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Automated Vermicomposting Using Portable Bin

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Abstract: An IoT based portable vermicomposting bin is a modern solution for efficient and convenient composting. This innovative approach utilizes the Internet of Things (IoT) technology to connect the vermicomposting bin to a network and unable real time monitoring and control of various parameters, such as temperature, moisture and pH level with automated controls and real time monitoring, the IoT based vermicomposting bin can simplify the composting process and reduce waste, minimizing the environmental impact. The type of worm which is mostly used for vermicomposting is Red Wiggler (Eisenia Fetida). Overall, the IoT based vermicomposting bin is smart and efficient way to recycle organic waste and produce high-quality compost.

Keywords: IoT, Vermicomposting, Organic Waste, Automated System, Eisenia fetida

I. INTRODUCTION

An IoT based vermicomposting bin is a modern and innovative way to monitor and control the vermicomposting process. One area where IoT technology is making a significant impact is in the field of agriculture and sustainability. One such application is the IoT based vermicomposting bin, which is designed to improve the efficiency and effectiveness of the composting process. It is an environmentally friendly way to disposing of organic waste while also creating a valuable resource for agriculture. An IoT based vermicomposting bin is designed to automate the process of composting and make it more efficient. The bin equipped with sensors that monitor temperature, moisture and other environmental condition, data logging system which are critical for the growth and health of the worms. The sensors are connected to a central control system, which can adjust the condition within the bin as needed to optimize the composting process. This data can be used to analyse the composting process and identify area for improvement. The data can also be used to communicate the result of the composting process to stakeholders and other interested parties.

II. METHODOLOGY

A. *Site Specification*

1) *Location of The Plot*

This study was conducted in Gandhi Institute for Technology (Autonomous) – In Vermicomposting Lab (20.2227°N, 85.6739°E). This area was near to the workshop where we have constructed our model frame for our experiments. For proper analysis of data, the total vermicomposting lab is divided into two portion, one side for IoT based bin and another side for manual vermicomposting.
LAYOUT

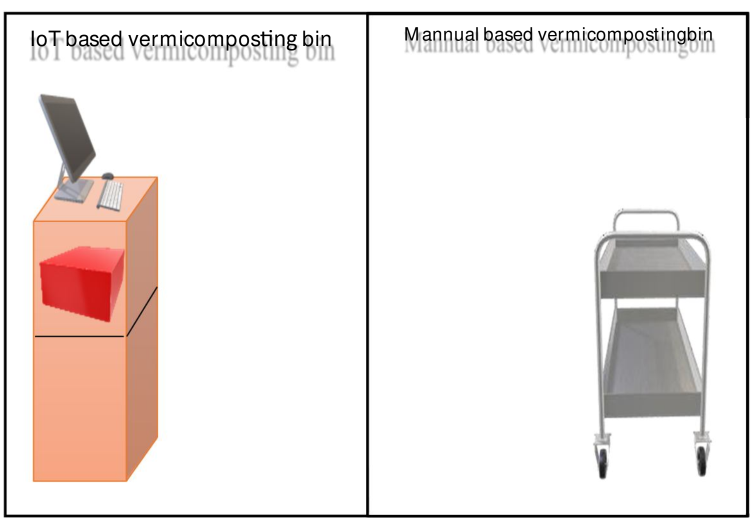

Fig 2.1 Layout of Vermicomposting Room

B. Project Description

This project aims to design and develop an automated portable vermicomposting bin using Raspberry Pi, sensors, LED grow light, an automated irrigation system, temperature sensor andsoil moisture sensor. The overall module should be a mixed combination of agriculture with technology. This automated portable bin will provide convenience and comfort to the user by sensing and controlling the parameter of the bin using a data logging system though which wecan control it effectively.

It has the following features:

