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# Smart-Waste Management System Based On Arduino and Motion Sensors

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***Abstract:*** ***Smart-Waste Management System involves the collection of the waste generated in separate dustbins that are equipped with Arduino based automated system. The segregation of the waste will be done by the IoT based system; the sensor will detect and segregate the waste into recyclable and non-recyclable waste. As with the increment in population the amount of garbage generation per year is increasing as well. Most of the garbage generated is left untreated and the garbage dumping places and garbage dumpsters are becoming more unhygienic and polluted. After the COVID-19 pandemic many people prefer contact less interaction. Automated-dustbins are the best ways to deal with this situation. The dustbins will be controlled by Arduino components allowing it to open when waste is detected; it will also notify the garbage collector when the dustbin capacity is full and the waste needs to be collected. So thus, the garbage collector need not to go collect the garbage unnecessarily. Secondly, after the waste is collected the wet garbage is being dumped and buried underground whereas the dry garbage needs to be segregated on the basis of recyclable and non-recyclable waste. The waste segregation is based on the sensor and system based on IoT that allows to segregate the waste into categories like wet, metallic, paper-plastics, etc. These will lead to save of fuel and time, at the same time automated system will lead to contactless collection of waste and segregation of waste will help to treat waste properly, classify them into categories and proceed them for further processes. This way the amount of unprocessed and untreated waste will get reduced to some extent; resulting in less pollution.***

***Index Terms: Arduino, Automated, Recyclable, Segregation, Smart-waste***

## I. INTRODUCTION

India is considered in the world's top 10 countries that generates municipal solid waste (MSW) because of rapid development and urbanization and economic growth of the country. The Energy and Resources Institute(TERI) reported that India typically generates 63 million tones(NT) of waste annually, and that amount is rising daily due to the country's expanding population. Only 43 million tons (70%)of the waste is collected by the municipal corporation, with 31 million tons are simply discarded in landfill sites or dumpsters and 12 million tons are treated before disposal; and on average the number is still changing. It is expected that the average waste generation will have increment of approximately 165 million tons by 2030. Thus from the data we can conclude that the most of the waste remains untreated and does not get collected. Inadequate waste management practices, including inadequate collection, transportation, and disposal, have emerged as significant contributors to environmental contributors to environmental, public health, and hygiene issues in the country.. With the growth in population, industrialization, and development in various fields pollution and waste generation still stands the major problem; resulting in global warming, depletion of natural resources, unhealthy environment and many more. Though there are several measures have been taken for these, untreated waste and the resulting problems by that is still a major problem in our country. Unhygienic environment near garbage dumpster, overflowing garbage, growing bacteria and insects, improper timing for the collection of the waste, are some of the problems that are still faced today.

Till date there are several research and projects based on waste segregation and optimization. There are even projects on Smart-waste management that collects separate waste and segregate it for further process. There were projects for the separate collection of waste, automatic lid-system for the dustbin, waste segregation of waste and few more. The segments of the Indian solid waste management market are collection, transportation, treatment and disposal. Due to inadequate infrastructure for collection and transportation, the collection and transportation sector accounts for the majority of the market. Our country still faces the problem of proper waste management and collection issue till date. There is defined system that identifies the fullness of litter in the smart-bin and delivers the message to the wireless mesh network as per the described in the paper[1]; due to such information the cleanliness workers are able to make wise decision. The introduction of an Arduino-based smart trashcan for waste management systems include an alarm system that uses LED blinking to provide information about dustbin disposal. At the top of the trash can is an ultrasonic sensor that, according to the research, calculates the distance from the bottom to the proper acquired level[2].

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To overcome this the project introduced is based on the smart waste collection as well as the segregation and disposal of the waste. The waste collection, transportation and treatment is to be processed. As it involves technology and automated equipment, it will make the process easier, automated and the environment more hygienic. As with the development in our age we need automated systems for the collection of waste as it can help us to keep the environment clean and hygienic; and the process of waste collection and segregation will be more relevant and faster.

