IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 9, Issue 6, June 2020

An Elementary Approach on Introducing Automation Assistance to a Conventional Poultry Farm

Ram Nivas Duraisamy[1], Nivisha Govindaraj[2], Janani Rajendran[3], Kavinaya Balakrishnan[4]

Assistant Professor, Department of ECE, P. A. College of Engineering and Technology, India[1]

UG Scholar, Department of ECE, P. A. College of Engineering and Technology, Coimbatore, India[2,3,4]

Abstract: Poultry is a supplementary service to agriculture. It helps the farmer in balancing their financial status during the time of non harvest. The proposed poultry management system aims in monitoring and controlling the environmental conditions like temperature & Moisture and parametric considerations like food & water quantity assessment in the poultry farm. They are the most important constraints responsible for the improvement in productivity output. Feed proportion maintenance, environmental parameter maintenance and providing healthy, risk free & low cost Equipments are the key aspects considered in design and development of our poultry management system. The inputs are sensors like HX711 Load cell amplifier module, LM35, FC28 and HC-SR04 for measuring weight, temperature, moisture and water level respectively. The processing is done with the help of Arduino Uno board. The output is displayed with the help of 16x2 LCD Display and the user is intimated with LED and Buzzers. This provides smart assistance for farmers to get alerted. Comparing to the conventional poultry farm, the proposed system has a better monitoring, profit, production and also reduces human intervention. It is cost effective and less complex system. The evaluation of efficiency and deviation in performance of sensors are studied and tabulated.

Keywords: Arduino Uno Board, Efficiency, Deviation, Poultry Management System (PMS), Sensors and Smart Systems.

I. INTRODUCTION

This document is a template. An electronic copy can be downloaded from the conference website. For questions on paper guidelines, please contact the conference publications committee as indicated on the conference website. Information about final paper submission is available from the conference website. Poultry has domesticated birds which are grown for their eggs and meat by the farmers. In south India we could see cattle in every fields and farms. They assist the farmers in farming activities and they also provide supplementary food assistance. Sometimes the harvest may not be sufficient enough to satisfy the personal or financial needs. A poultry farm is one way a farmer could bridge this gap. There are different species like chicken, Duck, turkey and goose for which poultry can be installed. For our convenience we chose chicken poultry farm as our field of interest.

Chicken meat is the main source of protein. It is prescribed to be consumed for better muscle growth and to improve the personal immunity. The consumption and its benefits are determined from farms, food, water and environment from which the birds are raised. The birds may encounter physical chemical or biological hazards. The micro organisms in the environment of farm have significant impact on the growth of birds [14]. So these measurements in environmental parameters would contribute to the at most level in better yield.

The poultry industry is the fully integrated system of animal agriculture. Each and every farmer has control over bird husbandry and health management aspects. These aspects include usage of microbial agents and production aspects. There are three segments like broiler chickens, turkey and layer chickens. In addition to food and water, antibiotics like bacitracin, chlortetracycline and erthomycin are responsible not only to avoid disease but also prevent the introduction of potential human food borne pathogens. As a result of this healthy birds are brought for processing [13].

The poultry water sanitation has greater impact on performance and welfare outcomes. Challenges prevail in study of environmental conditions. This has major impact in weight gain and welfare of birds [3].

As an initial step we visited Mr. M. Chandrasekaran, Farmer, Krishnapuram, a village near udumalpet, Tamil Nadu. He concentrates on Coconuts, Cattle and a poultry farm. As a result of this we could address the advantages, disadvantages, factors influencing and affecting, significance, implementation considerations and constrains in a conventional poultry and so on. Fig. 1. shows his poultry farm. The species chicken is polymorph of chick, cock and hen. Its incubation period is around 21 days. It has 39 chromosome pairs and its age at sexual maturity is from 18 to 20 weeks. A broiler is a chicken breed which is raised specifically for meat. They reach slaughter weight between four and seven weeks of age [16]. Any Poultry comprises of feeders and drinkers for providing food and water facilities to cattle and chickens. This system

IJARCCE
ISSN (Online) 2278-1021
ISSN (Print) 2319-5940
International Journal of Advanced Research in Computer and Communication Engineering
Vol. 9, Issue 6, June 2020

requires coir as basement flooring material. Its duration is about 45 days per batch, which should be moisture free and dry throughout the prescribed period.

Fig. 1 Poultry Farm of Broilers

The broiler weights an average of 1.5 to 2 Kilograms with a flexible breast bone cartilage and tender meat. While considering housing it is mandatory to be in east west direction to prevent from direct sunshine over the birds. They should also protect the birds from adverse climatic conditions, easy access, economic operations, ensuring scientific feeding and providing disease control [16].

