

Automatic Cattle Feeding Bot

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Abstract

Modern smart agriculture techniques have been much improved by the quick development of artificial intelligence, visual computing, and integrated automation technologies. This article describes the design and implementation of an artificial intelligence-driven automatic cattle feeding robot meant for effective cattle feeding operations. Through fast cattle identification and automated feed delivery systems, the proposed method tries to reduce human labor, improve feeding homogeneity, and enable self-operating farm management. A Raspberry Pi 5, the TensorFlow Lite AI framework, OpenCV for picture analysis, a USB webcam, an L298N motor driver, DC motors, and a servo motor-based feed dispensing unit make up this system. The USB webcam constantly records real-time video feed from the agricultural environment, and the captured photos are evaluated with OpenCV and TensorFlow Lite for cattle identification reasons. The robot stops and starts the servo system to distribute predetermined amounts of feed when cattle are precisely located with sufficient certainty. After the feed distribution, the robot returns to its autonomous navigation and maintains surveillance of its surroundings. Developed system efficiently demonstrated real-time cattle identification, self-guided robot navigation, accurate feed dispensing, and reduced human involvement throughout reviews. The suggested Automatic Cattle Feeding Bot is an affordable, intelligent, and portable answer for smart farming that fits right into the current livestock management and agricultural automation industries.

Index Terms - Artificial Intelligence (AI), Raspberry

Pi 5, TensorFlow Lite, OpenCV, Computer Vision, Smart Farming, Livestock Automation, Autonomous Robot, Cattle Detection, Feed Dispensing System, Embedded Systems, Agricultural Automation.

Introduction

Agriculture and livestock farming play a vital role in global food production and economic development. In dairy farms, proper feeding management is essential for maintaining cattle health, improving milk production, and increasing overall farm productivity. Traditional cattle feeding methods mainly depend on manual labor, where farmers are required to feed cattle regularly and continuously monitor feeding operations. These methods become difficult, labor-intensive, and time-consuming, particularly in farms with a large number of cattle. Irregular feeding schedules, improper feed distribution, and excessive feed wastage can negatively affect livestock health and farm efficiency. Therefore, there is an increasing demand for intelligent and automated systems capable of simplifying cattle feeding operations while reducing human effort.

Recent advancements in Artificial Intelligence (AI), computer vision, robotics, and embedded automation technologies have enabled the development of modern smart farming systems. Automated livestock management solutions using AI and image processing techniques are becoming increasingly popular in precision agriculture applications. Computer vision systems integrated with embedded platforms can identify cattle in real time using camera-based monitoring, thereby improving the accuracy and efficiency of feeding operations. Similarly, autonomous robotic systems can reduce farmer dependency on manual supervision and support continuous livestock monitoring inside farm environments.

The proposed Automatic Cattle Feeding Bot is developed as an intelligent and autonomous livestock feeding system capable of detecting cattle and dispensing feed automatically without continuous human intervention.

The system is implemented using Raspberry Pi 5, TensorFlow Lite AI model, OpenCV image processing, USB web camera, L298N motor driver, DC motors, and a servo motor-based feed dispensing mechanism. The USB web camera continuously captures real-time video frames from the surrounding environment, and the captured images are processed using OpenCV and TensorFlow Lite for cattle detection. When cattle are detected successfully with sufficient confidence, the robot automatically stops and activates the servo-controlled feed dispensing mechanism to release feed in controlled quantity. After feed dispensing is completed, the robot resumes autonomous movement and continues monitoring the environment.

The integration of Artificial Intelligence, computer vision, embedded systems, and robotic automation technologies enables the proposed system to perform intelligent livestock feeding operations efficiently and accurately. The developed system reduces manual labor, minimizes feed wastage, improves feeding consistency, and supports autonomous farm management. The Automatic Cattle Feeding Bot provides a cost-effective, portable, and intelligent smart farming solution suitable for modern livestock management and agricultural automation applications.

LITERATURE REVIEW

Recent advancements in Artificial Intelligence (AI), computer vision, robotics, and embedded systems have significantly influenced the development of smart farming and autonomous livestock management technologies. Researchers have increasingly focused on improving agricultural automation systems using intelligent monitoring, image processing, and robotic control techniques. However, many existing systems mainly concentrate on monitoring or feeding operations individually and do not provide a complete integrated autonomous livestock feeding solution.