## II. METHODOLOGY/EXPERIMENTAL

*A. Materials/Components*

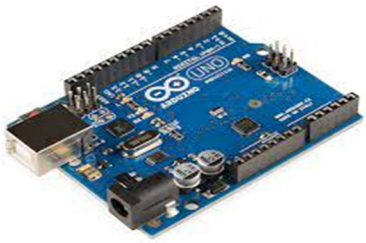
*1) Hardware Required*

*a)* Arduino Uno microcontroller board
*b)* Ultrasonic sensor (HC-SR04)
*c)* Servo motor(SG-90 micro)
*d)* Dustbin

*2) Software Required*

*a) Arduino IDE*

Arduino UNO( microcontroller board)



Arduino UNO (microcontroller) is based on the processor ATmega328P. It is basically a small working version of microcontroller that works by plugging in with the adapter or USB to the computer. The Arduino is easy to work with and is economically good as well. This whole project is based on the Arduino; two different microcontrollers are used simultaneously for the working of the project however it can replaced by the higher version of microcontroller too.

*b) Ultrasonic Sensor (HC-SR04)*




The ultrasonic distance sensor HC-Sr04 is used to determine how far an object is from the sensor position. It works on the basis of SONAR principle. It is ideally best for the projects like obstacle avoiding robot, distance measurement, etc. In our project, there are two consecutive sensor are used. One is for the gesture detection or hand movements detection (which can be replaced by gesture sensor in advancements) and the second for the detection of the state(full or emptiness) of the inside of the bin. The sensor can have various functions depending upon the sound waves used to measure distance or just to tract the object or detect motion(object).

*c) Micro Servo motor(SG-90)*



The SG-90 Micro servo motor is easy, relevant and of good quality. It is perfect for small robotics project and is designed to work with most radio control systems. This servo motor works best with remote-controlled objects. It is basically like a robot muscle that helps things move precisely; with specific commands, it moves in specific position with precise angles to reach that spot accurately. We have used servo motor in our project to basically open and close the lid of the dustbin to our need according to the command.

*d) Liquid Crystal Displays(LCD) with Arduino*




The LCD display which are compatible with Hitachi HD44780 driver are controlled by the LiquidCrystal library. The LCD in Arduino is a 16-pin interface thus easily distinguishable. The Microcontroller manipulates the lcd by several parallel interface pins to control the display at once. There are register pins, read/write pins, enable pin, 8 data pins, display contrast pin, power supply pins and LED backlight pins. We have used 16×2 LCD display in our project to display the percentage of the state of the bin and to print the corresponding message on the screen.

*e) Dustbin*

A normal dustbin is used as for the collection of waste. Wet and Dry garbage is used differently as it can help in the Waste Segregation.

*f) Arduino IDE*

The Arduino IDE i.e. Integrated Development Environment is a software that is used to write and execute code to the Arduino circuit/board. The simplicity of code and it's simple connection is the reason Arduino is mostly preferred for projects in robotics, remote-controlled systems, etc. The IDE application is suitable and convenient to use as it is works on variety of operating systems such as Mac OS, Linux and Windows. The code is basically written in either C or C++ language.

*B. Method*

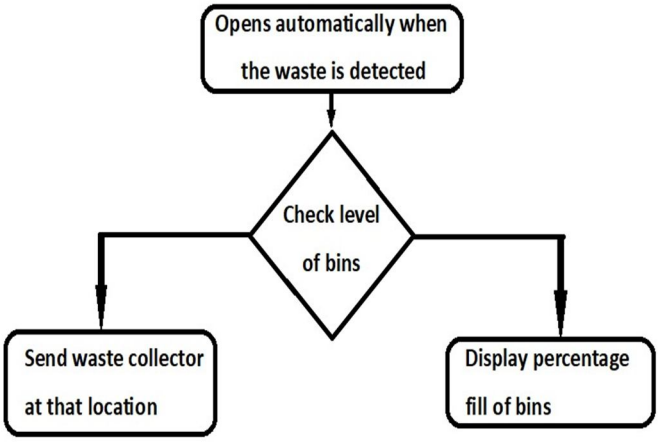
The Project is divided into two parts:

*1) Automatic Waste Collection*

The first part includes the smart-automated dustbin that involves collection of waste in more hygienic way than before. The disposal of Trash in proper way is important, and is everyone's responsibility. After the pandemic Era people are getting more concerned about health and hygiene and are preferring to be as much contactless as possible. The smart-automated dustbins are more important in these situation.

