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SMART COMPOST BIN FOR DOMESTIC WASTE

[1]Swapna Raghunath, [2]Charitha Madhagowni, [3]Marla Laya Madhuri, [4]Vemula Siva Shahitha, [5]Dornala Ravishalini

[1]Professor in Electronics & Communication Engineering , [2]Student, [3]Student, [4]Student, [5]Student
[1]Electronics & Communication Engineering,
[1]G. Narayanamma Institute of Technology and Science (For Women),Shaikpet-Hyderabad, India.

Abstract : In India today, only 5% of waste is recycled, and 77% of trash is disposed of in open landfills. According to bin audits, between 40 and 60 percent of the waste being dumped in landfills is organic waste. In India, open dumps are quite prevalent, which promotes the spread of mosquitoes, flies, rats, cockroaches, and other pests. Environmental issues have increased as a result of the amount of organic waste in municipal solid waste. Estimates suggest that it can be composted to a level of roughly 50%. Instead, the majority of it is burned and disposed of in landfills. It highlights how the great potential of composting organic waste is being under-utilized. Reducing the quantity of trash entering the main waste stream at home is simple with composting. Vegetable peelings are a particular kind of kitchen waste that have a number of distinctive qualities, including a high water rate, a high percentage of organic matter, and good biodegradability. Such waste can be composted biologically to be recycled, reduced, and made harmless. By examining the experimental results for the composting and fermentation of vegetable peels and leaves, a home-use automatic composting bin was developed. The objective of this paper is to develop an automated compost bin for residential kitchens that decomposes organic waste more quickly when the correct conditions exist. It combines a bio-waste treatment method with an aerobic composting approach.

IndexTerms **– Composting bin, autonomous composting, smart composting, waste recycling , domestic waste recycling.**

INTRODUCTION

Growing organic waste in the environment is having a significant worldwide impact. Organic garbage makes up 50% of the total amount of municipal solid trash produced in India. Statistics show that by the end of 2016, there were around 80 million tons of kitchen garbage produced annually. At an annual growth rate of 8% to 10%, this amount is predicted to increase by 7-8 times by the year 2030. Vegetable peels and leaves, a significant part of kitchen garbage, have a moisture content of up to 70% to 80%, and 93% of the waste is organic. Moreover, the nitrogen, phosphorous, potassium, and other nutrient contents are reasonably high, thus the compost products can be utilized as organic fertilizers. However, due to the dispersed nature of the kitchen waste production areas as well as the high levels of moisture and organic matter, acidification, mildew, and corruption can easily result in the production of a wide range of pathogenic microorganisms that may pollute the environment when the waste is transported and recycled together.

The biological decay of organic matter is considered to be a more honorable procedure than many other organic waste disposal techniques, such as landfilling and incineration. Reusing organic debris and leftover nutrients on farmland is a practical and desired idea. Compostable waste producers can use land application as a cost-effective outlet, while landowners may find it to be an inexpensive source of organic matter and fertilizer components. For many years, composting has been used as a method of recycling organic matter back into the soil to improve soil structure and fertility.

Composting is one of the most promising technologies to treat wastes in a more inexpensive way. T. A. Saleh et al. (2011) [4]. One of the unique low-cost and budget-friendly biological deterioration processes is composting. Bacteriological activity surrounds the composting process. Compost temperature, moisture content, the C: N ratio, soil condition, and aeration are some of the significant factors impacted by this process.

Since different forms of organic wastes have varying percentages of nutrients, including nitrogen, phosphorous, and potassium (N, P, and K), which are the major macronutrients found in fertilizers, many factors can affect the quality of the compost products. Heavy metals' presence demonstrates how composts can be applied to soils without causing any harm. Temperature, pH, moisture content, and the carbon-to-nitrogen ratio (C:N) are the primary variables that impact how effectively compost is produced. In 2016[10], A.K. Kadir Aeslina et al. Several rural and suburban regions have long used traditional composting techniques (pit, heap) using various sorts of organic materials.