Umapathi et al. [1] proposed an IoT-based smart livestock feeding system using embedded automation technologies for improving feeding efficiency in dairy farms. The system utilized automated feed control mechanisms and monitoring technologies to reduce manual labor. The study demonstrated that IoT-based smart feeding systems can improve farm productivity and feeding consistency. However, the proposed work mainly focused on IoT-based monitoring and did not include AI-based cattle detection using computer vision techniques.

Giannone et al. [2] presented a computer vision-based cattle monitoring system for real-time livestock management applications. The system used camera-based image acquisition and Artificial Intelligence techniques for cattle identification and monitoring. The research demonstrated that image processing and deep learning models can accurately identify cattle in farm environments. However, the proposed work mainly focused on cattle monitoring and did not integrate autonomous robotic feed dispensing operations.

Souza et al. [3] discussed precision feeding techniques for dairy farms and highlighted the importance of controlled

feed dispensing in improving cattle productivity and reducing feed wastage. The study explained that automated feeding technologies can improve livestock health, feeding efficiency, and milk production while reducing human intervention in farm operations. The work emphasized the growing importance of smart feeding technologies in modern livestock management systems.

Tinoco et al. [4] proposed a multi-sensory livestock monitoring system integrated with wireless communication and embedded automation technologies. The system used various sensing and monitoring techniques for observing cattle activities and improving smart farming operations. The study demonstrated that intelligent monitoring systems can support precision livestock farming and reduce manual supervision requirements. However, the system did not include AI-based image classification and autonomous robotic navigation features.

Chelotti et al. [5] reviewed automated sensing and monitoring techniques used in livestock farming applications. The study analyzed various image processing methods, sensing technologies, and embedded automation systems used for monitoring cattle behavior and feeding operations. The paper concluded that Artificial Intelligence and computer vision technologies have significant potential in improving agricultural automation and smart livestock management systems.

Siraskar et al. [6] developed an automated cattle feeding mechanism using embedded systems and motor control techniques. The proposed system reduced manual feeding effort and improved feeding consistency through automated feed dispensing operations. The research highlighted the importance of low-cost automation technologies for dairy farms and demonstrated the practical application of embedded systems in smart farming applications.

Google Developers [7] presented TensorFlow Lite as a lightweight Artificial Intelligence framework suitable for embedded systems and edge AI applications. TensorFlow Lite enables fast and efficient real-time image classification with low memory consumption, making it highly suitable for Raspberry Pi-based smart automation systems. The framework supports real-time object detection and intelligent decision-making operations in embedded AI applications.

From the literature survey, it is observed that most existing systems mainly focus on livestock monitoring, IoT-based automation, or feed dispensing operations separately. Very few systems combine Artificial Intelligence, computer vision, autonomous robotic navigation, and automatic feed dispensing into a single integrated smart farming solution. Therefore, the proposed Automatic Cattle Feeding Bot is developed by integrating TensorFlow Lite AI model, OpenCV image processing, Raspberry Pi 5, autonomous robotic movement, and servo-based feed dispensing mechanism for intelligent and efficient livestock feeding operations.

METHODOLOGY

The methodology adopted for the Automatic Cattle Feeding Bot focuses on developing an intelligent

and autonomous livestock feeding system using Artificial Intelligence, computer vision, embedded systems, and robotic automation technologies. The proposed system is designed to automate cattle feeding operations by detecting cattle in real time and dispensing feed automatically without requiring continuous human supervision. The methodology mainly involves image acquisition, AI-based cattle detection, autonomous robot movement, and servo-controlled feed dispensing operations.

The complete system architecture consists of Raspberry Pi 5, USB web camera, TensorFlow Lite AI model, OpenCV image processing, L298N motor driver, DC motors, servo motor, feed hopper mechanism, and power supply unit. The Raspberry Pi acts as the central processing and control unit of the entire system. The camera continuously captures real-time images from the surrounding environment and transfers them to the Raspberry Pi for processing and cattle detection operations.

