.kaa@st.futminna.edu.ng

Jibril A. Bala
Department of Mechatronics Engineering
Federal University of Technology, Minna, Nigeria
jibrilbala39@gmail.com

Arulogun O Tayo
Department of Computer Science and Engineering
LadokeAkintola University of Technology, Ogbomoso, Nigeria
otarulogun@lautech.edu.

***Abstract*—The advent of technology has led to the automation of a number of systems globally such that the use of machines, control systems and information technology are implemented to optimize productivity in the manufacturing of goods and delivery of services. A typical poultry farm requires a lot of labour, but automation can proficiently moderate the amount of effort required, thereby making farming easier, faster, and leading to increased productivity. A poultry liquid and solid feed dispensing system are designed to discharge feed at specific time intervals in a poultry farm. This study utilizes the technological advancement in Global System of Mobile Communications (GSM) for remote monitoring and control of the poultry feed dispensing system. This tackles the challenge of being physically present, thereby eliminating the problem of distance as well as saving time, thus, resulting in an increased return on investment. The remote and monitoring system applies the Sim900A GSM and AT2560 microcontroller in Arduino Uno for remote monitoring and control of the feed dispensing. The performance of the system was evaluated in terms of the system response time of the GSM module on different mobile network subscribers. This helps to overcome the drawback of energy conservation and inadequate time management in accessing the system, thus, enabling the user to remotely monitor and control the feed dispensing system from the mobile phone. Hence, the system provides a cost-effective way of administering feed to the poultry birds.**

Keywords: GSM, Agriculture, Poultry, Control, Feed, Dispenser.

I. INTRODUCTION

The Poultry industry is an attractive and fast growing agro-industry in many countries of the world. It is found throughout the country wherever there are human settlements [1]. This is accredited to the increasing demand for poultry meat and egg products. Its intensification has been towards a large commercial flock production. With this drifting, there has been an increase in the confinement housing for poultry. Hence, adequate feeding becomes a challenge, resulting to manual feeding technique in poultry farming[2]. This consumes a lot of time and expends a lot of energy on the human part. Also, the cost of production is highly capital intensive yet, generates low profit. Human limitations such as fatigue, stressful manual labour, negligence, unfavourable condition in the poultry, improper administration of feed, and high cost of maintenance are some of the factors that discourage a lot of people from investing in the poultry industry [3]. Poultry feed takes about 75% of the cost of managing a poultry farm [4]. The stress of feeding these poultry birds accumulates as the number of the poultry birds increases.

The advancement of technology has opened new ways to communicate between man and machine by generating human readable text instead of indicator bulbs and audible alarms which are stationary. Since Short Message Service utilizes the unused component of the Global System of Mobile Communications (GSM) voice bandwidth, almost every GSM mobile service provider lets subscribers send and receive SMS for a nominal fee. Thus, SMS opens a new medium for cost effective communication, across the globe for a fraction of the cost usually incurred in making a voice call or data[5].

The advancement in the telecommunications industry throughout the world has been very rapid as one innovation replaces another in a matter of weeks. A remarkable breakthrough being the wireless telephone system which comes in either fixed wireless telephone lines or the Global System for Mobile Communications (GSM). GSM is a technology that is widely valued and accepted globally as it has helped with various aspects of the economy. Mobile phones are more than just fixed-line alternative; they are now recognized as being 'mobile'[6]. This '*communications on the move'* continuum means people can engage in development activities that previously would not have been possible such as remote monitoring and control of devices.

GSM technology is one of the leading digital cellular systems. It uses narrowband Time Division Multiple Access (TDMA), which allows eight simultaneous calls on the same radio frequency. GSM networks are pioneers in many typical digital services including the Short Message Service (SMS), Over the Air (OTA) configuration and GSM positioning. The Subscriber Identification Module (SIM) card is a unique and essential component of GSM phones. Some of the merits of the introduction of GSM include the fact that GSM has greatly reduced the need and frequency of travelling for those who

have access to it and helps in proper and efficient management of time [7].

