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RabNEAT: An Automation System for Grow-Out Cages of Oryctolagus Cuniculus using ATmega 328P

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Abstract

The automation system designed for grow-out cages of Oryctolagus Cuniculus, utilizing the ATmega328P microcontroller, has the potential to foster considerable growth in the rabbit livestock farming sector and considerably aid rabbit farmers in optimizing their time and resources resulting in enhanced efficiency in scaling up rabbit production. The system is designed to provide technological advancement and a convenient solution for rabbit farmers by providing automated monitoring, waste management, watering, and ventilation of the grow-out cages. The automation system comprises several components: an RTC module, DHT22 temperature sensor, HX711 load cell sensor, HC SR04, and I2C 16x02 LCD. The authors adopted a methodical approach involving meticulous planning, building, and refining the system to guarantee its efficacy. A rigorous seven-day testing was conducted to ensure the system's functionality and reliability. The outcomes indicate exceptional results. The overall functionality test also shows that the system possesses the necessary capabilities. At the same time, the overall reliability test ensured that the system met all the required standards. These findings demonstrate that the RabNEAT (Automation System for Grow-Out Cages of Oryctolagus Cuniculus using ATmega328P) can be considered a valuable resource for the technological advancements of the rabbit livestock farming sector and has outstanding potential for improving the efficiency of rabbit livestock farming operations.

Keywords: Automation, Microcontrollers, Rabbit, Rabbit Farming, Rabbit Cage.

Introduction

Oryctolagus cuniculus, commonly referred to as rabbits, were first hunted and later domesticated by monasteries in Western Europe and the Mediterranean Basin during the Middle Ages [1]. Controlled breeding in the 16th century resulted in the emergence of several breeds, establishing them as popular livestock species [2 ,3].

In recent years, the livestock farming industry has increasingly recognized the benefits of automation systems for improving production efficiency and streamlining farming tasks [4, 5]. However, certain sectors, particularly cuniculture, require assistance in developing an automation system exclusively designed for the grow-out cages of rabbits (Oryctolagus cuniculus) [6-9]. To develop an effective automation system for grow-out cages it is crucial to consider the welfare and behavior of rabbits [10]. Manual management of waste, ventilation, watering, and monitoring in rabbit farming is a laborious and time-consuming task. Such practices lead to inaccuracies, inconsistencies, and potential health hazards for farmers, ultimately hindering farm productivity [11-15].

Therefore, developing an automation system exclusively for Oryctolagus Cuniculus grow-out cages can streamline rabbit farming tasks, reduce labor and time requirements, and ultimately benefit rabbit farmers [16-17]. This advancement in integrating technology in rabbit farms can result in more efficient and productive livestock farming, demonstrating a significant step forward.

Methodology

This study employed a Prototyping Descriptive Technique with a development system cycle shown in Figure 1. The authors developed an automation system that is mainly controlled by a microcontroller using ATmega328P shown in Figure 2