Selection of location is also an important aspect in installation of poultry farm. It should be away from industrial and residential area ensuring proper transport, water, electricity and ventilation facilities. Each broiler requires one square feet of floor space. The size of the farm depends on the number of birds[16]. The flooring should be made of concrete free from dampness. For providing better basement for chicken it is essential to lay a coir basement for collecting its excretion waste. It absorbs and manages the flooring to be moisture free as shown in fig. 2. At the end of the batch this is helpful that it can be used as manure.

Fig. 2 Housing and Spacing

The better quality, adequate quantity of food and water are required for improving the performance efficiencies like liveability, feed efficiency or conversion ratio and farm economy index. In addition to this care should be taken to ensure

IJARCCE
ISSN (Online) 2278-1021
ISSN (Print) 2319-5940
International Journal of Advanced Research in Computer and Communication Engineering
Vol. 9, Issue 6, June 2020

this. The feed is made of corn, dry dish and other supplements this is a primary means of growth. Care should be taken to ensure that it is free from contamination. The contaminated food may lead to increased mortality rate. The feeders used for this purpose are in the form jars. On the other hand water is also an important consideration. This should be clean as a healthy broiler will consume 1.5 to 2 times as much water on a weigh basis of feed.

The main aim of our work is to provide an additional assistance for improving the productivity. A prototype is developed for maintaining a contamination free feed. This also reduces the wastage there by ensuring the correct water level and moisture free environment for chicks.

The prototype is made of Arduino UNO board, HX711 Load Cell amplifier module, LM35, FC28 and HC-SR04 sensors for monitoring weight of feed, water level, temperature and moisture level in the basement. With the help of these easily available components a low cost, less complex poultry management system is designed, implemented and tested.

II. LITERATURE SURVEY

The primary objective of any poultry management system is to actuate, control the sensors and to monitor the required environmental parameters. In addition to this it should reduce the farmer's precious time and should improve the efficiency. Following are the few literatures reviewed for designing an efficient poultry management system.

Adenilson Mumbelli et al (2020) designed a low cost Internet of things based system for monitoring and remote controlling aviaries. This system aims in improving precision of the fetched data such as temperature, level of feed and lighting conditions. As an advantage to this, it can be made scalable. The system can be monitored and controlled from remote locations. Scalability and adaptability are the targets set to be met [1].

Adrian Batuto et al (2020) worked on e-Poultry for small farms. An android application was developed which prompts the server to deliver food and water for chicken. This also monitors the level of water in addition. The entire system is powered by the solar panel. The entire work is the up gradation of any traditional poultry system [2].

Ron Daniel M. Nicolas et al (2019) developed a IoT monitoring assistant. The system displayed various environmental parameters considered under study thereby ensuring optimum environmental conditions and better management plan [4].

Md. Mahfujul Islam et al (2019) incorporated GSM and IoT in poultry farm. He made this smart by replacing the ancient, outdated and time consuming procedures in to state of art procedures. He introduced fire protection authentication and over all surveillance. Each and every instance of tracked data is sent as notification to user[6].

Archana M.P et al (2019) implemented an IoT based system for monitoring and controlling a poultry farm. The system monitors parameters like temperature light intensity and ammonia gas. The monitored data is sent to the user via GSM to his mobile phones. The setup also monitors the food and water level. The setup comprises of RS100 LE Microcontroller, sensors, GSM and WSN [9].

B. Sharma et al (2018) addressed a survey in monitoring the health of cattle for increasing their products in worldwide supply. He justifies the lack of interest among farmers in dealing with unpredictable killing disease, health issue and breading costs. As a part of his work he implemented a wireless sensor network based intelligent health monitoring system in farm automation. This system monitors and records the health parameters so that any farmers can retrieve it and pre plan their precautionary strategies. The system improves the productivity and reduces the human intervention [8].

Luis Camacho et al (2017) deployed Multimedia Wireless Sensor network for monitoring the activities of animals. The set up comprises of arduino based controller, radio, camera flash, pir sensor and memory unit. The PIR response time and energy consumption are laboratory tested and tabulated. They discussed the usage of batteries and their frequent replacements. The design was modified with solar based power assistance instead of batteries [10]

J. Lu et all (2017) implemented an ultra small and low power wireless sensor nodes for animal husbandry and medical applications. This strongly reported the low power consumption, high accuracy design. The testing was done in white mouse and cow [11].

H. Zhang et al (2012) monitors the environmental parameters in a pig farm based on wireless sensor networks. He implemented the design based on ZigBee and Embedded platform and Technology LAN communication. He monitored the parameters like temperature and humidity and published them online. The device prompted if there is any exceed in the threshold value. He extended this in crop cultivation and livestock production [12].

In addition to this there are several other works which monitors the concentration of oxygen, carbon dioxide and ammonia [3]. L. Jacobs et al (2019) in his article on impact of water sanitation on broiler chicken production and welfare addressed the impact of water sanitation in changing environment of birds [9]. The temperature and humidity affect the health of birds. A real time application of smart birds cage provides smart assistance in health monitoring. This could be implemented in large scale[5].