1) Easy to handle
2) Economical
3) Compact and portable
4) Remotely Operated

C. Diagram of IoT based Vermicomposting Bin System

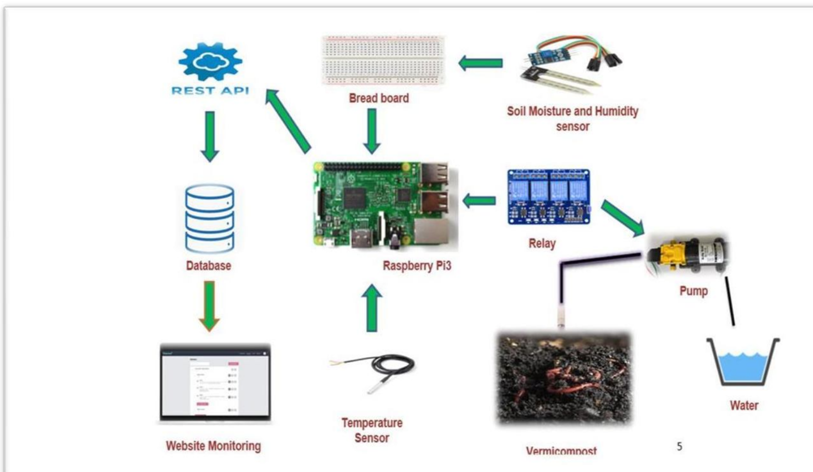

Fig 2.2 Complete working diagram of IoT based vermicomposting system using raspberry pi

The fig 3.1 depicts a symbolical representation of the vermicomposting bin with it's proper working prototype. Sensor, bread board, relay pump all are directly connected to raspberry pi3and whole data base is available in monitor as well whole set up was being controlled through the website monitoring. Where relay works as a switch for operating the water pump, whenever the measured moisture content of the compost is lower in comparison to the desired moisture content for the proper nutrient rich compost.

D. Material And Methods

Design and development

1) Hardware Module

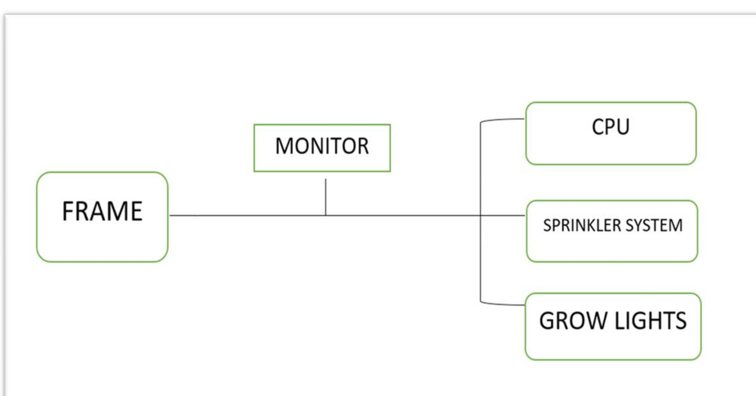

Fig 2.3 Block Diagram of the prototype

2) Fiber Frame

We have designed a frame for completion of the whole process, which is length= 0.63m, width= 0.52m, height= 1.64m as shown is fig. Whole frame is of 5 layers, which is made up ofsquare bar and fiber. First the top layer is design for the basement to the monitor and its CPU. Then rest four layer was designed for the installation of LED lights from top to its bottom. The LED lights are placed inside the chamber so it provides the right amount of light in each specific bin which helps the worm produce more energy as well also enhances the total carbondioxide produced by the worms.

Fig 2.4 Progress of model preparation work

3) Red Light As Grow Light

Red light is starting to be recognized as an essential component of vermicomposting, bringingthem to maximum efficiency. Despite lacking sight organs earthworms possess the ability to perceive light, which may not be news to us. Their skin possesses cells that are sensitive to light, enabling them to seek refuge in their bedding when exposed to light. This is especially important during daylight hours when sunlight can be lethal to them. Their reaction is a natural survival mechanism, causing them to immediately submerge themselves upon exposure to light when the lid is removed. Whereas red light does not affect earth worms as much as white or other colored light because they can't detect it. To avoid startling them and causing them to conceal themselves observe their feeding or reproduction habits using a red light.

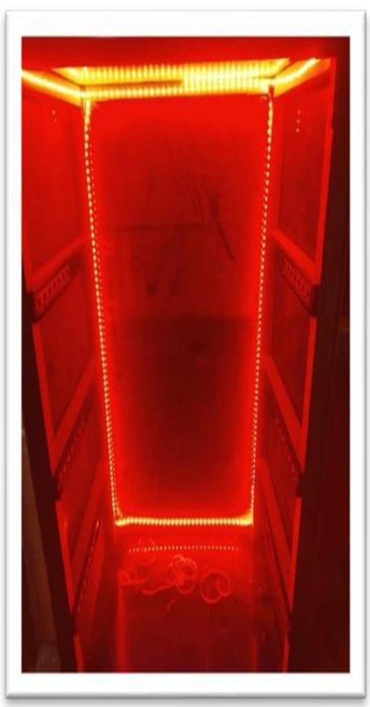

Fig 2.5 Red light as growth light for Vermi-worms

Table 2.1 Details of the amounts of worm produced in the wild, and under different kind of light colors in the lab worm bins.

