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Automatic Dung Collection Machine for Livestock Enclosures

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Abstract: Livestock farming plays a crucial role in the agricultural economy, but effective manure management remains a persistent challenge, particularly in dairy farms, gaushalas, and large animal shelters. Manual dung collection is labor-intensive, unhygienic, time-consuming, and increasingly impractical due to labor shortages and rising operational costs. Improper manure handling also leads to environmental pollution and health hazards for both animals and workers. This research article presents the detailed design, development, and analysis of an Automated Dung Collection Machine intended for livestock enclosures. The proposed system integrates a mechanical scraping mechanism, DC motor drive, Arduino Nano–based control unit, regulated power supply, and Bluetooth-enabled remote operation. The machine is designed to be cost-effective, portable, energy efficient, and adaptable to different shed layouts. Experimental observations indicate significant reduction in manual effort, improved hygiene, and enhanced operational efficiency. The system provides a practical solution for small and medium-scale livestock farms and contributes to sustainable and smart agriculture practices.

Keywords:*Automatic dung collection, manure management, Arduino Nano, livestock hygiene, agricultural automation.*

I.INTRODUCTION:

Livestock farming plays a vital role in the agricultural economy, but effective manure management remains a major challenge. Cow dung and other animal wastes accumulate rapidly in sheds and enclosures, requiring frequent removal to maintain hygiene and animal health. Traditionally, dung is collected manually using shovels and containers, a process that is labor intensive, time consuming, and associated with health risks due to exposure to pathogens and unpleasant odors.

With increasing herd sizes and acute labor shortages, manual dung collection has become inefficient and economically unsustainable. Improper handling and disposal of manure can also result in environmental pollution, including water contamination and greenhouse gas emissions. These challenges have driven the need for automated, reliable, and user-friendly dung collection systems.

This paper proposes an Automatic Dung Collection Machine designed to address these issues by mechanizing and automating the cleaning process in livestock enclosures. The system combines mechanical, electrical, and electronic components to provide a practical and scalable solution suitable for small and medium dairy farms.

II.BACKGROUND AND MOTIVATION

Poor manure management practices can lead to serious consequences such as the spread of infectious diseases, contamination of soil and water resources, and emission of greenhouse gases like methane and ammonia. Inadequate cleaning of livestock enclosures also affects animal comfort and productivity, leading to reduced milk yield and increased veterinary costs.

The motivation behind this work is to develop a mechanized solution that automates dung collection while remaining accessible to small and medium farmers. Unlike expensive imported systems or fully autonomous robots, the proposed machine focuses on a semi-automated approach that balances functionality and cost.

III.LITERATURE SURVEY

A comprehensive literature survey reveals significant research efforts toward automating cleaning and waste management in agricultural environments. Studies have demonstrated the effectiveness of automated and robotic cleaning systems in reducing manual labor and improving operational efficiency in farm and industrial environments [1], [4], [8]. Conveyor-based and scraper-type manure removal mechanisms have been reported to enhance hygiene levels in livestock enclosures while minimizing human intervention [3], [5].

Several researchers have emphasized the role of floor type, scraper design, and housing configuration in determining the effectiveness of dung removal systems, particularly in dairy housing applications [5], [6].

The adaptability of cleaning machines to different flooring conditions and livestock housing layouts has been identified as a critical design consideration [7].

To address power availability issues in rural and semi-urban regions, solar-powered and battery-operated dung cleaning machines have been proposed, offering energy-efficient and sustainable alternatives to conventional systems [2], [9].

The integration of microcontrollers, programmable logic controllers (PLC), and automated control strategies has further improved system reliability and operational precision [9].

Recent studies have also highlighted the use of sensors, wireless communication, and remotely operated control systems to enhance automation and ease of use in manure management equipment [2], [10].Despite these advancements, existing solutions often remain costly, bulky, or complex to maintain. Therefore, there is a continued need for cost-effective, lightweight, and easily maintainable automated dung collection systems that are well suited to local farming conditions, particularly for small and medium-scale livestock operations [4], [7].

IV.PROBLEM STATEMENT

The primary problem addressed in this work is the inefficiency and health hazards associated with manual dung collection in livestock enclosures. Key issues include:

1. Labor-intensive and time-consuming cleaning processes.
2. Poor hygiene leading to disease transmission among animals.
3. Lack of adaptability of existing systems to varied shed sizes.
4. Dependence on stable power supply.

V.OBJECTIVES OF THE STUDY

The main objectives of this study are:

1. To design and develop an automated dung collection system that reduces manual labor.
2. To improve hygiene and cleanliness in livestock enclosures.
3. To enable remote control and monitoring using Bluetooth technology.
4. To ensure reliable operation under variable electrical conditions.
5. To develop a portable, user-friendly, and cost-effective machine.

MANUAL AND AUTOMATED DUNG COLLECTION

A. Manual Dung Collection

Manual dung collection involves physically removing manure from animal housing areas and transporting it to storage or disposal locations. Although widely practiced, this method has several drawbacks: 1) High labor and time requirements. 2) Unhygienic working conditions and health risks. 3) Inconsistent cleaning leading to poor shed hygiene. 4) Limited suitability for large-scale operations.