This article focuses on the development of a mobile communication for remote monitoring and control of the poultry feed dispensing System. The monitoring and control of the system are provided by the mobile device over a Global system for Mobile Communication (GSM) network. To solve the problem of remote monitoring and control of automated poultry feed dispensing system, this work makes it possible to monitor the dispensing system anywhere and anytime via a mobile phone under the coverage of a GSM wireless network. The system is capable of measuring the poultry feed levels using an ultrasonic sensor as well as dispensing the poultry feed if necessary depending on the level and the command sent to the system using the GSM. The remaining sections of the article are divided into three. Section one provides review of related baseline works, Section three shows the methods and materials selected for the developed feed dispensing system and Section four and five provides results and discussion as well as conclusions and scope for future research, respectively.

II. REVIEW OF RELATED WORKS

Several related works exist in literature. [8] proposed a timed automatic pet feed and water dispenser system capable of automatically providing solid feed and water to animals upon preselected timed intervals simultaneously. With the help of the timer, it predetermines the quantity of feed to be dispensed. Some of the limitations of this system are that it is immobile; the semi-solid feed that is ready for consumption will contribute to the dirt of the device as a result of dispensing both the water and food at the same time.

In addition, a self-propelled poultry feed dispenser with a feed level detector was constructed by [9]. The system could sense the feed level and dispense the feed at time intervals. This system is connected to a computer via a parallel port, but the limitations of this system were high cost of maintenance of the parallel port connection and the ability to move only in a horizontal or vertical manner based on its position. In addition, [10] developed a mobile intelligent poultry feed dispensing system to address the mobility limitation in[9]. This system could move, detect and avoid obstructions and dispense solid feed to poultry birds. Some of the limitations of the system are that it could not dispense liquid feed, and the solid feed dispensed was sometimes too large for the chicks to feed on.

Also, a mechanical family poultry feeder was developed by [11]. This system could dispense solid feed to the feeder trough from the hopper; it controls the amount of feed dispensed using a spring and depended on the weight of the feed in the trough. The limitations of this system are that it was large in size; it was not mobile and was not capable of dispensing liquid feed. [12] also, developed an intelligent poultry liquid feed dispensing system using Fuzzy Logic control techniques. The system succeeded in dispensing of Liquid feed which was a limitation to[10]. The limitations are that the system could not feed a large number of birds, the liquid feed was not flowing in a recycling manner to prevent contamination of the liquid feed. It could not dispense solid feed and the system was not mobile.

Furthermore, [13] developed an intelligent mobile poultry liquid feed dispensing system using GA tuned PID control technique. This system was able to move on a track and had the ability to dispense liquid feed from the trough into a drinker and back into the drinker to prevent contamination of the liquid feed. The liquid feed was able to flow in a recycling manner into the system therefore avoiding contamination. The limitation of this system is that the system could not dispense solid feed.

In this work, we improved upon [3] and [14]mobile intelligent feed dispensing system. The systems developed by [14] were mobile and capable of dispensing both solid and liquid, but the system has a poor power management consumption. In addition, the system reduces human intervention, stress and wastage of feed which were some of the limitations in the earlier discussed systems. The efficiency of the system can be enhanced by remotely monitoring and controlling it. Table 1 gives a summary of the review of the related systems, their capabilities and drawbacks.

Table 1: Existing Poultry Systems, Capabilities and drawbacks.

S/N	System	Capability(s)	Drawbacks(s)
1	Timed automatic pet feed and water dispenser [8]	Capable of simultaneously dispensing water and food automatically.	The system is not mobile. The semi-solid feed that is ready for consumption will contribute to the dirt of the device.
2	Self-propelled poultry feed dispenser with a feed level detector [9]	The system was capable of sensing feed level. Dispense the feed at time intervals in the respective feeding trough.	High cost of maintenance of the parallel port connection Ability to move only in a horizontal or vertical manner
3	Mobile intelligent poultry feed dispensing system [10]	The system was mobile It was capable of dispensing solid feed to poultry birds	It could not dispense liquid feed Solid feed dispensed was sometimes too large for the chicks to feed on
4	Intelligent poultry feed and water dispensing system using fuzzy logic control technique [12]	The system was capable of dispensing liquid feed The system could detect feed level and dispense if the levels was low	System was not mobile. Fuzzy Logic is not suitable for highly complex systems.