The physical, chemical, and biological characteristics of soil, such as their texture, structure, ability to hold water, porosity, particle density, and microbial activity, are changed by compost, which serves as an additional source of organic matter. These changes make soil more suitable for plants' nutrient needs. The bulk density value varied from 420 to 655 kg m-3. The readings for the moisture content were between 23.50 and 32.10 percent. The values for the water retention capacity ranged from 3.50 to 4.40 g water/g dry. For various compost types, the porosity values ranged from 60.69 to 72.47%. With various types of compost,

the pH ranged from 6.3 to 7.8, while the EC values ranged from 2.6 to 4.1 dS m-1. El-Sayed et al. (2015) [12]. It has great soil-conditioning abilities. Compost's distinctive property of reducing the bioavailability of heavy metals that pollute soil and groundwater cannot be overlooked. As a result, it also serves as bioremediation for damaged soils. By composting such materials and using them for kitchen gardening, the initiated project expands and improves the organic recycling project. Particularly in poorer nations, composting ought to be practiced more frequently. [1] H. Daniel et al.

There are several composting bins built utilizing different technologies, including, Design by Sachin Jayaprakash et al., 2018[2] The components of the compost bin are a separate chamber for the beginning compost, a composting chamber with a mixing blade (powered by a DC motor and rechargeable batteries), an air filter system, and a compost collection tray. The product is portable since rechargeable batteries are utilized in it. The neem leaves and cow dung are filled manually into the air filters, so there are only a limited number of bins available for these types, and they are expensive as well. The air filter contains pellets made of Azadirachta Indica (neem) and Gomaya (cow dung), which are used to keep away bad odours and act as a disinfectant but due to the high cost of the bin it cannot be afforded by majority of households, even it includes manual work for filling the air filters with cow dung and neem leaves . A. Yuwono and colleagues (2016)[11] , the composting bin was designed using a natural static pile composting system, where the volume of the composting bin was 7.5 m 3 per batch with a minimum area of 64.5 m 2.As the pile of organic waste is not turned, it takes 1-2 months to get decomposed and convert to compost, and there is a chance that the amount of foul odour will increase due to a lack of aeration

State of the art composting techniques have been developed as an alternative to conventional composting. A novel tactic, the two-stage composting technique, according to Y. L. Li et al. (2017)[5], is gaining popularity. It entails turning the composting system on and off at various points throughout the composting process. There is insufficient data on the efficiency and effectiveness of two-stage composting systems in terms of cost, time, compost quality, and greenhouse gas (GHG) emission as it is fairly new.
The composting bin designed in this paper includes mixing blades that chop kitchen waste for faster decomposition and it is also used for the aeration process. The Arduino software is used for automatic waster sprinkling when required, automatic turning on of the mixing blades at regular intervals of time, and notes the temperature inside the bin. With little to no manual labor required and at a relatively low cost, the smart composting technology of household organic waste is shown in this paper. The compost can be formed at a relatively low cost and because of the bin's proper aeration, which significantly reduces the odor.

Figure:1. Food wastage in India

METHODOLOGY

Creating a microcontroller-based, completely automated quick-composting bin that can be used to recycle regular organic waste into compost, which can then be used for small-scale residential organic farming. [2] A compost bin comprises of a composting chamber with a mixing blade. In order to speed up the composting process, the rapid composting bin will optimize all the parameters. The following criteria are taken into account while composting:

The length of time it takes for compost to mature is reduced by one week by the greater surface area of the trash that is being exposed to microorganisms on smaller wastes. Regularly spaced-apart sharp blades attached to a single phase induction motor will shred the deposited garbage into smaller pieces. Using the function components such wringer blade and cross blade broken baffle, the functions of crushing pre-treatment, material transfer, fermentation, and separation were achieved. Wang, N., et al. (2019) [7].

Higher temperatures, such as 45 to 65 degrees Celsius, are ideal for the composting microorganisms. To keep the composting process continuing, the pile needs to be turned over every so often. Due to the relatively long time the waste is left in the composter when temperatures do not approach the thermophilic phase, these pathogenic microorganisms can naturally decompose. by V. V. Daniele et al (2017) [8] A temperature sensor will be installed in the compost bin to track the temperature, which will rise as a result of the pile's constant mixing.

Figure:2 Model of compost bin used in this study

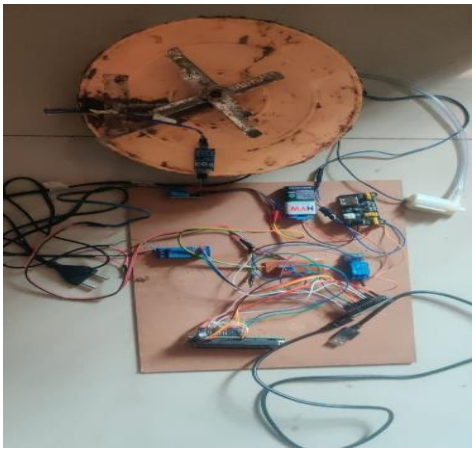


Figure:3. Internal design

To ensure appropriate aeration and hasten the composting process, the composting pile needs to be turned over on a regular basis. To bring the outside material to the surface, the pile is stirred by blades coupled to a single-phase induction motor.