S. W. R. Cox reviews the contribution of electronic instrumentation and control systems to United Kingdom's agriculture and horticulture. He deals with quality assessment and environmental control in poultry sheep and pig farms. He also extended the implementation of electronics in planting, spraying fertilizer, harvesting, crop drying and storage[15].

From all the works it is evident that all the works claims to improve the performance and efficiency of the poultry management system when compared with the conventional or traditional poultry farms. But when considering the design they are a bit complex and they are costlier in a prototype level as they use processors. They may serve good at their

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 9, Issue 6, June 2020

proposed conditions. But for measuring simple parameters few considerations must be taken in to account. It is more sufficient if a farmer is benefited with fewer devices as his needs are limited to small boundaries.
From all the observations and considerations we are ready to implement a simple, smart poultry management system for monitoring and alerting the temperature changes, basement conditions, food and water levels.

III. POULTRY MANAGEMENT SYSTEM

The Poultry Management System [PMS] is a typical embedded system which comprises of controller, Input and output devices which contributes to a dedicated function. The dedicated functions can be divided in to two. One is monitoring the level of feed and water. Other is monitoring the environmental conditions like temperature and moisture.
The conventional system as studied earlier has only feeders and drinkers connected to tank. The quantity of the food is not monitored. And the environmental conditions are also not taken in to account. As our farmers are comfortable with this conventional method this could give them good yield. Let us enrich this by modifying the setup as smart feeders and drinkers. These feeders prompt the farmer with food level and water level indication. The temperature of the environment is also monitored and the basement made of coir is also monitored for ensuring moisture free flooring conditions.

The system has Arduino Uno Board, HX711 Load Cell amplifier module, LM35, FC28, HC-SR04 sensors Light emitting diode, Liquid crystal Displays and Buzzers. The sensors used in the experimental setups are Arduino Uno compatible. The HX711 Load Cell amplifier module, LM35, FC28, HC-SR04 constitutes the input unit of the PMS. The procession or decision mapping is done in arduino uno controller. The LCD, LED and Buzzers are used to intimate the users regarding the outputs. The description of each and every component is as follows.

A. Hardware Description
1. Arduino UNO Board : The arduino uno is the heart of the project which has ATmega328 microcontroller. It has 14 digital input or output pins and six analog input pins. In addition to this it has reset button, 16 MHz crystal oscillator and USB terminal. The controller can be easily programmed by simply connecting it to computer with Arduino UNO software. As the controller is programmed it can be powered independently by AC to DC adapter or battery. The operating voltage is 5 V. DC current for I/O pin is 40 mA. Flash memory is 32 KB of which 0.5KB used by bootloader. SRAM is 2 KB and EEPROM is 1 KB.

2. Sensors: Sensors are used in day to day applications like touch sensitive elevator buttons and lamps. Since the micro machinery are getting advanced and ease to use the applications are expanded beyond traditional fields of parameter measurement. There are sensors for measuring chemical and physical properties of environment and material. Following are the sensors which are used in our prototype for measuring temperature, humidity, weight and quantity. The brief study of different sensors in building poultry management system is shown below.

3. Ultrasonic Sensors: The device transmits a short burst of ultrasonic waves in the air. The waves encounter the object and returns back to the sensor. The reflected waves are detected by the sensor unit. This gives the distance between the obstacle and sender.. The device is mounted in drinker and the rise and fall of water is monitored. By setting an threshold indicator an empty drinker is detected.

3. Temperature Sensor: LM35 is the sensor used for detection of temperature. It is an integrated temperature sensor whose output voltage is linearly proportional to the temperature. The advantage of this over other thermistor is that it does not require external calibration. It has the operating range of -55º to +150ºC. It draws only 60µA current from supply. Voltage is 5 V.

4. Load Cell for Weight Measurement: Load cell and HX711 amplifier module are used to measure weight. The load cell is a transducer which converts force or pressure into electrical signal. The magnitude of the electrical output is directly proportional to the applied force. The load cell is of wheat stone bridge configuration. This has 24 high precision analog to digital converters. This hx711 converts low electric output signals in to amplified and digital signals.

5. Moisture sensor: FC-28 is the moisture sensor which measures the volumetric content of the water in our poultry basement and returns the moisture output. This is used along with LM 293 Comparator. It has Vcc, A0- analog output, D0- Digital output and Ground. The potentiometer is used to set the threshold for detection. The input voltage and current are 5V and 35mA. The LED in the sensor lights up when the sensor value is more than the threshold value. This indicates the presence of moisture. The light goes down when the light goes below the threshold value.

6. Output Unit: The Output unit of out PMS has 6 x 2 LCD Displays, buzzer and led indication. They display environmental temperature, basement condition and food/ water quantity assessments. Any discrepancy is prompted to user by buzzer and light emitting diode.