Condition of Production by colors	Amount of cast produced (Ton)	Production relativeto control in this experiment	Production relativeto natural production in the wild
The wild (natural) (Madge, 1969; Lavelle et al., 1998, etc)	200	0.18	1
Control (Dark)	1127.8	1	5.64
White Light	761.3	0.68	3.81
Green Light	1486.5	1.32	7.43
Blue Light	1670	1.48	8.35
Red Light	1872	1.66	9.36

Fig 2.6 Brass water sprinkling nozzle with 12 V electric pump

4) Mobile Application

The dashboard will provide an overview of the current status of the vermicomposting bin, including temperature, humidity and water requirement to the bin. This can help us ensure that the condition is optimal for worms to thrive and break down the organic waste. This application can collect the data on the vermicomposting process, which can be analyses to identify patterns and optimize the process for maximum efficiency. The application can send notification to your screen when the bed temp is high that you need to switch on the exhaust fan to cool down the environmental condition insidethe bin. This gives us through data on which we can analyses the process with right temp and pH for better vermicomposting. This application can make it easier to manage and monitor our vermicomposting system from anywhere using our mobile device. It can help us optimize the vermicomposting process and produce high- quality compost for plants.

5) Cutting Paper

Addition of cutting paper to the vermicomposting process contributes to the bedding materials which should ideally make up about rest and bedding mechanisms, to make the breakdown process as fast as possible and ensure you end up with a good nutrient balancefor your vermicompost.

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Fig 2.7 Paper cutting

6) Paddy Straw

The main purpose of the use of the paddy straw is to increase the water holding capacityand providing bedding materials that consists of high carbon content. During composting, C isa source of energy for microorganisms to build up cells aid in plant growth and in soil fertility.

Fig 2.8 Paddy straw

7) Cow Dung

Elimination of harmful ammonia gas and pathogens like E. coli, as well as weedseeds, composted cow manure will add generous amounts of organic matter to the vermicomposting bed.

Fig 2.9 Cow Dung

8) Organic Waste

Kitchen waste is nutrient rich, or containing high level of Carbohydrates, lipids, proteins and other organic molecules which can support for populations of microorganisms.

Fig 2.10 Kitchen waste collection

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9) Eisenia fetida

The species we have used for vermicomposting process is Eisenia fetida which are suitablebecause of species are small, strategists, and have a short life cycle and high reproductive rates has the ability to eat wastes equal to their body weight

Fig 2.11 Eisenia fetida

10) Cost Analysis

Table 3.2 Total cost Estimation of Vermicomposting Bin

SL NO	MATERIALS	PRICE
1	Bin	750/-
2	Square Bar	2,050/-
3	Hardware	1,605/-
4	Telescopic Channel	1,290/-
5	Fibre Sheet	3,400/-
6	Cow dung+ Earthworm	955/-
7	Wheel	400/-
8	Sensors and Electronics	12,500/-
9	LED Light	1,250/-
10	Exhaust Fan	270/-
11	Gasket Strap	80/-
12	Pipe + Bucket	170/-
13	Carpenter	1,500/-
14	Flex+ NPK Test	800/-
15	Travel	3,500/-
	TOTAL	30,520/-

This is the total estimation that cost us during manufacturing of the IoT based vermicompostingbin.

III. RESULT AND DISCUSSION

A. *Observation of bin 01: (55-60) days with manual Process*

To check the efficiency of our prototype we have conducted an experiment based on its performance on two different bins. One is with manual bin with outside environment and another is with IoT based bin which is kept under controlled environment.

Table 4.1 Observation of manual vermicomposting bin

DAYS	TEMPERATURE	MOISTURE CONTENT(%)	pH
1	25	48.94	6.44
5	25	48.58	6.75
10	26	48.06	7.00
15	27	47.88	7.06
20	26	47.62	7.13
25	26	47.41	7.15
30	27	47.26	7.20
35	26	46.93	7.23
40	25	46.73	7.30
45	25	46.35	7.36
50	25	45.98	7.40
55	27	45.56	7.38
60	28	45.25	7.45

After about 60 days the volume of the material has dropped substantially. At this point, the compost and the worms were recovered from each trial pits. The recovered compost dried,
sieved through 2.5mm sieve and final product obtained . Finally, the compostcan be used as a manure and the earthworm were used for the next cyclic processes.

