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An Intelligent Wet Waste Recycling System

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Abstract: This paper presents the conceptualization and realization of an innovative, intelligent system for recycling wet waste, engineered to offer a compact, mobile, and automated approach to kitchen waste management. The system simplifies the entire process of waste treatment, encompassing bag opening, collection, fermentation, and storage as fertilizer. Key functionalities include: automatic garbage bag disposal, freeing users from direct contact with waste; resource recovery by converting waste into compost or biogas, contributing to a circular economy; and smart technology integration that enables tracking and promotes user engagement in the recycling process. Designed primarily for small-scale settings such as individual homes or small businesses, the system promotes sustainability by boosting recycling rates and diminishing overall household waste.

Keywords: WetWaste Recycling, Automatic garbage bag disposal, Biogas, Intelligent system.

I. Introduction

As waste sorting initiatives move from trial phases to widespread adoption, the need for efficient processing of kitchen waste has never been clearer. This push has seen a surge in the separation volumes of kitchen waste, highlighting the critical need for enhanced backend processing capabilities. Effective treatment of this waste category is key to reducing overall household waste. To address these challenges, imagine a compact, highly mobile intelligent wet waste treatment device that automates the entire process—from bag opening to waste collection, fermentation, and fertilizer storage. Leveraging straightforward mechanical designs in tandem with advanced IoT technologies, this envisioned solution promises to deliver a harmless, efficient, and smart way to handle kitchen waste at smaller establishments like hotels, restaurants, and cafeterias.

II. The Design Scheme of the Device

A. Display of the Device

Based on existing wet garbage recycling schemes and with the goal of harmless waste processing, this plan aims to design a compact intelligent wet garbage processing device. This device would automatically handle various functions, including breaking garbage bags, crushing wet garbage, separating oil and water, microbial degradation, drying organic fertilizer, and collection, thus efficiently processing kitchen waste resources. Integrated with smart technologies like apps, it will be able to monitor kitchen waste disposal volumes and award points to users, enhancing their experience. Designed for small venues like hotels, restaurants, and cafeterias, its portability will aid in increasing the recycling rate of kitchen waste.

As illustrated in Fig.1, it includes a single-motor dual-axis mechanical arm, a shredder, a cylindrical tank, mixing equipment, microbial formulation spraying equipment, temperature control equipment, and a fertilizer storage unit. Additionally, the system incorporates a double sliding door at the disposal entrance that interacts with the single-motor dual-axis mechanical arm. The single-motor dual-axis mechanical arm comprises a fixed arm, a smaller arm, guide rails, a first spring, a second spring, and an electric push rod, with a blade plate attached to the fixed arm. The double sliding doors at the entrance are mounted on the external frame and linked to the smaller arm via a first connecting rod and a pivot.

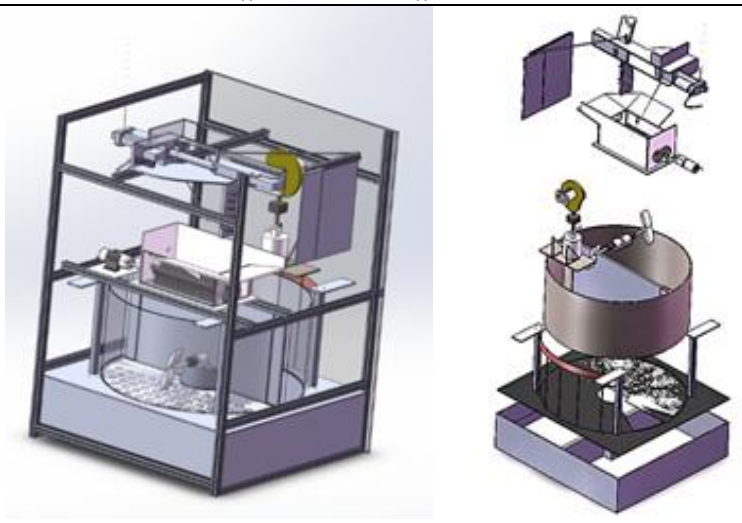

Fig.1 Design Scheme and structure of the Intelligent Wet Waste Recycling System

B. Mechanical architecture and control strategy

1) Single motor robotic arm

As shown in Fig. 2, the smaller arm is manipulated by an electric push rod to either swing or extend along the guide rail. As the smaller arm extends, the double sliding doors at the input simultaneously open. When a user hooks the handle of a wet waste-filled garbage bag into the clamp on the smaller arm, the bag is secured by the action of the second spring. Subsequently, as the smaller arm retracts, piercing the garbage bag with the blade plate when it reaches the first position. The smaller arm continues to retract, and under the limit's influence, it swings to tear open the garbage bag, allowing the wet waste inside to spill out.