IJARCCE
ISSN (Online) 2278-1021
ISSN (Print) 2319-5940
International Journal of Advanced Research in Computer and Communication Engineering
Vol. 9, Issue 6, June 2020

B. Block Diagram of PMS

Figure 3 represents the block diagram of our simple poultry management system. Each and every sensor is powered by 5v supply from the Arduino board which is referred to be the heart of our project.

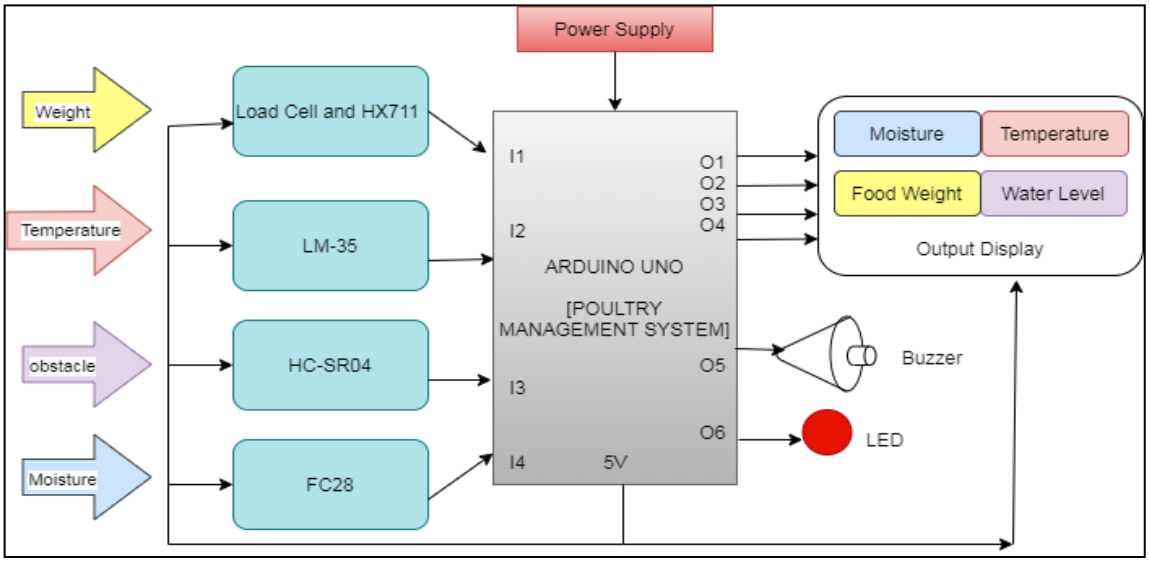

Fig. 3. Block Diagram of PMS

IV. RESULT AND DISCUSSIONS

The implementation is made with the help of the above mentioned procedures and components. The implementation is done in software level and hardware level. The software level implementation ensures the proper working behavior of the prototype and it is done with the help of Proteus V 7.8 tool. Fig. 4, 5, 6 shows the software implementation of feed weight measurement, water level, moisture level of the coir basement and room temperature.

The inputs are virtually adjusted by user defined values. The LM35 output Voltage pin is connected to A1 terminal of the Arduino UNO Board. The push button switch which is connected to the 8 th terminal feeds the basement condition. the output. the output of the temperature and basement status is displayed in the 16 x2 LCD display. LED is connected to 13 th pin. The user defined values in LM 35 are exactly produced in display. Any key press in push button switch indicates the poor basement indication as shown in fig. 4.

The Fig. 5 represents the distance measurement for water level indication. The ultrasonic sensor has trigger and echo pins. It is powered by 5v supply from arduino board. The trigger and echo pins are connected to 13th and 11th pin respectively. For simulation purpose the distance value is given manually. The output is displayed in 16 x 2 LCD display.

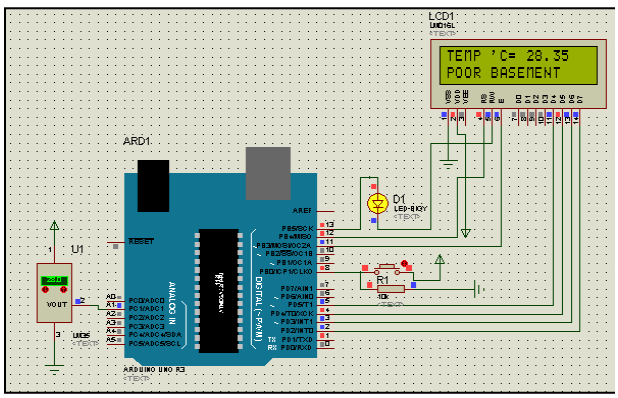

Fig. 4. Temperature and Basement Condition Evaluation

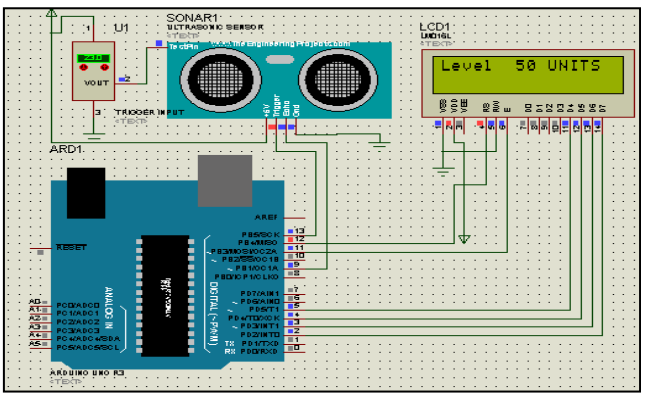

Fig. 5. Distance Measurement using Ultrasonic sensor.

