e-TUBONG: AN AUTOMATED POULTRY FEEDING MACHINE CONTROLLED WITH ANDROID APPLICATION

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ABSTRACT: *This study focused on developing an automated poultry feeding system, called "e-Tubong". Following the Agile methodology, the research focused on collaborative planning, analysis, design, implementation, testing, and evaluation. The study aimed to integrate a hardware device and application for efficient poultry feeding schedules. System performance was assessed using ISO 9126 quality metrics. Results reveal that the integrated system adhered to quality parameters specifically on functionality, reliability, usability, efficiency, maintainability, and portability, with mean scores of 4.1, 4.3, 4.5, 4.5, 4.5 and 4.4, respectively. The study showcases the successful integration of technologies, allowing poultry owners to easily manage feeding schedules through an android application. The device automatically feeds the poultry at scheduled times, with the application sending the feeding schedule to the machine via SMS and providing feedback to the user. The research can be applied in commercial and small-scale poultry operations, research settings, educational programs, and broader smart agriculture initiatives to enhance efficiency, automate feeding schedules, and contribute to sustainable and technologically advanced poultry farming practices.*

Keywords: microcontroller, poultry, smart farming, industry 4.0, ISO 9126

1. INTRODUCTION

Poultry raising has been one of the top sources of food for the past few years, and it is noticeable how the growth of production of poultry products increased. The growth in chicken demand has been faster than other meats due to its affordability, lower fat content, and the absence of cultural and religious hindrances. In addition, chicken is the preferred meat in fast food outlets, which is a sector experiencing fast expansion throughout the country. As the country strives for more supply of chicken, the production of poultry products needs also to rise to meet its demand. To meet this demand, one candidate mechanism to increase production is to integrate automation in poultry management. Numerous methods exist for creating an intelligent management platform with monitoring, analysis, and reporting functionalities. Ultimately, the key consideration is the level of sophistication required to meet the specific requirements of a farm [1]. The Industry 4.0 revolution seeks to automate manufacturing and production processes, replacing manual labour with digital and automated operations [2]. This involves incorporating principles like decentralized decision-making and information transparency. The implementation of Industry 4.0 involves multiple layers of digitalization, starting with the measurement of environmental variables using simple devices and progressing to the optimization of production algorithms based on various measures collected over an extended period. The advancements in diverse technologies and services including the Internet of Things, have recently facilitated the emergence of a new farming and poultry methodology known as "Smart farming" [3]. This approach is acknowledged as the evolution of precision agriculture (PA). Although it shares the core components of data collection, analysis, and implementation with PA, Smart farming introduces intelligent computer-aided assistance. It actively considers the local context and specific nuances, operates in real-time based on events, and proposes or executes suitable actions [4]. The use of smart sensors, big data, and the Internet of Things (IoT) in poultry management has been shown to enhance production and welfare [5]. Automation in poultry feeding is cost-efficient and labour-less as mentioned in the study of Chinaeke-Ogbuka [6], his research on feeding automation for poultry found that compared with other conventional methods, their system, Arduino microcontroller-based system, shows excellent performance with its advanced digital technology, and it is more effective as it saves both time and energy. Many countries invest more in Smart farming, Ananya [7] mentions that smart management systems in poultry farming can lead to automated production, reduced human efforts, and healthier poultry. The use of smart farming technologies, particularly those based on the Internet of Things (IoT), is increasingly being explored in developing countries to improve agricultural productivity and sustainability [8].

Meanwhile, in the context of the Philippines, the current literature lacks a comprehensive exploration of the integration of automated poultry feeding systems with Android applications. While technological advancements in agriculture are recognized, there may be a gap in understanding the specific needs and challenges faced by poultry owners in the Philippines in adopting such automated systems. This has prompted the researchers to develop "e-Tubong", an Automated Poultry Feeding Machine Controlled by Android Application. The word "tubong" is a waray-waray term which means "to feed".

2. OBJECTIVES OF THE STUDY

The primary objective of this research is to develop an integrated system called "e-Tubong: an Automated Poultry Feeding Machine Controlled with Android Application." Additionally, the study seeks to design an application that enables poultry owners to manage their feeding schedules seamlessly. The device will autonomously administer feed to poultry at designated intervals, while the accompanying application will transmit these schedules to the dispensing machine via SMS and provide feedback to the end user. Lastly, the research aims to assess the system's performance using quality metrics outlined by ISO 9126.

