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Garbage Bin Monitoring System using Performant Internet of Things (IoT)

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Abstract:- The Internet of Things (IoT) will be able to integrate a wide range of various and heterogeneous end systems transparently and smoothly, while also offering open access to chosen subsets of data for the creation of a wide range of digital services. Solid waste management has been one of the key environmental issues in the Philippines, where it not only upsets the ecosystem but also has a negative impact on societal health. This device uses a single ultrasonic sensor to get data on waste level. After eight months of research and development at Eastern Samar State University's Salcedo Campus, the device was finished. Benchmark, Alpha, Beta, and Usability tests were conducted, and the results showed that the Garbage Bin Monitoring System is fully functional and can monitor the level of the garbage in the bin. It is now ready for implementation. The Trash Bin Monitoring System project is an extremely creative technology that will aid in maintaining clean towns. This device keeps an eye on the waste bins and sends SMS updates on the amount of trash being collected there. Also, all the information is sent to garbage bin users via this SMS.

Keywords:- *Arduino Microcontroller, Solid Waste Management, Internet of Things (IoT)*

I. INTRODUCTION

In today's times, as the population grows by the day, overflowing rubbish bins in most cities create an unsanitary atmosphere, increasing the danger of many forms of unknown diseases and lowering the standard of living.

Aziz, et.al (2018) highlighted that an efficient Solid Waste Management (SWM) system was required to manage the rising solid waste created by a growing population and to keep waste sites clean. Yet, a competent SWM is costly since it needs cash, employees, equipment, infrastructure, and an effective operating plan. The authority's and the public's support and engagement are critical for the running of a contemporary SWM. An integrated waste management system for an urban population necessitates careful planning of waste material transit from source to treatment and disposal facilities

Based on the research in the urban area (Sirisha Yerraboina 2018), waste was become a severe issue in the present century. Population increase, lack of responsibility towards the environment. Improper resources management, etc. were the primarily reasons for excessive generation of garbage. This issue was prevailing continuously resulting in various problems irrespective of the developed or developing nation. The problem of garbage collection and monitoring was worsened by the fact that garbage was widely scattered, abundantly created, and generally uncontrolled. Bins were well-known and widely used means of rubbish collection. To avoid this problem and to keep our environment clean and green, we need seek for an effective garbage collection and bin monitoring system.

The Internet of Things (IoT) was an evolving technology that has spawned a plethora of applications. It was the integration of information, communication, and networking technologies via a shared platform.

Since day by day people were moving towards internet and technology, even the people from were now moving towards technology and in coming few years most of the population or world have shift to urban life style which have eventually increase the demand of internet and the various wireless sensors have been related to it, which this eventually helped in the building of Internet of Things paradigm. When wireless sensor start in building their place in the society then that helps to grow the city infrastructural outlook and the city was also considered to be smart city.

A smart city is an urban region that employs several types of Internet of Things sensors to gather data and use this data to efficiently and effectively manage resources and assets. This definition focuses on how smart cities may genuinely

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contribute to redefining ways to manage pollution and enable city inhabitants live with peace and hygiene, as well as the newest access to various technical components that may actually help people keep peace with the increasing globe.The wireless sensor used in smart cities can basically help in different aspect in daily life as well, Proper garbage management is one of the most important aspects of our daily life. As Proper garbage management impacts on the quality of life the citizens has. The truth behind this fact was that waste disposal was a leading factor in any person's well-being. To live a healthy life proper waste disposal was important. (Joshi and Bagga, 2020)

The proposed system ensures that waste is collected as soon as the rubbish level reaches its maximum level. As a result, the system produces more accurate reports, enhancing the system's efficiency. The use of sensors to monitor the waste level in real time minimizes the number of visits necessary by the garbage collection truck, lowering the overall cost connected with the rubbish bin. This device comprises of a single ultrasonic sensor that collects trash level data.

II. OBJECTIVES OF THE STUDY

The study aimed to design, develop and test the Garbage Bin Monitoring System.