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 9, Issue 6, June 2020

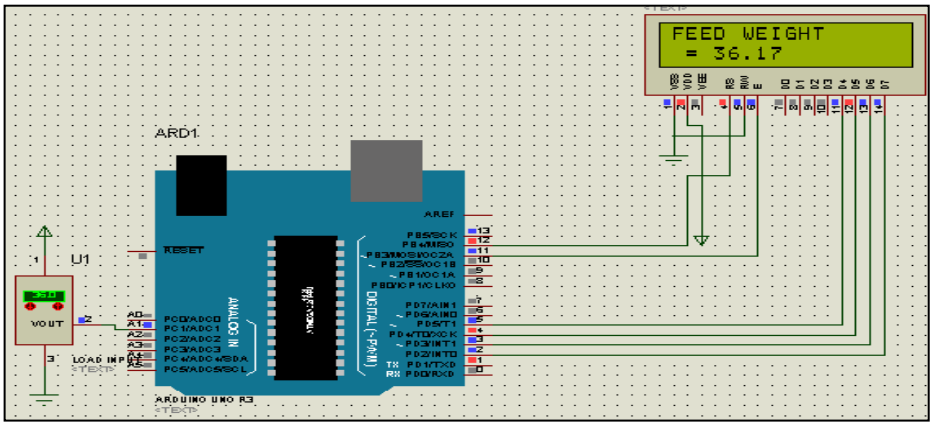

Fig. 6. Weight measurement

Similarly, the Figure 6 shows the feed weight measurement. The user defined weight values are displayed. From the simulation results it is evident that the results are one hundred percent accurate as they solve the desired requirement without any delay. And we can conclude that all the above mentioned methods are risk free easily implementable and accurate.

The hardware implementation can be two modules they are feeder module which measure the feed mass and the drinker module from where the water level is indicated.

The temperature sensor is exposed to the working environment. The ultrasonic sensor is mounted above the drinker bowl and the coir basement is placed in the wide bowl nearby. The moisture sensor is immersed in it. The working is similar as per the pseudo code discussed in the previous section.

The Fig. 7 shows the module which analyses the water level, basement condition and temperature indication. All the initial adjustments are made. All the peripherals are provided with supply voltage. The temperature of the working environment is fetched by LM 35.

The temperature of the working environment is displayed. It shows the linear increment or decrement according to the change. The moisture sensor FC 28 is immersed in the coir basement. When it is exposed to water the display intimates the poor basement and the buzzer LED enables. This is shown in Fig 8 and 9

The HC-SR04 monitors the incoming water and checks for the water level frequently. The level is displayed. Any discrepancy in the results are prompted to the farmer as shown in figure 8.

Module 2 is purely the modified feeder structure. The bowl is mounted on one end of the load cell and the other end is static. The farmer is prompted to drop the prescribed amount of feed. As shown in the fig. 10. When the farmer fills the feeder the corresponding feed quantity is displayed as shown in fig 11.

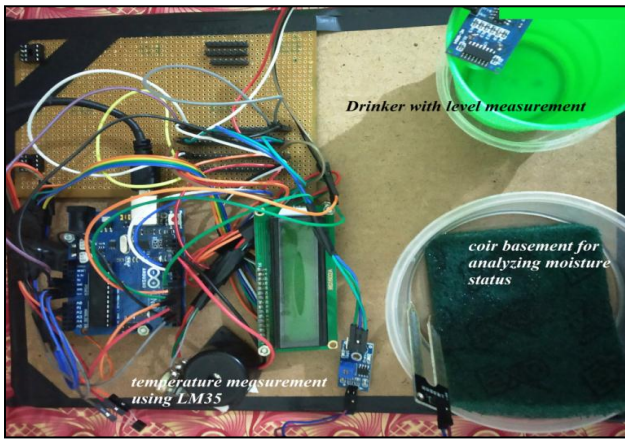

Fig. 7. Module 1 (Temperature, moisture and water level indication)