The composting pile should have a moisture content of 40 to 60%. The composting container has a moisture sensor installed. A water sprinkler controlled by a microcontroller will release little amounts of water to restore the moisture level if it drops below 50%. As the moisture level drops below 50%, the water sprinkler will automatically stop.

In general, 30 parts carbon are consumed for every 1 part nitrogen by microorganisms that break down compost. Just keeping the moisture level of the composting pile between 50% and 60% allows the rapid composting bin to maintain the 30:1 carbon to nitrogen ratio.

In-vessel composting is more effective and efficient in terms of process variables than traditional techniques. This procedure can be crucially used for small-scale, community-based compost manufacturing, which will be essential to connecting daily household trash. Vivek, M., et al. (2017)[3]. Kitchen garbage made up around 97% of all waste types used, and about 66% of compost bin owners contribute waste to their bins once each day. According to a questionnaire survey, the introduction of this technology among the populace resulted in a 69% decrease in the amount of garbage disposed to waste collection services. (2009)[6] L. Manuja et al.

ALGORITHM

Step 1: With the aid of a cutting blade arrangement, vegetable waste is gathered into a compost bin and finely diced to maximise the area of decomposition.
Step 2: Connect the Arduino nano plug and the motor plug. Compost starter, which contains bacteria to kickstart the composting process, is added.
Step 3: Fill a container with water so that the water sprinkler can fit inside of it and submerge itself in the liquid.
Step 4: Turn the board on. Vegetable waste and compost starter powder are continuously mixed for efficient composting with the aid of a mixing equipment powered by a ac motor.
Step 5: Let the compost bin sit for a couple of hours.
Step 6: Repeat steps 1 through 6 for 2 to 3 weeks, then gather the compost that has developed inside the bin.
Step 7: After using the gadget, turn it off.

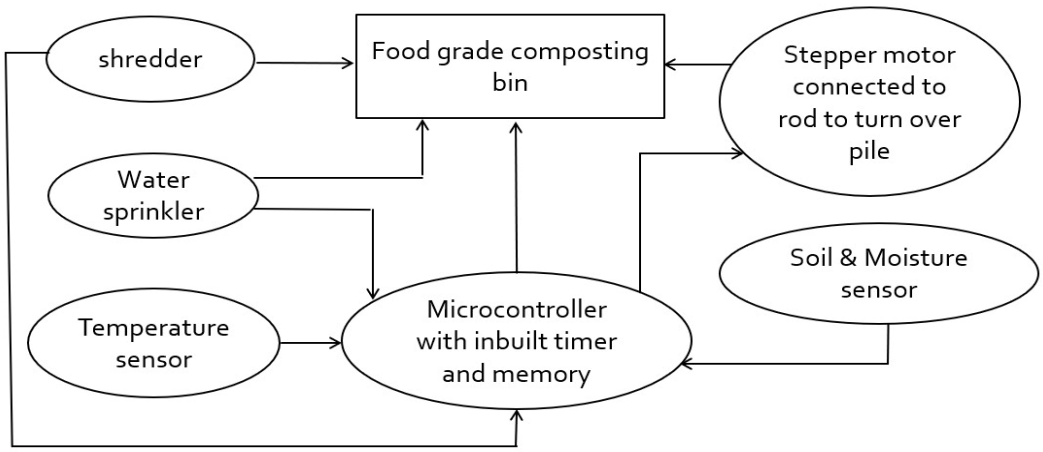


Figure:4. Flowchart for implementation of compost bin

The microcontroller, an Arduino Nano is one sort of microcontroller board, and it is designed by Arduino.cc, makes up the compost bin's block diagram as shown in Figure 4. A microcontroller like the Atmega328 can be used to construct it. This microcontroller is also utilised by the Arduino UNO. It is a flexible board that is modest in size and has many different applications. Similar to an Arduino Demilune board, this board has various features and capabilities. Yet the packaging for this Nano board is unique. Although it lacks a DC jack, power can be supplied via a tiny USB port, which is otherwise directly connected to pins like VCC and GND. Using the tiny USB port on this board, 6 to 20 volts can be delivered to this board.