- Design a garbage bin monitoring system using Internet of Things (IoT).
- Develop a garbage bin monitoring system to monitor the level of the bin using laptop and sensors.
- Test the garbage bin monitoring system using Internet of Things (IoT).
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III. METHODOLOGY

A. Planning, Design and Specification

Figure 2 shows the system's data flow diagram. This illustrates how data moves throughout the entire network. To gauge the level of the applied parameters, sensors were used. The sensors evaluated the level of the trash cans. The garbage bin monitoring program received the data after the sensors evaluated the bin levels. When that happens, the mobile phone will receive a notice from the Trash Bin Monitoring System application. The smartphone then received message via GBMS application.

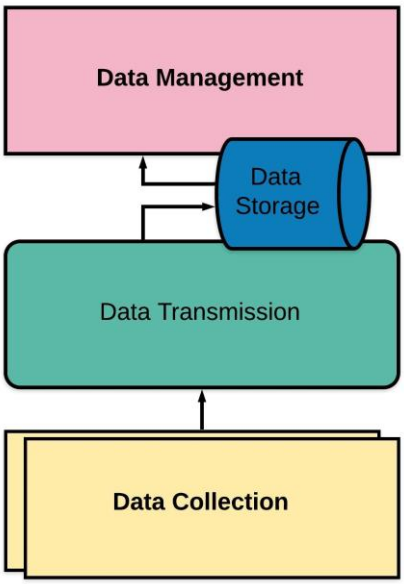

Fig 2. Data Flow Diagram of the Garbage Bin Monitoring System

The two key system parameters were the passive SMD buzzer and ultrasonic sensor. The system's block diagram is shown in Figure 4.

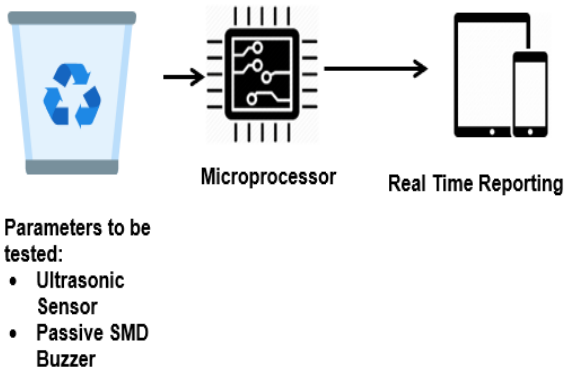

Fig 9. Block Diagram of Garbage Bin Monitoring System

IV. RESULTS AND DISCUSSION

The application underwent a number of tests following the development period in order to gauge its quality. This made it possible for the researchers to assess whether the requirements met during the development process and after each testing. Following each test, the respondents assessed which criteria needed to be removed, updated, and added to.

Based on the ISO criteria, which assessed the system's functionality, reliability, usability, efficiency, maintainability, and portability, the system was given a rating.

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A. Benchmark Testing

After a successful test, all benchmark test criteria were computed, and Table 1 provides a summary of the benchmark test on the quality characteristic of garbage bin monitoring using Performant IoT. To get the overall mean, the results of the six criteria were summed. Based on the mistakes made, the system has been altered, modifying the picture and the animations. The performance of the system was enhanced following the benchmark test.

In the criteria of "Functionality", it obtained a mean score of 2.8 and was interpreted as Good. On the "Reliability", "Usability" and "Portability" it obtained a mean score of 3.0 which was interpreted as Good. On the "Efficiency" it obtained a mean score of 2.6 and was interpreted as Good. And the "Maintainability" it obtained a mean score of 2.7and was interpreted as Good. This means that the developed system in terms of functionality, reliability, usability, efficiency, maintainability, and portability needs to undergo major revision.

TABLE I. BENCHMARK TEST RESULT

Criteria	Mean	Interpretation
1. Functionality	2.8	Good
2. Reliability	3.0	Good
3. Usability	3.0	Good
4. Efficiency	2.6	Good
5. Maintainability	2.7	Good
6. Portability	3.0	Good
Overall Mean	**2.8**	**Good**

B. Alpha Testing

Table 2shows the summary result of the Alpha Test. The evaluators recommendations led to the system's functioning being enhanced and made more accurate results. This indicates that the system is now prepared for beta testing, during which the researchers will examine the system's effectiveness and functioning, though dependability needs to be improved.