3. METHODS

3.1 System Development

The development of the system follows the Agile methodology [9][10] comprising several key phases. The adoption of agile methods in system development is seen as a powerful solution to address the rapidly changing business environment and increasing customer expectations [10]. In the initial planning phase, the researchers collaborate with the Income Generation Project Office (IGPO) of the host Institution and other stakeholders to gather input through surveys and consultations, identifying desired features for the application. The collected data is then evaluated, and the team scrutinizes concerns and outlines essential tasks. This phase lays the foundation for subsequent planning activities. The planning phase involves conceptualizing various system components, including both hardware and software aspects. The researchers explore existing studies to support application development, prepare a graphical user interface (GUI), and estimate costs. Additionally, the team delves into creating different concepts that will guide the overall project. As part of the requirement phase, the necessary tools for hardware and software are identified, encompassing materials for the feeder's creation and the selection of appropriate software development tools and microcontrollers. This phase serves as a crucial step in detailing the project's prerequisites. Moving on to analysis and design, mathematical instruments and data-gathering tools are determined, respondents for alpha and beta testing are targeted, and the feeder's mechanism is engineered. The GUI design and the software module mechanisms are also developed during this phase. The subsequent implementation and prototyping phase involves creating the feeder's dispensing mechanism, developing the controlling Android application, and building micro-components like feedback or messaging systems. The integration of these components is a critical step to ensure seamless communication between them. Testing follows the implementation, with a focus on assessing the integration between the dispensing machine and the controller. Real-time responsiveness and prompt feedback are evaluated, and client perspective testing is conducted. If the system fails any testing phase, iterations are performed until it successfully meets the required standards. Finally, the evaluation phase assesses the system's adherence to the predefined evaluation tools.

3.2 System Testing

The researcher used ISO 9126 [11] which is an international standard that specifies a model for the assessment of software quality. It outlines a framework that includes various quality characteristics such as functionality, reliability, usability, efficiency, maintainability, and portability, providing guidelines for evaluating and ensuring the quality of software products. The same questionnaire was utilized by Villaluz [12]. The questionnaire can be rated by checking the number scale from 5 to 1. 5 if the respondent strongly agrees with the criterion, 4 if the respondent agrees with the particular criterion, 3 if the respondent slightly agrees with the particular criterion, 2 if the respondent disagrees with the particular criterion and 1 if the respondent strongly disagrees with the particular criterion.

4. RESULTS

After the development and evaluation of the prototype, the following results were obtained:

4.1 Mobile Application

Figure 1 and 2 shows the dashboard of the system which contains the primary interface of the mobile application. The user may feed instantaneously or may schedule feeding and lastly check the main container. This interface is responsible for creating a schedule for the dispensing machine. The user must enter the amount of the feeds and the quantity of the chicken the system will display the total amount of feeds prompted by the user.

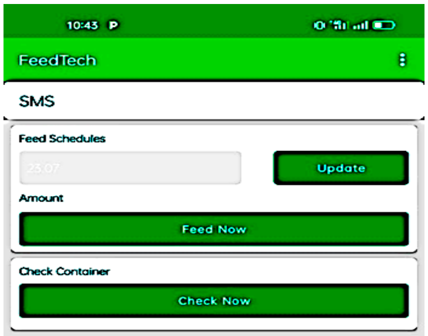

Figure 1. Main Interface

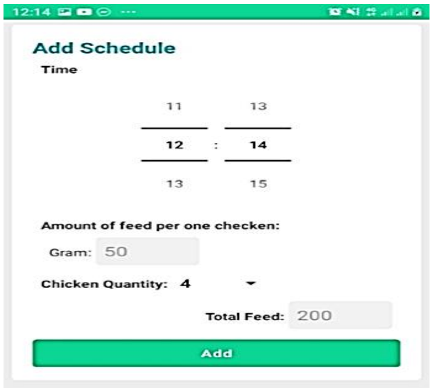

Figure 2. Schedule Adding Interface

Figure 3 and 4 illustrate all feeding schedules initiated by the end-user, displaying scheduled feeding times and corresponding quantities. This figure allows end-users to easily retry sending commands and add new schedules, contributing to the creation of instantaneous feeding. Figure 4 specifically guides the end-user to input the desired amount and quantity of chickens for effective scheduling.