5	An intelligent mobile poultry liquid feed dispensing system using GA tuned PID control technique [13]	The system was mobile The system had the ability to dispense liquid feed to poultry birds The system had a mechanism to prevent contamination	The system could not dispense solid feed GA technique used suffers from premature convergence and is not suitable in solving large optimization problems
6	Mobile intelligent feed dispensing system using PSO tuned PID control technique [14]	This system was mobile. Capable of dispensing both solid and liquid.	The system has poor power management consumption. The system could not reduce human intervention in deep litter

III. METHODS AND MATERIALS

The developed dispensing system consists of various parts which include the wheels, troughs, feeder, drinker, DC motor, DC liquid pump, Arduino Uno board microcontroller, Sim900A GSM module, ultrasonic sensors, relays, TIP transistors, a feed conveyor and the liquid feed hose. The overall block diagram is shown in Figure 1.The remote monitoring and control module consists of an SMS enabled phone, a sim900A GSM module, and two LM2596 DC-DC ultrasonic sensor. The SMS enabled phone and the embedded system are connected by the sim900A GSM module to pin10 and pin11. Also, the two LM2596 DC-DC ultrasonic sensors are connected to Pin 3 and 2, 13 and 12 of the Arduino Uno board respectively. Pin 9, 8, 7, 6 and 5 are connected to BP, FM, MB, MF and FP as shown in Figure 2.

The ultrasonic sensors are used for measuring the solid and liquid feed levels of the system. The GSM module establishes a GSM network connection with a specified mobile operator to receive SMS messages from a remote location. The DC motors and DC pumps are implemented to dispense the solid and liquid feeds respectively. The relays and transistors are used for switching the output of the microcontroller to the required output by the DC motors and DC pumps.

The mobile device (from Figure 1) establishes a connection with the GSM module and thus the AT2560 microcontroller on Arduino Uno. Once a connection is successfully established, the user then sends controlling commands from the mobile phone in the form of text message, but with a special character attached to it for security. After reading and parsing the commands, then the microcontroller controls the GSM wireless module to send the address and data codes to achieve the remote monitoring and control of system ultimately. The microcontroller processes the commands and provides the appropriate output to the monitoring and control units. The bulk converter steps down voltage while stepping up current from the input to its output to provide the required power to the GSM module according to the given command. The system will provide updated information whenever requests come from authenticated users.

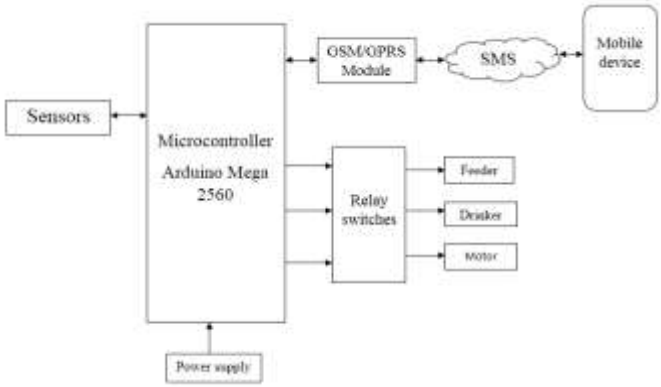

Figure 1: GSM based remote monitoring and control system

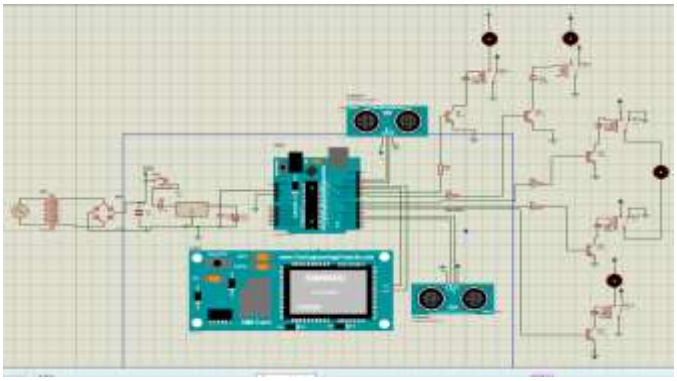

Figure 2: System circuit diagram using Proteus:

A. Hardware Design Specifications

Table 2 shows the hardware specifications of the proposed system. The various components used for the development of the hardware are listed.

Table 2: Hardware specification of the system.