1. Image Acquisition and Preprocessing

The USB web camera continuously captures real-time video frames from the farm environment while the robot moves autonomously. These captured image frames are transferred to the Raspberry Pi for processing. OpenCV image processing techniques are used for preprocessing operations such as image resizing, normalization, filtering, and feature extraction. The preprocessing stage improves image quality and prepares the frames for efficient AI-based cattle detection.

2. AI-Based Cattle Detection

The processed image frames are analyzed using the TensorFlow Lite Artificial Intelligence model trained for cattle detection. The AI model compares the extracted image features with trained cattle image datasets and predicts whether cattle are present in the captured frame. The confidence score generated by the model is compared with a predefined threshold value. If the confidence value exceeds the threshold limit, cattle detection is confirmed successfully.

3. Autonomous Robot Navigation

During normal operation, the Raspberry Pi continuously controls the DC motors through the L298N motor driver to move the robot autonomously inside the farm environment. The robot continuously scans the surroundings for cattle presence while navigating through the farm area. If cattle are not detected, the robot continues forward movement without interruption.

4. Feed Dispensing Operation

When cattle are detected successfully, the Raspberry Pi immediately stops the robot movement by controlling the motor driver. After stopping near the cattle, the Raspberry Pi activates the servo motor connected to the feed dispensing mechanism. The servo motor rotates and opens the flap door of the feed hopper, allowing feed to be dispensed automatically in controlled quantity. After feed dispensing for a fixed duration, the

servo motor returns to its original position and closes the feed outlet flap automatically.

5. Continuous Monitoring and Return Operation

After completing feed dispensing, the robot resumes autonomous movement and continues monitoring the surrounding environment for additional cattle detection. A cooldown mechanism is implemented to prevent repeated feeding of the same cattle within a short duration. The system continuously performs cattle detection, robot navigation, and feed dispensing operations without requiring human intervention. The implemented methodology enables intelligent livestock feeding, reduces manual labor, minimizes feed wastage, and improves automation efficiency in smart farming applications.

OBJECTIVES

1. Automated Cattle Feeding:

The main objective of the proposed system is to develop an autonomous robotic feeding system capable of dispensing feed automatically to cattle without requiring continuous human supervision. The system is designed to reduce the manual labor involved in traditional livestock feeding operations and improve feeding efficiency in dairy farms.

2. AI-Based Cattle Detection:

Another important objective is to implement a real-time cattle detection system using TensorFlow Lite Artificial Intelligence model and OpenCV image processing techniques. The camera-based detection system continuously monitors the farm environment and identifies cattle accurately before initiating the feed dispensing operation.

3. Autonomous Robot Navigation:

The project aims to design a robotic platform capable of moving autonomously inside the farm environment using DC motors and motor driver control. The robot continuously travels through the farm while monitoring cattle presence and performing feeding operations automatically.

4. Controlled Feed Dispensing:

The proposed system also aims to develop a servo motor-based feed dispensing mechanism that releases feed in controlled quantity whenever cattle are detected successfully. This controlled dispensing operation helps reduce feed wastage and ensures proper feed distribution for livestock management.

PROBLEM STATEMENT

1. Manual and Labor-Intensive Feeding Operations:

Traditional cattle feeding methods require continuous human effort and regular monitoring. Farmers must manually feed cattle at scheduled intervals every day, making the process time-consuming and labor-intensive, especially in farms with a large number of cattle.

2. Irregular Feeding and Feed Wastage:

Improper feeding schedules and inconsistent feed distribution may negatively affect cattle health, growth, and milk production. Manual feeding methods can also lead to

excessive feed wastage and inefficient feed utilization.

3. Lack of Intelligent Cattle Detection:

Most conventional automated feeding systems operate using fixed timers or predefined schedules without verifying the actual presence of cattle. This reduces feeding accuracy and may result in unnecessary feed dispensing operations.

4. Limited Integration of AI and Automation:

Many existing livestock monitoring systems mainly focus on IoT monitoring or simple feed dispensing mechanisms separately. Very few systems combine Artificial Intelligence, computer vision, autonomous navigation, and automatic feed dispensing into a single integrated smart farming solution.