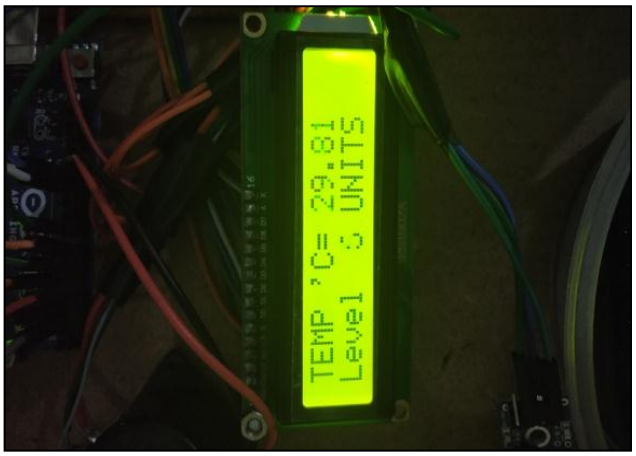

Fig. 8. Temperature and Water level Indication

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 9, Issue 6, June 2020

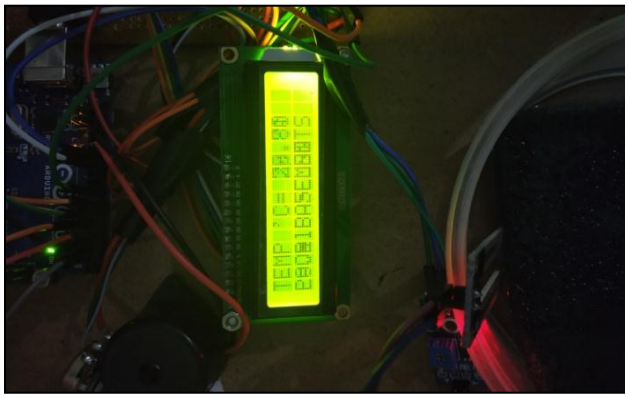

Fig. 9. Indication of Poor Basement Condition

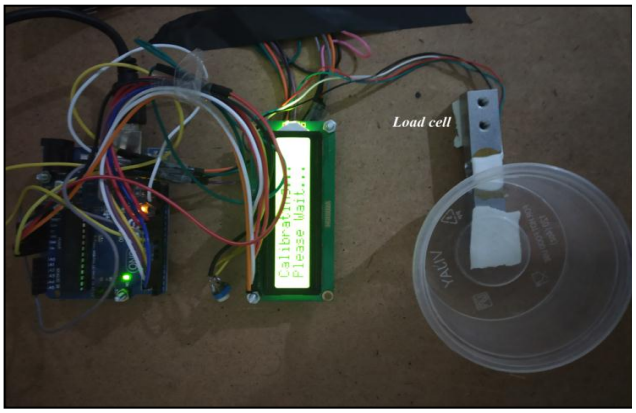

Fig. 10. Module 2 (Feeder with load cell)

Fig. 11. Measured feed weight

The Table 1 compares the actual output values of the sensors with that of obtained values. Lesser the deviation more is the efficiency. The proposed PMS attains 98 percentage of the systems efficiency. The same test is carried out for another 10 different trails and they show the same average of accuracy. This is shown in Table 2.

Table 1 Comparison of Actual and Obtained Values

Sensors	**Actual Value**	**Obtained Value**	**Deviation**	**Efficiency**
LM35	30 0C	28.9 0C	0.19 0C	96.3
FC28	Exposed to Water	Detected	0%	100
HC-SR04	2-5 Cm	2- 5 Cm	0 Cm	100
HX711	100 Grams	99 Grams	1 gram	99
Overall Efficiency				98.83%

The deviation is the difference between the actual value and obtained value. This may be a positive constant. The efficiency is the ratio of obtained value to the actual value.

The overall efficiency is the average of all the other sensor efficiencies. The sample calculation for calculating Efficiency and deviation is as shown below.

Sample Calculation:
Efficiency = Obtained Value / Actual Value x 100
Efficiency = 28.9/30 x 100 = 96.3%
Overall Efficiency = sum of all efficiency / 4
Overall Efficiency = 96.3 + 100 + 100 + 99 = 98.23%
Overall Output efficiency = sum of overall efficiency of individual sensors/4
Overall Output efficiency = 96.83+100+99.4+98.6 = 98.7%
Over all Deviation = sum of all deviations / 4
Over all Deviation = 3.17+0+0.6+1.4/4 = 1.3

IJARCCE
ISSN (Online) 2278-1021
ISSN (Print) 2319-5940
International Journal of Advanced Research in Computer and Communication Engineering
Vol. 9, Issue 6, June 2020

Table 2 Comparison of Overall Deviation and Overall Efficiency

Trail No.	LM35	FC28	HC-SR04	HX711	%
1	96.3	100	100	99	98.83
2	99	100	100	98	99.25
3	98	100	99	98	98.75
4	96	100	100	99	98.75
5	96	100	99	99	98.5
6	98	100	99	99	99
7	97	100	100	98	98.75
8	96	100	98	99	98.25
9	96	100	100	98	98.5
10	96	100	99	99	98.5
Overall Output Efficiencies (%)					
	LM35	**FC28**	**HC-SR04**	**HX711**	**%**
	96.83	100	99.4	98.6	98.7
Overall Deviation					
	LM35	**FC28**	**HC-SR04**	**HX711**	**Average**
	3.17	0	0.6	1.4	1.3