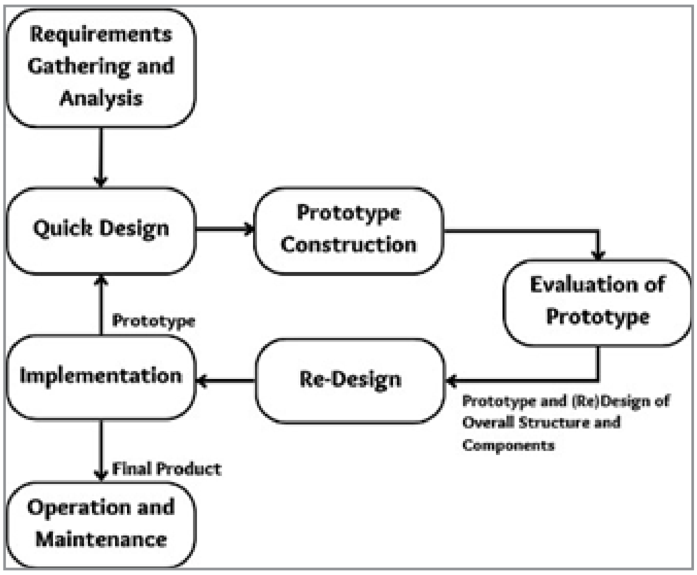

Figure 1: Development System Cycle

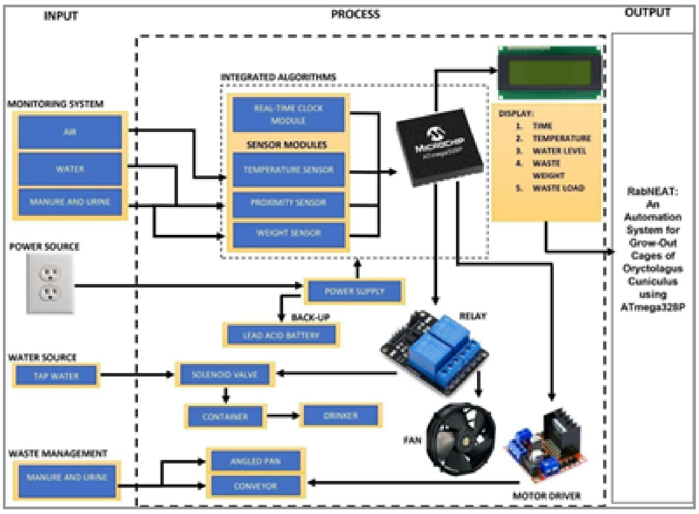

Figure 2: Conceptual Framework

Results and Discussions

The tables presented are the overall results of the testing process performed by the authors utilizing various ISO 25000 testing procedures to guarantee the system's functionality, reliability, and accuracy.

Functionality Test

Every sensor, module, and every other component of the automation system is tested for functionality to ensure that it works as intended and meets specifications. Functional test results help locate errors or problems with the automation system, which can then be corrected before the system is deployed or made available. This makes it easier to ensure that the system is working as expected and has the required capabilities. The test results of the functionality of the sensor and modules are summarized in Table 1. The tests cover a wide range of areas and are intended to ensure that the system meets the requirements.

Table 1: Summary of Completed Functionality Test

Test Type	Result
LCD 16x2 Testing	Passed
Straight Bar Load Cell Sensor & HX711 Amplifier Testing	Passed
DHT22 Sensor Testing	Passed
HC-SR04 Ultrasonic Sensor Testing	Passed
DS3231 RTC Module Testing	Passed
L298N Motor Driver Testing	Passed
Buzzer Testing Testing	Passed

Reliability Test

Reliability testing is conducted to evaluate an automation system's capability to function effectively and efficiently without errors or failures. The objective is to identify and fix potential problems or bugs that may affect the system's reliability or performance. Table 2 summarizes the reliability test results for each system, demonstrating that each test has passed. A range of tests is performed to meet reliability criteria, and the overall system is deemed reliable and trustworthy after each test.

Table 2: Summary of Completed Reliability Test

Test Type	Result
Ventilation Testing	Passed
Conveyor (Day Time) Testing	Passed
Conveyor (Night Time) Testing	Passed
Watering Testing	Passed
Urine Alarm Notification Testing	Passed
Manure Alarm Notification Testing	Passed

Accuracy Test

Accurate and reliable measurements from sensors are crucial for the automation system to function properly and generate useful data for decision-making. The goal of accuracy testing is to ensure sensors measure physical variables like temperature, water level, urine level, and manure weight precisely. Table 3 demonstrates that the reading for the measurement scale of the sensors for the four parameters of the monitoring system is 99.37% accurate and is interpreted verbally as Excellent. This indicates that the readings of the various parameters of the enclosures, including temperature, manure weight, urine level, and water level, are highly acceptable.

Table 3: Overall Accuracy Percentage Test Rating for Sensor Readings

Test Type	Accuracy Percentage
Reading of DHT22 Sensor (Temperature)	99.08%
Reading of Load Cell Sensor (Manure)	99.60%
Reading of Ultrasonic Sensor (Urine)	99.60%
Reading of Ultrasonic Sensor (Water)	99.21%
Overall Accuracy	99.37%
Verbal Interpretation	Excellent

Conclusions and Future Works

In this study, the RabNEAT automation system was developed to streamline various rabbit farming tasks that reduced labor and time requirements benefiting rabbit farmers. The system's sensors, actuators, and microcontrollers effectively automate the watering, ventilation, and waste management systems. The automated monitoring system accurately displayed the grow-out cage status. The overall testing utilizing ISO 25000 ensured that the system met all the required standards. These findings demonstrate that the RabNEAT (Automation System for Grow-Out Cages of Oryctolagus Cuniculus using ATmega328P) can be considered a valuable resource for the technological advancements of the rabbit livestock farming sector and has outstanding potential for improving the efficiency of rabbit livestock farming operations.

The limitation of this study is the system's inability to monitor air quality and feed consumption data due to resource constraints.

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