5. Difficulty in Continuous Livestock Monitoring:

Continuous monitoring of cattle inside large farm environments is difficult for farmers and requires significant manpower. Lack of intelligent monitoring systems may reduce operational efficiency and increase dependency on manual supervision.

SOLUTION OF THE PROBLEM

1. Automated Cattle Feeding Operation:

The proposed Automatic Cattle Feeding Bot automates the cattle feeding process using Raspberry Pi 5, DC motors, and a servo-controlled feed dispensing mechanism. The robot moves autonomously inside the farm environment and dispenses feed automatically without requiring continuous human intervention.

2. AI-Based Real-Time Cattle Detection:

The system uses a USB web camera along with OpenCV and TensorFlow Lite AI model for real-time cattle detection. The AI model continuously analyzes captured image frames and confirms cattle presence before activating the feed dispensing mechanism.

3. Controlled Feed Dispensing Mechanism:

A servo motor-controlled feed hopper is used to dispense feed in controlled quantity only when cattle are detected successfully. This minimizes feed wastage and improves feeding consistency in dairy farms.

4. Integration of AI and Robotic Automation:

The proposed system combines Artificial Intelligence, computer vision, embedded systems, and autonomous robotic movement into a single smart farming platform. This integration improves automation efficiency and enables intelligent livestock feeding operations.

5. Continuous Autonomous Monitoring:

The robot continuously monitors the surrounding farm environment using camera-based image acquisition and autonomous movement control. This reduces human supervision requirements and improves operational efficiency in livestock management applications.

BLOCK DIAGRAM

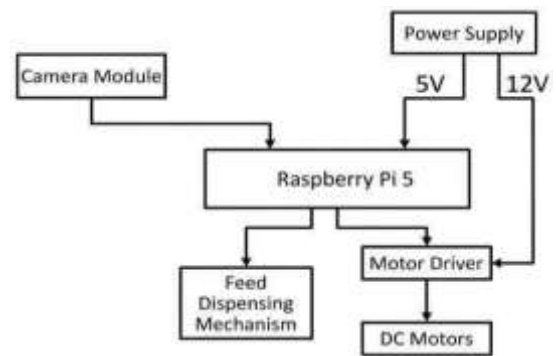


Figure 1: Block Diagram of the proposed system

The block diagram of the Automatic Cattle Feeding Bot represents the overall architecture and working connection between the major hardware components used in the system. The system mainly consists of a Camera Module, Raspberry Pi 5, Motor Driver, DC Motors, Feed Dispensing Mechanism, and Power Supply unit. All these components work together to perform autonomous cattle detection and automatic feed dispensing operations.

The **Camera Module** is connected directly to the Raspberry Pi 5 and continuously captures real-time video frames from the surrounding farm environment. The captured images are transferred to the Raspberry Pi for image processing and cattle detection using OpenCV and TensorFlow Lite Artificial Intelligence model. The camera acts as the vision system of the robot and enables real-time monitoring of cattle presence. The **Raspberry Pi 5** serves as the central processing and control unit of the entire system. It receives image data from the camera module and processes the captured frames using AI and computer vision techniques. Based on the cattle detection result, the Raspberry Pi controls the movement of the robot and activates the feed dispensing mechanism automatically. The Raspberry Pi also sends control signals to the motor driver for controlling the DC motors.

The **Motor Driver** acts as an interface between the Raspberry Pi and the DC motors. Since the GPIO pins of the Raspberry Pi cannot provide sufficient current required for motor operation, the motor driver amplifies the control signals and supplies the required power to the motors. The motor driver controls the direction and movement of the robot based on commands received from the Raspberry Pi.

The **DC Motors** are connected to the motor driver and are responsible for autonomous movement of the robot inside the farm environment. During normal operation, the motors move the robot continuously for cattle monitoring. When cattle are detected successfully, the Raspberry Pi stops the motors and initiates the feed dispensing process.

The **Feed Dispensing Mechanism** is controlled by the Raspberry Pi using a servo motor arrangement. When cattle are detected, the Raspberry Pi activates the servo motor, which opens the feed outlet flap and dispenses feed automatically in controlled quantity. After feed dispensing is completed, the flap closes automatically and the robot resumes movement.