Figure 1: Manual dung collection in cowshed

B. Automated Dung Collection

Automated dung collection machines are designed to reduce human effort and improve efficiency. Existing systems include manure scrapers, conveyor-based collectors, robotic cleaners, and dewatering machines. These systems offer benefits such as reduced labor costs, improved hygiene, and better manure utilization for fertilizer or biogas production. However, many commercially available solutions are expensive or complex, limiting their adoption by small farmers.

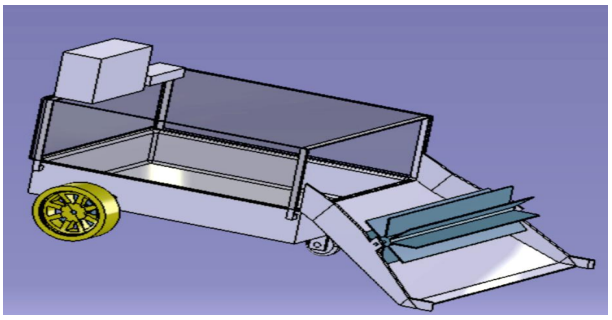

Figure 2: Automated Dung Collection 3 D design and Actual Model.

VI.METHODOLOGY

The methodology adopted in this research involves the following stages:

1) Detailed study of existing dung collection methods.

2) System design and component selection.

3) Fabrication of mechanical structure.

4) Development of control and power circuits.

5) Integration and testing of the complete system.

SYSTEM ARCHITECTURE AND DESIGN

A. Mechanical Design

The mechanical system consists of a rigid frame, scraper blade, collection tray, wheels, and transmission mechanism. The scraper is designed to effectively push dung along the floor into the collection tray without damaging the shed surface.

B. Electrical and Electronic Design

The electrical system includes a 12 V DC battery, voltage regulator, DC motor, motor driver, Arduino Nano microcontroller, and Bluetooth module. The voltage regulator

ensures stable power supply to sensitive electronic components.

C. Control Strategy

The Arduino Nano acts as the central controller, coordinating motor operation based on user commands received via Bluetooth. The control logic allows forward and reverse movement, ensuring efficient coverage of the enclosure area.

WORKING PRINCIPLE

The Automated Dung Collection Machine operates by moving along the floor of the livestock enclosure. The rotating scraper pushes dung towards the collection tray. The collected dung can then be disposed of or used for composting and biogas production. The system can be operated manually or remotely using a mobile application.

EXPERIMENTAL RESULTS AND DISCUSSION

Experimental trials were conducted in a simulated livestock enclosure environment. The results demonstrated a significant reduction in cleaning time and manual effort compared to traditional methods. The machine operated smoothly under varying load conditions and maintained stable performance.

VII.CONCLUSION

This study successfully demonstrates the design and development of an Automatic Dung Collection Machine intended to address the challenges of manual manure management in livestock enclosures. By integrating mechanical scraping mechanisms with a microcontroller-based control system and wireless monitoring, the proposed solution provides an efficient, hygienic, and economically viable alternative to traditional cleaning methods. The system is particularly well suited for small and medium-scale dairy farms, where affordability, ease of operation, and reliability are critical factors.

- The developed Automatic Dung Collection Machine effectively automates the dung removal process in livestock enclosures, significantly reducing the dependency on manual labor while improving operational efficiency and workplace hygiene.
- The integration of a mechanical scraping mechanism with an Arduino Nano microcontroller enables precise coordination of system components, ensuring reliable and systematic dung collection under varying operating conditions.
- The use of a Bluetooth module allows remote control and monitoring of the system through mobile devices, enhancing user convenience and enabling flexible operation without continuous physical supervision.
- The precision motor controller, in combination with the L293D motor driver, provides efficient bidirectional control of the dung collection motor, contributing to smooth operation and reduced power losses.
- The diaphragm pump, employed as a positive displacement pump, ensures controlled and reliable transfer of collected dung from the enclosure to the disposal or storage area, minimizing spillage and maintaining cleanliness.
- The relay-based power management system enhances operational safety and energy efficiency by regulating power supply to individual components as required.
- The inclusion of an LCD display provides real-time system feedback, enabling on-site monitoring, fault identification, and system adjustments, thereby improving the overall user interface and operational transparency.
- The system demonstrates adaptability to different livestock environments and enclosure layouts, making it suitable for dairy farms, gaushalas, and similar agricultural settings.
- The proposed design emphasizes cost-effectiveness, ease of maintenance, and user-friendly operation, ensuring practical feasibility for farmers with limited technical expertise.
- Overall, the Automatic Dung Collection Machine represents a comprehensive and intelligent solution for modern livestock management, contributing to improved animal health, reduced disease transmission, enhanced farm sanitation, and sustainable agricultural practices.

APPLICATIONS AND BENEFITS

A. Applications

1) Dairy farms and gaushalas.
2) Livestock sheds and animal shelters.
3) Rural and semi-urban farming environments.

B. Benefits

1) Significant reduction in manual labor and drudgery.
2) Improved hygiene and reduced disease risk.
3) Time and cost savings for farmers.
4) Enhanced animal welfare and productivity.
5) Better manure management for fertilizer and biogas applications.

LIMITATIONS AND FUTURE SCOPE

The current system requires human supervision and periodic emptying of the collection tray. Future work may include full autonomy, sensor-based navigation, solar power integration, and IoT-based monitoring.

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