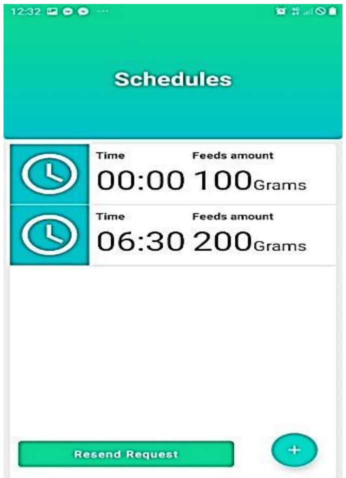

Figure 3. List of Schedules Interface

Figure 4. Feed Amount Interface

3.2 Hardware Component

Figure 5 shows the microcontroller and its components. The microcontroller is the "brain" of the hardware and the breadboard is responsible for the flow of the current and pin arrangement and connectivity.

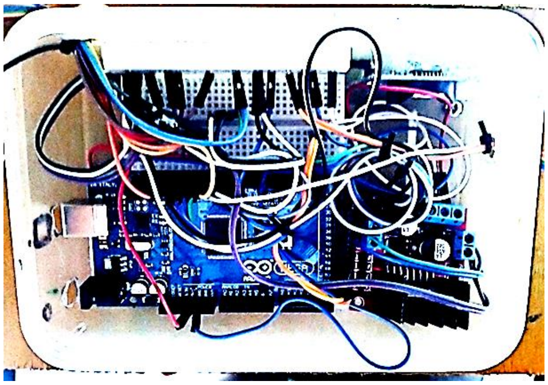

Figure 5. Device Microcontroller

Figure 6 shows the operational mechanics involving the DC motor within the system. Specifically, it elucidates the DC motor's integral role in propelling and manoeuvring the sub-container, which serves as the conduit for dispensing poultry feeds under specified quantities.

Figure 4. Sub-container Mechanism

Figure 7. Hardware overview

Figure 7 shows the overall view of the hardware component. Including the sub-container and the main container and the prototype feeding cage.

3.3 System Evaluation

During the alpha testing the embedded system underwent system testing to measure the different aspects as outlined in the ISO 9126.

Parameter	Mean	Interpretation
Functionality	4.1	Agree
Reliability	4.3	Highly Agree
Usability	4.5	Highly Agree
Efficiency	4.5	Highly Agree
Maintainability	4.5	Highly Agree
Portability	4.4	Highly Agree

The table above shows the result of the system evaluation using parameters as outlined in ISO 9126. In terms of functionality, the data reveals a mean of 4.1, interpreted as Agree. This is a unanimous agreement among respondents that the system can perform dispensing feeds, organise feeding schedules, send commands to hardware, and receive notifications from the dispensing machine. In terms of reliability, the analysis yielded a mean score of 4.3, signifying a high level of agreement on the system's reliability. In terms of usability, the data shows a mean score of 4.5 which is interpreted as Highly Agree. This suggests that users find the system intuitive and easy to navigate. In terms of efficiency, the majority of respondents, as indicated by a weighted mean of 4.5, highly agree that the system operates efficiently, emphasizing its ability to meet performance expectations. The maintainability aspect resulted in a weighted mean of 4.5 reflecting widespread agreement among respondents on the system's ease of maintenance. In terms of portability, a mean score of 4.4 was recorded, signifying a consensus among respondents that the system is highly portable. These findings collectively affirm the software application and dispensing machine as a reliable, user-friendly, efficient, maintainable, and portable solution, reflecting positively on its overall performance and user satisfaction and therefore adhering to international standards.

5. CONCLUSIONS

After multiple iterations in software development, the researcher successfully implemented an automated dispensing machine using an Arduino microcontroller, with control facilitated through an Android application capable of dispensing feeds via SMS. The application underwent alpha and beta testing, achieving significant milestones. The application software demonstrated proficiency in checking feed levels, instantly dispensing feeds, scheduling feeding routines, and sending commands to the dispensing machine. On the hardware front, the system effectively housed feeds, dispensed them under the arranged schedule, and received commands via SMS while notifying end-users. The overall evaluation of the embedded system, conducted using the ISO 9126 Usability evaluation for mobile applications, garnered unanimous agreement among respondents. The system exhibited functionality with a 4.1 approval rate, while reliability, usability, efficiency, and maintainability received high agreement scores of 4.3, 4.5, 4.5, and 4.5, respectively. This signifies that the system aligns with ISO 9126 standards, establishing its functionality, reliability, usability, efficiency, and maintainability, marking a successful integration of hardware and software components.

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