The **Power Supply** provides electrical power to all hardware components used in the system. A regulated **5V supply** is

provided to the Raspberry Pi 5 for stable operation of electronic components, while a **12V supply** is provided to the motor driver and DC motors for autonomous robot movement. The dual-power arrangement ensures efficient and reliable operation of the entire system.

Thus, the block diagram illustrates the integration of Artificial Intelligence, image processing, embedded systems, and robotic automation technologies for intelligent and autonomous livestock feeding operations

SYSTEM DESIGN

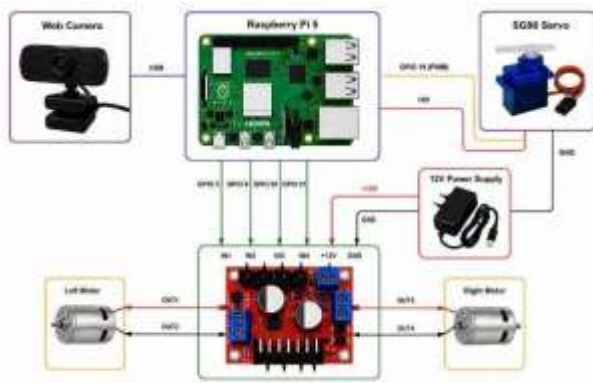


Figure 2: Circuit Design

The Automatic Cattle Feeding Bot integrates Raspberry Pi 5, USB web camera, TensorFlow Lite AI model, OpenCV image processing, L298N motor driver, DC motors, servo-based feed dispensing mechanism, and power supply unit into a unified architecture, where each component communicates efficiently to perform real-time cattle detection, autonomous robot navigation, and intelligent automatic feed dispensing operations.

1. USB Web Camera Module:

Captures real-time video frames from the surrounding farm environment and transfers the captured images to the Raspberry Pi 5 for cattle detection and image processing operations.

2. Raspberry Pi 5:

Acts as the central processing and control unit of the system, performing image processing, TensorFlow Lite AI execution, motor control, and automatic feed dispensing operations.

3. L298N Motor Driver:

Amplifies control signals received from the Raspberry Pi and supplies sufficient current and voltage required for operating the DC motors efficiently.

4. DC Gear Motors:

Drive the robot autonomously inside the farm environment and enable continuous cattle monitoring and navigation operations.

5. SG90 Servo Motor:

Controls the feed dispensing mechanism by rotating the flap

door of the feed hopper for automatic feed delivery in controlled quantity.

6. Feed Dispensing Mechanism:

Dispenses cattle feed automatically whenever cattle are detected successfully by the Artificial Intelligence model.

7. 12V Power Supply:

Provides electrical power to the motor driver, DC motors, Raspberry Pi, and other hardware components used in the system.

8. Robotic Chassis:

Acts as the structural frame of the robot and supports all hardware components required for autonomous movement and feeding operations.

9. Wheels:

Attached to the DC motors and enable smooth movement of the robot across the farm environment during monitoring and feeding operations.

HARDWARE & SOFTWARE REQUIREMENTS

1. Hardware Requirements:

- Raspberry Pi 5
- USB Web Camera Module
- L298N Motor Driver
- DC Gear Motors
- SG90 Servo Motor
- Feed Dispensing Mechanism
- Robotic Chassis
- 12V Power Supply

2. Software Requirements:

- Raspberry Pi OS
- Python
- OpenCV
- TensorFlow Lite

ADVANTAGES

1.Reduces Manual Labour:

The Automatic Cattle Feeding Bot automates the entire cattle feeding process, reducing the need for farmers to manually carry and distribute feed regularly. This minimizes human effort and makes livestock management easier, especially in farms with a large number of cattle.

2.Reduced Feed Wastage:

Feed is dispensed only when cattle are detected successfully by the TensorFlow Lite AI model. This controlled feed dispensing mechanism minimizes unnecessary feed wastage and improves feed utilization efficiency.

3. Consistent Feeding:

The system dispenses feed in controlled quantities whenever cattle are detected successfully. This helps maintain proper feeding consistency and ensures that cattle receive feed at regular intervals, improving livestock health and farm productivity.