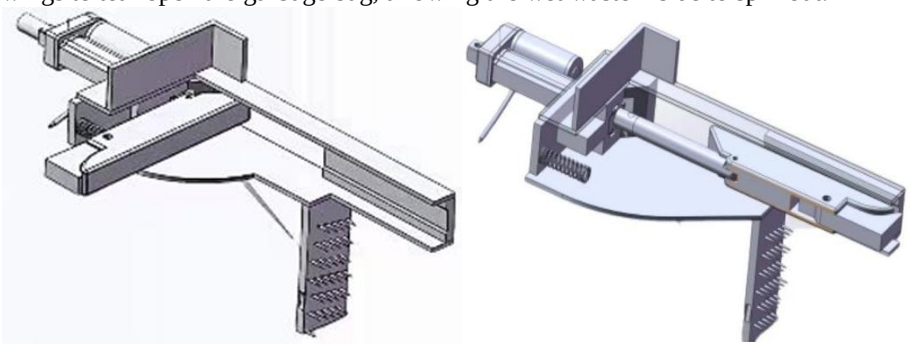

Fig. 2 Startup and Silent Status of robotic arm

2) Cylindrical barrels

As shown in Fig. 3, the inner liner is affixed to the partition, which can be rotated by the first motor. The rotation axis and the first fixed plate provide support for the inner liner. The circular bottom plate area used for wet waste fermentation features a sector groove with a 30° central angle for the discharge of organic fertilizer after fermentation. As depicted in the schematic of the circular bottom plate structure in Figure 7, the left half is for wet waste collection, consisting of a water-filtering plate made from nylon cloth and steel net, while the right half is for wet waste fermentation, fitted with a fermentation plate that includes an open sector groove and a central circular groove for the easy installation of the first motor.

When the garbage in the left half of the inner liner (serving as the collection half-barrel) reaches a certain weight, the first motor inside the motor housing rotates 180 degrees counterclockwise, causing both the inner liner and the partition to also rotate counterclockwise. Consequently, the garbage initially on the left side is moved to the right side (serving as the fermentation half-barrel), during which the mixing equipment, microbial formulation spraying equipment, and temperature control equipment operate systematically to facilitate fermentation. Moreover, the left half of the inner liner continues to serve as the collection half-barrel, enabling continuous waste collection.

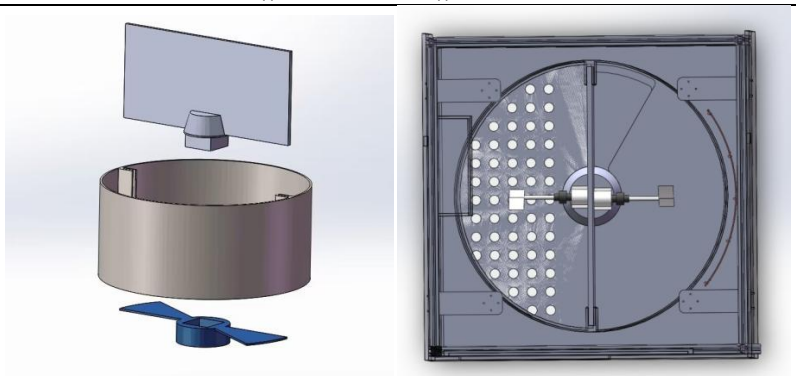

Fig. 3 Cylindrical barrel and bottom plate structure

C. Selection and Design of Hardware Circuits

To realize the automation control of the wet waste treatment device, four Arduino Uno development boards are used. Each board has 14 digital input/output pins, of which 6 can be used for PWM output to control output waveforms, 6 analog inputs, a 16MHz crystal oscillator clock, a USB connection, a power jack, an ICSP header, and a reset button. It only needs to be connected to a computer via a USB cable for power supply, program burning, and serial data communication. Compared to other main control modules on the market, this module has various advantages such as ease of control, high integration, and low cost, making it suitable as the main control component for the wet waste treatment device. The electrical control part of this device, as shown in Fig.4, integrates 4 motor drivers to connect, drive, and control the 6 motors within the device.

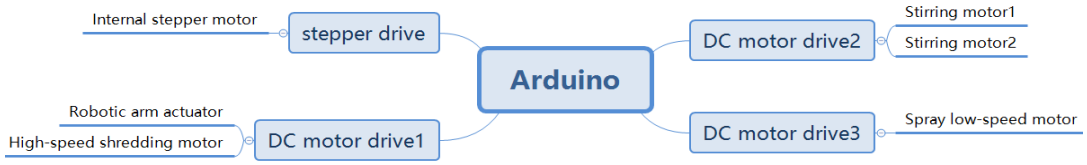

Fig. 4 Device's electrical control system

III. Conclusion

This intelligent wet waste system is capable of autonomously executing an array of tasks, including puncturing garbage bags, pulverizing wet waste, separating grease from water, decomposing materials through microbial action, dehydrating organic fertilizer, and amassing these substances. It efficiently transforms kitchen waste into valuable resources. Ideal for deployment in confined areas such as restaurants and cafeterias, the equipment boasts exceptional portability, thereby contributing to the augmentation of kitchen waste recycling rates. As environmental consciousness continues to rise, an expanding demographic is anticipated to take notice of and advocate for this ecologically sound method of waste management.

Acknowledgment

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