In the criteria on "Usability", it obtained a high mean score of 4.0 and this was interpreted as "Very Good". It was followed by the "Efficiency" and "Portability", it obtained a mean score of 3.6 and was interpreted as "Very Good". Then "Functionality", it obtained a mean score of 3.5 and was interpreted as "Good". "Maintainability", it obtained a mean score of 3.3 and was interpreted as Good. And "Reliability", obtained a mean score of 3.2 and was interpreted as Good. This means that the developed system is functional but still needs an improvement in terms of reliability and maintainability.

TABLE II. ALPHA TEST RESULT

Criteria	Mean	Interpretation
1. Functionality	3.5	Very Good
2. Reliability	3.2	Good
3. Usability	4.0	Very Good
4. Efficiency	3.6	Very Good
5. Maintainability	3.3	Good
6. Portability	3.6	Very Good
Overall Mean	**3.5**	**Very Good**

C. Beta Testing

The summary of the beta test is presented in Table 3. According to the test's findings, the system is well-designed and executes its functions precisely. Following beta testing, the researchers eagerly anticipated the respondents' suggestions. The program has been upgraded and enhanced.

All of the criteria obtained a weighted mean score of 5.0 and interpreted as "Excellent". This means that the developed system in terms of functionality, reliability, usability, efficiency, maintainability, and portability conforms to the specifications identified during the design and development stage.

TABLE III. BETA TEST RESULT

Criteria	Mean	Interpretation
1. Functionality	5.0	Excellent
2. Reliability	5.0	Excellent
3. Usability	5.0	Excellent
4. Efficiency	5.0	Excellent
5. Maintainability	5.0	Excellent
6. Portability	5.0	Excellent
Overall Mean	**5.0**	**Excellent**

D. System Usability Test

after the completion of the acceptance testing. The created system was put through usability testing to ensure it met the specifications and was ready for implementation. The System Usability Scale (SUS) from Digital Equipment Corporation (1996) was used by the respondents to gauge how well a product helps users achieve their objectives. SUS has established itself as a dependable and strong assessment instrument. It has a strong correlation with other arbitrary usability measurements. When the respondents have had a chance to utilize the system being reviewed, but before the evaluation, a debriefing or conversation takes place, the SUS Scale is typically employed.

The summary for the system usability scale test is shown in Table 4. It displays the total score obtained from the 10 item statements. It had a SUS rating of 87.5 overall. This indicates that the system has been successfully built and is now ready for use.

TABLE IV. SYSTEM USABILITY TEST RESULT

Criteria	Mean	SUS Score
1. I think that I would like to use the system frequently	4	3
2. I found the system unnecessarily complex	1	4
3. I thought the system is easy to use	4	3
4. I think that I would need the support of a technical person to be able to use the system	1	4
5. I found the various functions in this application were all integrated	4	1
6. I thought there was too much inconsistency in this system	1	4

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7. I would imagine that most people would learn to use this system very quickly	4	1
8. I found the system very cumbersome to use	1	4
9. I felt very confident using the application	4	3
10. I needed to learn a lot of things before I could get going with this system	1	4
SUS Score x 2.5		35
Overall SUS Score		**87.5**

V. CONCLUSION

Based on the findings of the study, the researchers had come up with the following conclusions:

- The Garbage Bin Monitoring had been successfully developed and tested.
- The Garbage Bin Monitoring System met the standards laid down during the proposal, it was successful and functional.
- The Garbage Bin Monitoring System was effective and usable since the result may dependent on the sensor.

RECOMMENDATION

- Based on the results of the study, the researchers had drawn the following recommendations:
- The Garbage Bin Monitoring System should be implemented.
- The Garbage Bin Monitoring System since the result was dependent on the sensor, other sensors must be purchased.
- The Garbage Bin Monitoring System could also be used online using wireless devices such as cellphones.

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