S/N	Hardware Components	Specifications
1.	Micro Controller	Arduino Uno
2.	Transistor	TIP 120
3.	GSM Module	SIM 900A
4.	Ultrasonic sensor	5V HC-SR04
5.	Bulk Converter	LM2596 DC-DC
6.	Step down transformer	240V/ 15V – 50Hz
7.	Relay	12V
8.	Battery	Lead acid 12V-18Ah
9.	DC pumps	12V

10.	DC motors	12V

The listed components were chosen based on factors such as cost, availability and compatibility between the DC motors and DC pumps.All the selected components of the system are connected to the AT2560 microcontroller and simulated in Proteus virtual environments as shown in Figure 2, after which the system was simulated to verify that it is functioning properly.

B. Software Design Considerations

This section describes the software design considerations for the remote monitoring and control system for poultry dispensing. It includes the computer applications used for the simulation of the system software programming of the microcontroller. Proteus was used for schematic capture and microprocessor simulations. Proteus Version 8 running on a Windows 10 HP envy x360, 6th generation Intel core i5 (2.3-2.8GHz) processor, 8GB RAM and 500GB Hybrid Hard drive was used in designing the circuit diagram for the GSM based remote monitoring and control system. C programming language was used to program the Microcontroller using Arduino 1.6.x IDE, version 1.6.7. The system flowchart is shown Figure 3. Once the system is on and the GSM network is connected, a command is sent to the mobile number on the system which, when received, will execute the action that is designed to take.

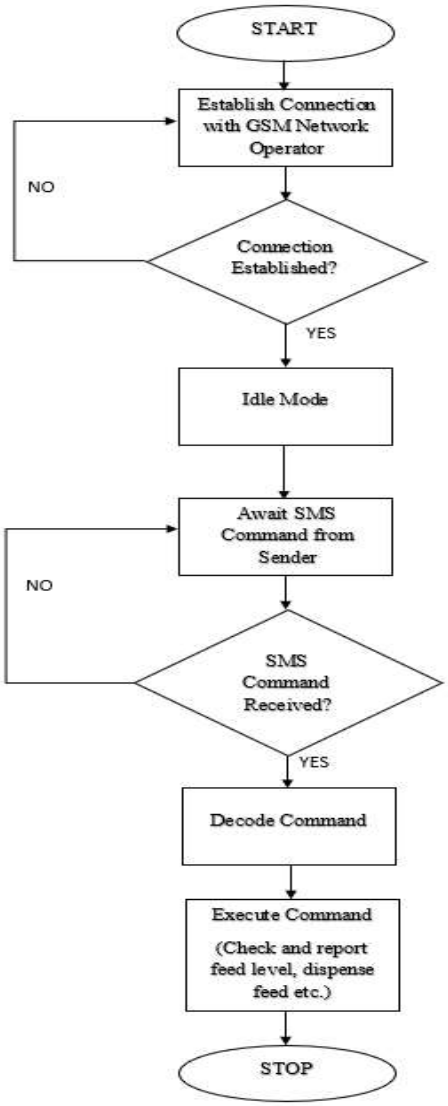

Figure 3: Flowchart of the GSM based remote monitoring and control system.

IV. RESULTS AND DISCUSSION

The results obtained from the design and development of a GSM based remote monitoring and control system for poultry feed dispensing is as shown in Figure 4. The Arduino microcontroller and the GSM module are contained in the embedded unit (red enclosure). The entire system is powered by the black 12V DC battery. At the initial stage, the user will have to go through the process of inserting the mobile sim on the mobile device. After which the system will require the user to send an SMS text with the content #1, #2, #3, #4, #5 representing Dispense feed, move forward, dispense water, move back and check status respectively. The status of both the feed and the water is received from the Sim 900A GSM module that send the request command as shown in Figure 5a and 5b .

At the GSM module unit, the message is received once there is mobile network and enough SMS units. It then transmits the

code to the Arduino Uno microcontroller which reads the data and carries on the action requested.