A microcontroller-based gadget, the compost bin uses an Arduino nano as its microcontroller. The bin is made so that the blades are spun every 15 minutes and for 5 minutes to offer aeration for the compost and to chop up the kitchen trash. When the moisture sensor indicates that the compost contains less than 50% of the required amount of moisture, the water sprinkler automatically turns on. This entire mechanism is managed by the Arduino nano software, which collects and analyses data and executes actions based on the data received from the sensors.

Through the use of a temperature and humidity sensor, the bin keeps track of the temperature of the compost. complicated with an output of a calibrated digital signal. It guarantees high dependability and outstanding long-term stability by utilising the unique digital-signal-acquisition technique and temperature & humidity sensing technology. This sensor links to a high-performance 8-bit microprocessor, allowing for outstanding quality, quick response, interference resistance, and cost effectiveness. It also includes components for measuring temperature and humidity. Since temperature is a key factor in composting, the LCD will show the temperature within the bin as measured by the DHT11 sensor.

Maintaining the necessary moisture content is key to producing compost of high quality. A soil moisture sensor measures the amount of water in the soil. Farmers can regulate soil moisture better throughout key plant growth stages, which not only allows them to grow crops with less water overall but also results in higher yields and higher crop quality. Many other fields of study besides agriculture use soil moisture sensors. Golf courses are now integrating sensors to improve irrigation system efficiency in order to avoid overwatering and fertilizer and other chemical leakage offsite. Soil sensor is used to display the moisture level of the compost inside.

The bin is made such that the mixing blades turn on and off at regular intervals; to do this we employ an electric switch. Relays are electrical switches that are opened and closed by another electrical circuit. The switch's original design uses an electromagnet to open or close one or more sets of contacts. Relays can be viewed broadly as a type of electrical amplifier since they have the ability to control an output circuit that has more power than the input circuit. Relays are used to turn the engine on and off at regular intervals, and they themselves are utilize ed as switches for operating the motor.

Display in Figure 9 features two rows with up to 16 characters per row and an LED backlight. The pixels that make up each character are visible on the screen along with the rectangles that represent them. The display is intended to show text and is just black on green. The LCD screen serves as an interface between the user and the Arduino, displaying messages that allow the user to learn the temperature, moisture content of the compost, and the status of the motor (on/off). It initially displays the message "AUTOMATED COMPOST ORGANIC WASTAGE" and then displays the messages "TEMP" showing the temperature of the compost, "SOIL" indicating the moisture status of the compost (dry/wet), and "CRUSH" to indicate whether the motor is on.

A single phase induction motor is used to power the mixing blades, as shown in the block diagram. All of our houses and offices are solely provided with a single-phase A.C. supply because single load systems often have low power requirements. Using suitable motors with this single-phase supply will provide optimal working conditions. The motors must also be affordable, dependable, and simple to fix in addition to compatibility. The motor in this compost container serves two purposes: (1) aeration of the compost to hasten the decomposition of kitchen waste (2) crushing of the trash to hasten the rate of decomposition by reducing the size of the waste particles, which is accomplished by the sharp blades soldered together to the rod of motor.

Figure:5 Indicates Temperature value & Soil status of compost

Figure:6 Display of project title

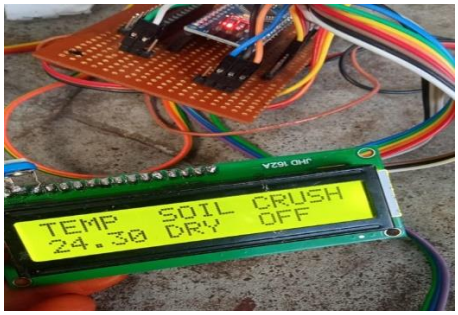
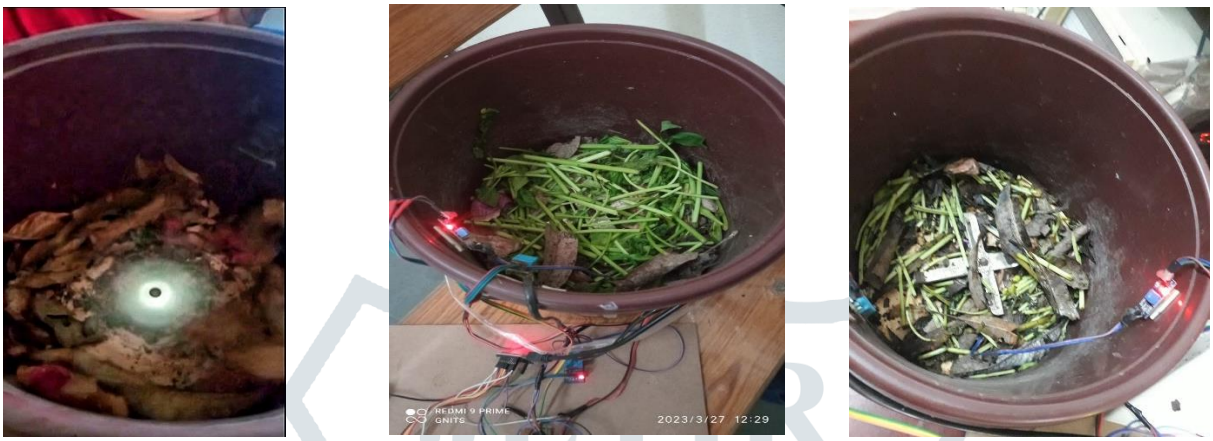