B. Observation Of Bin 02: (63-65) Day Under Controlled Environment

The second experiment was on kitchen waste, like vegetable waste, fruits peel etc. We observe the pH, moisture content and temperature through temperature sensor and hygrometer.

Table 4.2 Observation of IoT based vermicomposting bin

DAYS	TEMPERATURE	MOISTURE CONTENT (%)	pH
1	23.06	45%	6.91
3	24.08	44.45%	6.98
6	23.05	44.13%	7.00
9	23	43.81%	7.21
11	23.25	43.75%	7.27
15	23.45	43.71%	7.33
18	24	42.41%	7.36
22	23.25	42.78%	7.38
25	23.85	42.45%	7.39
29	23.08	42.32%	7.41
33	24	41.66%	7.45
36	24.25	41.32%	7.51
40	24.48	41.27%	7.52
44	23.85	40.87%	7.55
48	25	40.47%	7.56
50	25.45	40.32%	7.58
54	25.02	40.25%	7.60
56	25.85	40.14%	7.63
60	26	40.13%	7.66
63	26.45	40.07%	7.69
65	26.85	40.01%	7.71

The whole vermicomposting process is completed in 65 days under controlled environment. The moisture content and the pH value as well as the temperature of the bin gives us fruitful result. The pH values of the compost are within the standard limit thoughtit is neither acidic nor alkaline. By monitoring the real time temperature, we generate the reports on the proper temperature of the worm bin which provides valuable insights into the health and productivity of the compost. After whole completion of the process the nutrient rich compost is ready to use. So, the NKP value is (nitrogen-0.17%, potassium-
0.48 % and phosphorus-0.52%).

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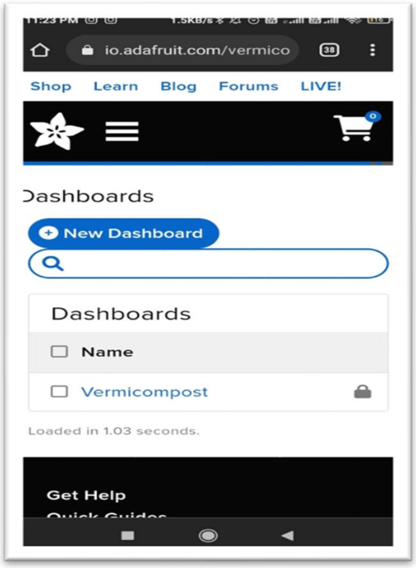
C. Application Interface

To digitally display the parameter of vermicomposting bin we have use Adafruit IoT application. The interface has been used to monitor the parameter and regulate it remotelyif necessary.



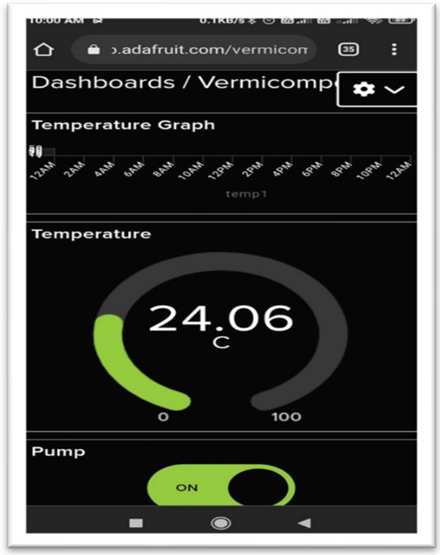


Fig 3.1 Project Interface Fig 3.2 Regulation of vermicompostingbin on Application

The above figures depict the use of Adafruit application for regulation of model. The project was named as Automated vermicomposting using portable bin, with temperature control and water pump switch as input data shown in fig 4.2. The compost moisture content is represented in terms of percentage which works when the neutron probe is inserted to the soil.

D. Prototype Set-Up

Fig 3.3 Integrated Prototype Fig 3.4 Working Model

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IV. CONCLUSION

IoT based portable vermicomposting bins offer several benefits for small scale vermicomposting operations. The use of IoT technology allows for remote monitoring and control of critical environment conditions, which can improve the efficiency and effectivenessof the composting process.

Overall, IoT based portable vermicomposting bins have the potential to revolutionize the way small- scale vermicomposting is done, making it more efficient, effective and accessible to a wide range of users. However, careful consideration and management of the potential threats and challenges is essential to ensure their safe and effective use. This prototype takes to the new era where people are able to connect with the bin via a mobile application.

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