Figure 4: Developed GSM based remote monitoring and control system

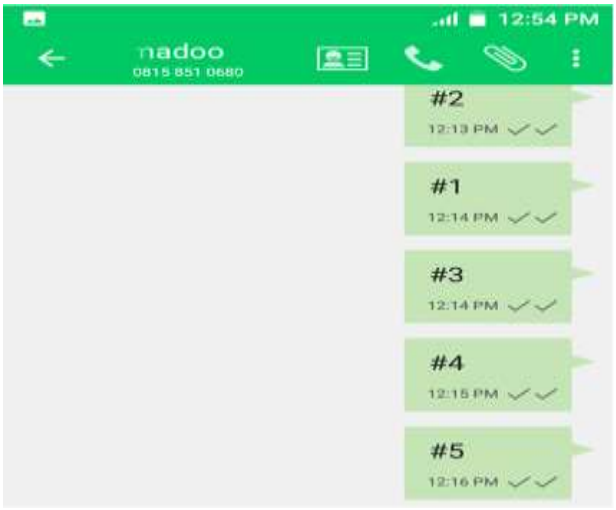

Figure 5: Screen shot of the SMS sending command

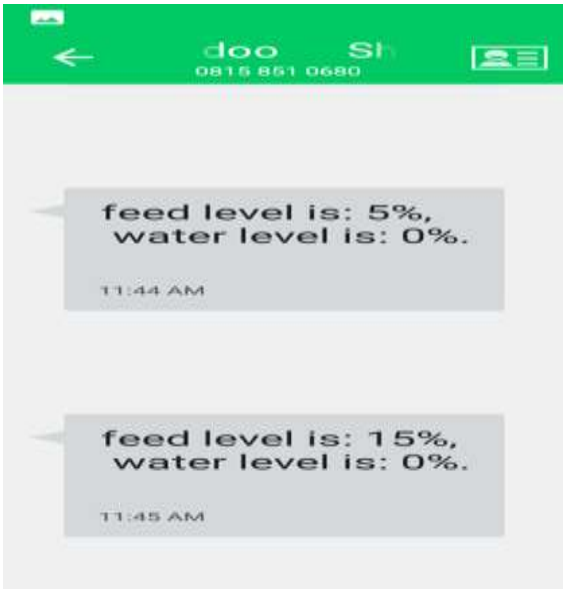

Figure 6: Screen shot of the system status

A. System Performance Evaluation Measure

The system was evaluated using the response time metric for the GSM module and the different network subscribers which is needed to measure the accuracy of the developed system and the quality of service coverage in GidanKwano of Minna, Niger State, Nigeria area thereby saving time, energy and giving a faster result when distance is considered. The result obtained is shown in Table 3 while Figure 6 shows the graphical view of obtained results.

Table 3: Comparison of system response time with the various GSM networks

Time(seconds)	RESPONSE TIME PER NETWORK			
	Etisalat	Glo	MTN	Airtel
1	5	2	1	4
2	4	3	2	3
3	2	1	3	4
4	3	1	1	2
5	4	1	1	2

The average response time for each network was calculated as follows:

$$\text{Average Response Time} = \frac{\text{Total Response Time}}{\text{Total Number of Instances}}$$

For Etisalat:

$$\text{Average Response Time} = \frac{5+4+2+3+4}{5}$$

$$\text{Average Response Time} = \frac{18}{5}$$

Average response Time = 3. 6 seconds

For Glo:

$$\text{Average Response Time} = \frac{2+3+1+1+1}{5}$$

$$\text{Average Response Time} = \frac{8}{5}$$

Average response Time = 1.6 seconds

For MTN:

$$\text{Average Response Time} = \frac{1+2+3+1+1}{5}$$

$$\text{Average Response Time} = \frac{8}{5}$$

Average response Time = 1.6 seconds

For Airtel:

$$\text{Average Response Time} = \frac{4+3+4+2+2}{5}$$

$$\text{Average Response Time} \frac{15}{5}$$

Average response Time = 3 seconds

From these computations ,it shows that the dispensing systems performs better with Glo and MTN when compared to Etisalat and Airtel networks in thee selected mobile network coverage area of the Gidan-Kwano campus of Federal University of Technology, Minna, Niger State, Nigeria.