From the efficiency analysis it is evident that the overall efficiency of the device is more than 95 percentage. It is observed that the decline of efficiency is contributed from the LM35. This shows the minimum deviation in all the trails. The deviation may be due to the environmental factors prevailing in the work place. FC 28 detects the water as soon as it is exposed to it. It has negligible delay. HC –SR 04 also serves its part well in the measurement. The deviations are very less when compared to LM 35.

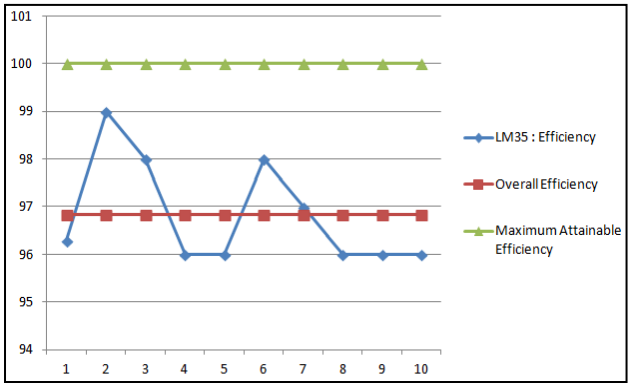

Fig. 12 Efficiency of LM35

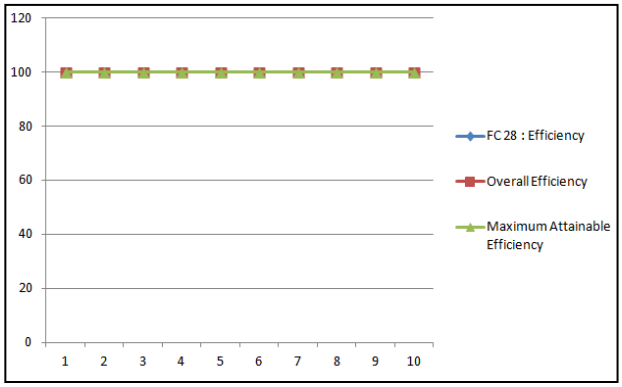

Fig. 13 Efficiency of FC28

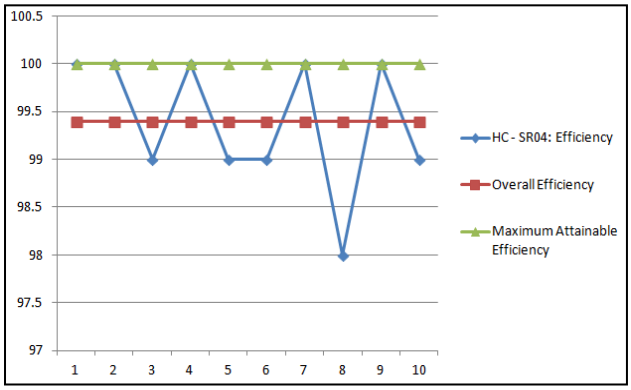

Fig. 14 Efficiency of HC SR 04 %

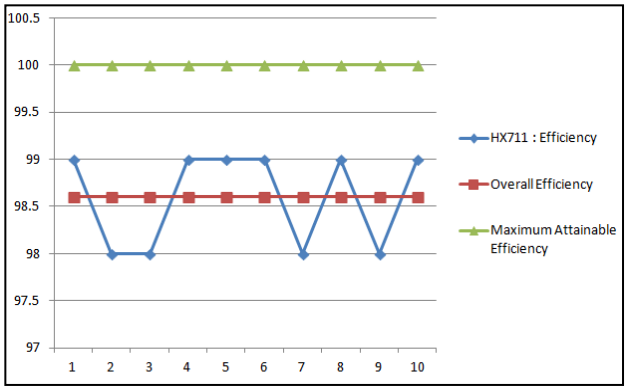

Fig. 15 Efficiency of HX711%

This deviation is also due to the poor mounting. This could be avoided. HX711 is sensitive to weight. It suffers from deviation in few instances. But this can be calibrated. When considering the rank of efficiency FC 28 stands first followed by HC-SR04, HX711 and LM35. Overall deviation is 1.3 units which has only negligible impact. The spacing between

the overall efficiency and the maximum attainable frequency is the deviation gap. The FC 28 Show overlap and there is no deviation. Each and every sensor serves their purpose well in an efficient way. From the table 2 it is evident that the sensors satisfy more than 96 percentage of their desired task. Overall efficiency of the system is 98.7 percentage.

Fig. 12 - 15 represents the efficiencies attained by individual sensors and their deviation gaps.