4. Autonomous Operation:

The robot operates autonomously using camera-based cattle detection and embedded control systems. It continuously monitors the farm environment, detects cattle in real time, and performs feed dispensing operations automatically without requiring continuous human intervention.

5. Reduced Human Supervision:

The proposed system reduces the requirement for continuous monitoring by farmers. The robot performs cattle detection, navigation, and feed dispensing operations independently, allowing farmers to focus on other farm management activities.

6. Improved Smart Farming Efficiency:

The integration of Artificial Intelligence, computer vision, embedded systems, and robotic automation technologies improves operational efficiency in modern smart farming applications and supports intelligent livestock management.

RESULTS & DISCUSSIONS

The proposed Automatic Cattle Feeding Bot was successfully developed and tested using Raspberry Pi 5, TensorFlow Lite, OpenCV, DC motors, L298N motor driver, USB web camera, and SG90 servo motor. Experimental testing confirmed that the system was capable of performing intelligent cattle detection, autonomous navigation, and automatic feed dispensing operations effectively.

During operation, the USB web camera continuously captured live video frames from the farm environment. These frames were processed by the Raspberry Pi using OpenCV image processing techniques and the TensorFlow Lite AI model. The trained model successfully identified cattle in real time under normal environmental conditions with reliable detection performance.

The robotic movement system operated smoothly throughout the testing phase. The DC motors controlled through the L298N motor driver enabled continuous forward movement of the robot while scanning the surroundings for cattle presence. The movement control mechanism also allowed immediate stopping of the robot whenever cattle were detected successfully.

Once cattle were identified with sufficient confidence, the Raspberry Pi activated the SG90 servo motor connected

to the feed dispensing mechanism. The servo motor opened the feed outlet flap and released feed in controlled quantity for a fixed duration. After dispensing was completed, the flap closed automatically and the robot resumed monitoring operation.

The implemented cooldown mechanism helped avoid repeated feeding of the same cattle within a short time interval. This improved feeding efficiency and reduced unnecessary feed wastage during continuous operation. The return movement mechanism also operated successfully, allowing the robot to move back approximately to its starting position after completing the feeding cycle.

The developed system demonstrated reliable autonomous operation with minimal human intervention. The integration of Artificial Intelligence, computer vision, embedded control, and robotic automation technologies improved livestock feeding efficiency and reduced manual labor requirements in smart farming applications.

Overall, the Automatic Cattle Feeding Bot provided an intelligent, cost-effective, and portable solution for modern livestock management and agricultural automation system

CONCLUSION

This work presented the development of an intelligent Automatic Cattle Feeding Bot designed for modern smart farming applications. The proposed system combined Artificial Intelligence, image processing, embedded control, and robotic automation to perform autonomous cattle feeding operations with reduced human involvement.

The implemented system utilized Raspberry Pi 5, TensorFlow Lite, OpenCV, USB web camera, L298N motor driver, DC motors, and servo-based feed dispensing mechanism for real-time cattle detection and automated feeding. Experimental testing confirmed that the robot was capable of detecting cattle accurately, navigating autonomously inside the farm environment, and dispensing feed in controlled quantity whenever livestock presence was identified successfully.

The automated feeding mechanism reduced manual labor requirements and improved feeding consistency compared to conventional livestock feeding methods. The use of AI-based cattle detection also minimized unnecessary feed wastage by ensuring that feed was dispensed only when cattle were present near the robot.

Overall, the developed Automatic Cattle Feeding Bot demonstrated reliable performance and effective integration of Artificial Intelligence and robotic automation technologies for livestock management applications. The proposed system provides a practical, cost-effective, and scalable solution for smart dairy farming and agricultural automation environments.

FUTURE SCOPE

Obstacle detection sensors can be integrated to improve autonomous navigation and avoid collisions during robot movement. IoT and cloud connectivity can be added for remote monitoring and control of feeding operations. The TensorFlow Lite AI model can be trained using larger datasets to improve cattle detection accuracy under different environmental conditions. In future, the system can also be upgraded with cattle health monitoring, GPS tracking, and solar power support for advanced smart farming applications.

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