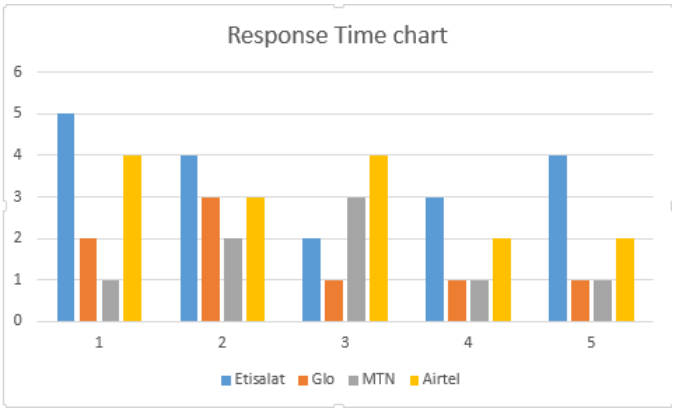

Figure 7: System response time with the various GSM network

V. CONCLUSION AND RECOMMENDATIONS

GSM technology is used in the development of the system which tackles the problems of low energy conservation and inadequate time management. Thus, enabling the user to remotely monitor and control the feed dispensing system from the mobile phone. Hence, the Poultry feed dispensing system provides a cost-effective way of administering feed to the poultry birds. This will yield a higher return on investment in the farming system. Future works can attempt to make incorporate an interface using the World Wide Web. This will increase the coverage area of the remote monitoring and control of the poultry feeding system.

REFERENCES

[1] A. A. Adeyemo and M. P. Onikoyi, "Challenges of Small Scale Poultry Operations in Nigeria," *Agric. J.*, vol. 7, no. 6, pp. 388–393, 2012.

[2] A. Adebanjo, "Poultry production," *ANP 313 Lecture Note: National Open University of Nigeria*, 2008. [Online]. Available: http://www.nouedu.net/sites/default/files/2017-03/ANP 313 MAIN TEXT 2_0.pdf. [Accessed: 18-Oct-2018].

[3] O. M. Olaniyi, T. A. Folorunso, J. G. Kolo, and J. . Bala, "Towards The Development of a Mobile Intelligent Poultry Feed Dispensing System Using Particle Swarm Optimized PID Control Technique," *African J. Comput. ICT*, vol. 8, no. 3, pp. 93–106, 2015.

[4] A. Odunsi, *A Practical Approach to Animal Production and Health*. Oluseyi Press Ibadan, 2009.

[5] J. K. Kanthi, "GSM based remote Monitoring," *Digital Library university of Moratuwa Sri Lanka*, 2011. [Online]. Available: http://dl.lib.mrt.ac.lk/handle/123/1387. [Accessed: 18-Oct-2018].

[6] T. Adeyinka, N. Adetoro, and P. A. Adekunle, "A Case Study of the Global System of Mobile Communication (GSM) in Nigeria," *Eur. J. Informatics Prof.*, vol. 5, no. 3, pp. 54–59, 2012.

[7] M. W. Olatokun and I. O. Bodunwa, "GSM usage at the University of Ibadan," *Electron. Libr.*, vol. 24, no. 4, pp. 530–547, 2006.

[8] L. P. . Robert, "Timed Automatic Pet Feed and Water Dispenser," 665, 1987.

[9] B. Omosebi, "Development of a self-propelled poultry feed dispenser with Feed level detector," Ladoke Akintola University of Technology, Nigeria, 2006.

[10] O. T. Arulogun, O. M. Olaniyi, A. O. Oke, and D. O. Fenwa, "Development of Mobile Intelligent Poultry Feed Dispensing System," *Medwell J. Eng. Appl. Sci.*, vol. 5, no. 3, pp. 229–233, 2010.

[11] V. I. Umogbai, "Development of a Mechanical Family Poultry Feeder," *J. Emerg. Trends Eng. Appl. Sci.*, vol. 4, no. 6, pp. 837–846, 2013.

[12] O. M. Olaniyi, O. F. Salami, O. O. Adewumi, and O. S. Ajibola, "Design of an Intelligent Poultry Feed and Water Dispensing System Using Fuzzy Logic Control Technique," *Control Theory Informatics*, vol. 4, no. 9, pp. 61–72, 2014.

[13] A. Adejumo, "Design and Development of a Mobile Intelligent Poultry Liquid Feed Dispensing System using GA Tuned PID Control Technique," Federal University of Technology, Minna, Nigeria, 2015.

[14] O. M. Olaniyi, T. A. Folorunso, K. J.G., and J. A. Bala, "A Mobile Intelligent Poultry Feed Dispensing System Using Particle Swarm Optimized PID Control Technique," in *Proceedings of ISTEAMS*

Multidisciplinary Cross Border Conference, University of Professional Studies, Accra, Ghana, 2016, pp. 185–194.