Figure:7. LCD displaying "CRUSH ON" **Figure:8.** LCD displaying "CRUSH OFF"

RESULTS AND DISCUSSIONS

For better kitchen waste breakdown, a layer of soil is initially present inside the bin. No matter how much waste is put in a particular size of bin, the amount of soil used for layering stays the same. The 300-gram-plus onion and spinach scraps that make up the kitchen waste are disposed of in the trash can on top of the soil layer. Two plugs turn on the bin, and the sprinkler is set within a water container. The bin was maintained at a regular temperature; the interior's average reading ranged between 29℃ - 31℃. A manually detachable plastic cover was used to shut the trash can. The crusher gets on every 15 minutes and runs for roughly 5 minutes. During this crushing process, the liquids from the crushed waste increased the moisture of the soil and the sprinkler remained off. When the crusher first started rotating, the pieces of the kitchen waste are chopped of initially, and it took about 1.5 hours to get smaller pieces as it gets on and off periodically.



(A) **(B)** **(C)**

Figure:9 Various composting stages of organic waste

Repeating the process for 1-2 days causes the moisture contained to decrease because the increased warmth causes breakdown as well. Even maggots can form in the bin after a week if it is placed in a garden area, which will hasten the composting process. The bin is put in a room, and after a week, the procedure is completed, turning the soil waste into a semi-liquid state. Black compost will form and be visible in less than two weeks. Inorganic fertilisers, which contain predetermined concentrations of minerals, can be used on plants in place of chemical fertilisers.

Although they frequently include the "big three" minerals (nitrogen, phosphorus, and potassium), they usually lack the variety of micronutrients that a plant would get from naturally decomposing materials in favour of having a lot of "filler." Excessive mineral concentrations might instantly harm, similar to root burn. Long-term chemical use can change your soil's pH balance and result in a hazardous build up of some nutrients. Plants may grow healthier as a result of this arranging fertiliser produced from a compost bin.

Figure:10. Compost resulted after 3 weeks

Figure:11. Growth of sapling in post compost

CONCLUSIONS

The results of a small-scale experiment on the composting and fermentation of pericarpal wastes from kitchen waste were analysed in this paper. Based on the optimised design of the composter's structure, a small household composter that combines pre-treatment by crushing with composting and fermentation was created. This gadget may lessen and recycle household trash by regulating the particle size of composting materials and improving the composting conditions of kitchen waste. Some issues were easily resolved. For instance, it was challenging to collect and manage kitchen garbage in a centralised manner due to its dispersion, and residents were encouraged to adopt a greener lifestyle.

There are many different types of kitchen garbage, and since the apparatus created for this study is only appropriate for processing vegetable leaf litter, other kitchen waste cannot be properly disposed of. In the ensuing research and design, a multifunctional kitchen waste disposer will be developed through the continuous updating and improvement of functional components to meet full coverage of kitchen waste disposal and to address the environmental pollution of kitchen waste from household cited material.

FUTURE SCOPE

Further future scope is required for the bin's operation to be improved, such as upscaling the compost bin and expanding its use in places where there is a lot of food waste, such as restaurants and convention halls. The blade set up can be made of multiple sizes for proper chopping of vegetables, and deployment of various blades at multiple horizontal levels will be useful for decomposition of large amounts of waste. Wheels can be added to the base of the bin for easy transportation, allowing it to be easily shifted from place to place. The base that supports the compost inside the compost bin can be swapped out for a steel strainer that drains the extra liquid while preserving the compost's proper moisture level. A system for extracting surplus liquid from compost and moving it to a container where it can later be used to raise the moisture content of the compost. To reduce the need for human interaction, mechanism for automatically removal of produced compost can be deployed.

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