V. CONCLUSION AND FUTURE WORK

Monitoring of environmental parameters in the Poultry management is addressed and implemented using Arduino. The proposed system ensures the user-friendly environment that promotes the better growth of the chicken. This introduces automation in basic level to conventional poultry farming there by facilitating the Monitoring and control. It is clear that the system is very simple, less complex and can be implemented with readily available components.

From the experimental results it is evident that the proposed system is 98% efficient. The system works with good accuracy for the desired application. The future enhancement are planned to introduce Processors and communication interface for providing smarter assistance. Improvement in accuracy and smartness are the major constrains and scope for future advancements.

REFERENCES

[1]. Adenilson Mumbelli, Robison Cris Brito, Vinicius Pegorini and Luis Felipe Priester, " Low Cost Iot- Based system for Monitoring and Remote Controlling Aviaries", IEEE, 3rd International Conference on Information and Computer Technologies. May 2020, pp 531-535, 2020.
[2]. Adrian Batuto, Timothy Bryan Dejeron, PaoloDela Cruz and Mary Jane C. Samonte, "e- Poultry: An IoT Poultry Management System for Small Farms", IEEE 7th International Conference on Industrial Engineering and Applications, pp 738 – 742, May 2020.
[3]. L. Jacobs,1 M. E. Persia, N. Siman-Tov, J. McCoy, M. Ahmad, J. Lyman, and L. Good, "Impact of water sanitation on broiler chicken production and welfare parameters" JAPR: Research Report, Elsevier Inc. on behalf of Poultry Science Association Inc. 2019, pp 258-268.
[4]. Ron Daniel M. Nicolas, Wei S. Zhou, Shota C. Kitamura and Mary Jane C. Samonte," An IoT Monitoring Assistant for Chicken Layer Farms" IEEE International Conference Information and Communication Technology Convergence, PP 71-75, December 2019.
[5]. Subono, Alfin Hidayat, Vivien Arief Wardhany, Abdullah Fahmi "Smart Cage Bird Lovebird Based on Arduino Using Internet of Thing" IEEE Conference in Proceedings 2nd International Conference of Computer & Informatics Engineering (IC2IE), September 2019, pp 126– 130
[6]. Md. Mahfujul Islam, Shahara Souov Tonmoy, Sazzad Quayum, Al Russel Sarker, Sumaiya Umme Hani and Mohammad Abdul Mannan," Smart Poultry Farm Incorporating GSM & IoT, IEEE International Conf on Robotics, Electrical and Signal Processing Techniques (ICREST), Jan 2019.
[7]. Mohammed Hanif Lashari: Ali Asghar Memon: Syed Asif Ali Shah: Ferwa Shafqat,"IoT based Poultry Environment Monitor System", IEEE , International Conference intelligent system, January 2019.
[8]. B. Sharma and D. Koundal, "Cattle health monitoring system using Wireless sensor network: A survey from innovation Prospective", IET Wireless Sensor System, 2018, Vol 8, pp 143-151
[9]. Archna M P, Uma S K,Raghavendra Babu T M, " Monitoring and Controlling Of Poultry Farm Using IOT ", International Journal of Innovation Research in computer and communication Engineering.Vol.6, Issue 4,April 2018.
[10]. Luis Camacho , Reynaldo Baquerizo, Joel Palomino, and Michel Zarzosa, "Deployment of a Set of Camera Trap Networks for Wildlife Inventory in Western Amazon Rainforest", IEEE SENSORS JOURNAL, VOL. 17, NO. 23, DECEMBER 1, 2017.
[11]. J.Lu, L. Zhang, S. Matsumoto, H. Hiroshima, R. Maeda, T. Gotoh, M. Sato, A. Toyoda and N. Ohkohchi, "Development of wireless sensor nodes for animals husbandry and medical applications" IEEE Sensors, Oct 2017 pp1-3.
[12]. H. Zhang, J. Li, Z. Yuan, H. Shen, Q. Cao, Y. Gao and X. Zhang, "Design of pig farm environmental parameters monitoring system based on wireless sensor networks", IEEE Conference inproceedings, 3rd International Conference on System Science, Engineering Design and Manufacturing Informatization, Vol 1, Oct 2012, pp 332-335.
[13]. Charles L. Hofacre, "The health and management of poultry production", International Journal of Infectious Diseases I Vol 6, Supplement 3, 2002, pp 353 -357
[14]. A.S.Ahl & B.Buntain, Risk & the food safety chain: animal health, public health & the environment", Rev. sci.tech. Off. int. Epi., 16(1), pp.322-330.
[15]. S.W. R, Cox, "Electronics in UK agriculture and Horticulture", A Physical Science, Measurement and instrumentation, Management and education and horticulture, Vol 134, No. 6, June 1987, pp 466-492.
[16]. https://www.agritech.tnau.ac.in/expert_system/poultry/index.html