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In this project we have decided to create a smart-automated dustbin based on Arduino as per the work[1].
Along with that we are embedding the dustbin with the LED display and alarm system or notification system that will indicate the fullness/ state of the dustbin[2].The Ultrasonic Sensor embedded in the dustbin is used to dictate the Object/trash and sends the signal to the Arduino UNO board. When the microcontroller board sends a signal or order to the servo motor attached to the board, the motor operates and raises the bin's lid. There is a LCD fixed to the setup along with the system that will display the state/status of the bin. The percentage fill level of the dustbin will be showed at the LCD and after the certain fixed amount of the dustbin is filled the servo motor will be locked and the lid will not open unless the key is used to open it. The signal received from the sensor will be transferred to the board and Status will be received by the LCD. After the waste each a certain level in the dustbin, the sensor will detect the level and send the notification of urgent collection of garbage to the garbage collector, as the bin will be locked as well. The notification will be sent to the garbage collector by the webpage, where he will get to know the dustbin number and it's status; thus the collector need not to heedlessly go to every area to collect the trash. Henceforth, resulting in saving of fuel and time.




*2) Waste Segregation*

As for the advancement of the project waste segregation of the collected waste will be done. As the waste is already collected separately as dry and waste further segregation will be based on the recyclable, disposable and metallic factors. It will be based on the IR sensor, and metallic sensor that will use to segregate the waste into categories. This will usually help for the further process for recyclable and non-recyclable waste. We are planning to extend the project to the segregation part in the future. Several research modules and methods have been done in this regard.

## III. RESULTS AND DISCUSSIONS

1) *Efficient waste Collection:* Implementation of smart dustbins with the notification level and real-time fill status of the bin will result in more efficient waste collection processes; and will help the authorities to prioritize tasks and collection based on the data collected.
2) *Impact on Environment:* The real-time data of the bin level helps significantly in reducing the overflowing of the bin; resulting in the cleaner and litter free environment(reduced environmental pollution).
3) *Challenges and Limitations:* Technological acceptance with up-to-date methods are important and should be taken into consideration. People's response and feedback as well as the basic knowledge about the system and it's acceptance among them should be made. Moreover using this technology at greater extent is a little difficult at the beginning.

## IV. FUTURE SCOPE

*A. Waste Optimization*

1) *Efficiency:* Smart dustbins provide real-time data on the status of the time. So there is no need for the collection for partially filled and empty dustbins, saving time and resources.
2) *Cost Saving:* Reduce fuel consumption, efficient management and resources will help the municipal corporation for better work and improvement.

*B. Public Health and Hygiene*

*1) Disease Prevention:* Improper dumping of garbage and overflooding of garbage in the bins are avoided; that helps to reduce spreading of diseases and unhygienic environment.

*2) Timely Collection:* As the collector is notified about the condition of the bin, the bin gets collected before over-flooding.

C. Technological advancements and integration with Smart cities:

*1) IoT integration:* Smart bins can get integrated into citied with large population and waste generation; contributing to the efficiency of urban environments.

*2) Interconnected Systems:* Integration with advance technology can lead to the development and advancement of smart cities.

*3) Battery Efficiency:* To extend the battery life of the smart bins, improvement in battery technology can be made.

*4) Technological Innovations:* Advancements in sensor technology and advance coding can lead to more accurate fill level monitoring.

## V. CONCLUSION

This paper describes an automated smart waste management system using a gesture sensor and Arduino components (which can be expanded upon dependent on needs). We have demonstrated the above system's use and implementation, along with its advantages for our society. These papers have addressed and emphasised the growing population and its effects on several aspects such as waste collection, disposal, and generation, and most significantly, public health and hygiene. These projects give waste collectors access to a methodical waste management system that facilitates the collection and segregation of waste produced and collected, improving litter treatment and lowering the amount of waste that overflows dumpsters. People will consider this idea more convenient considering it implements a contactless method.

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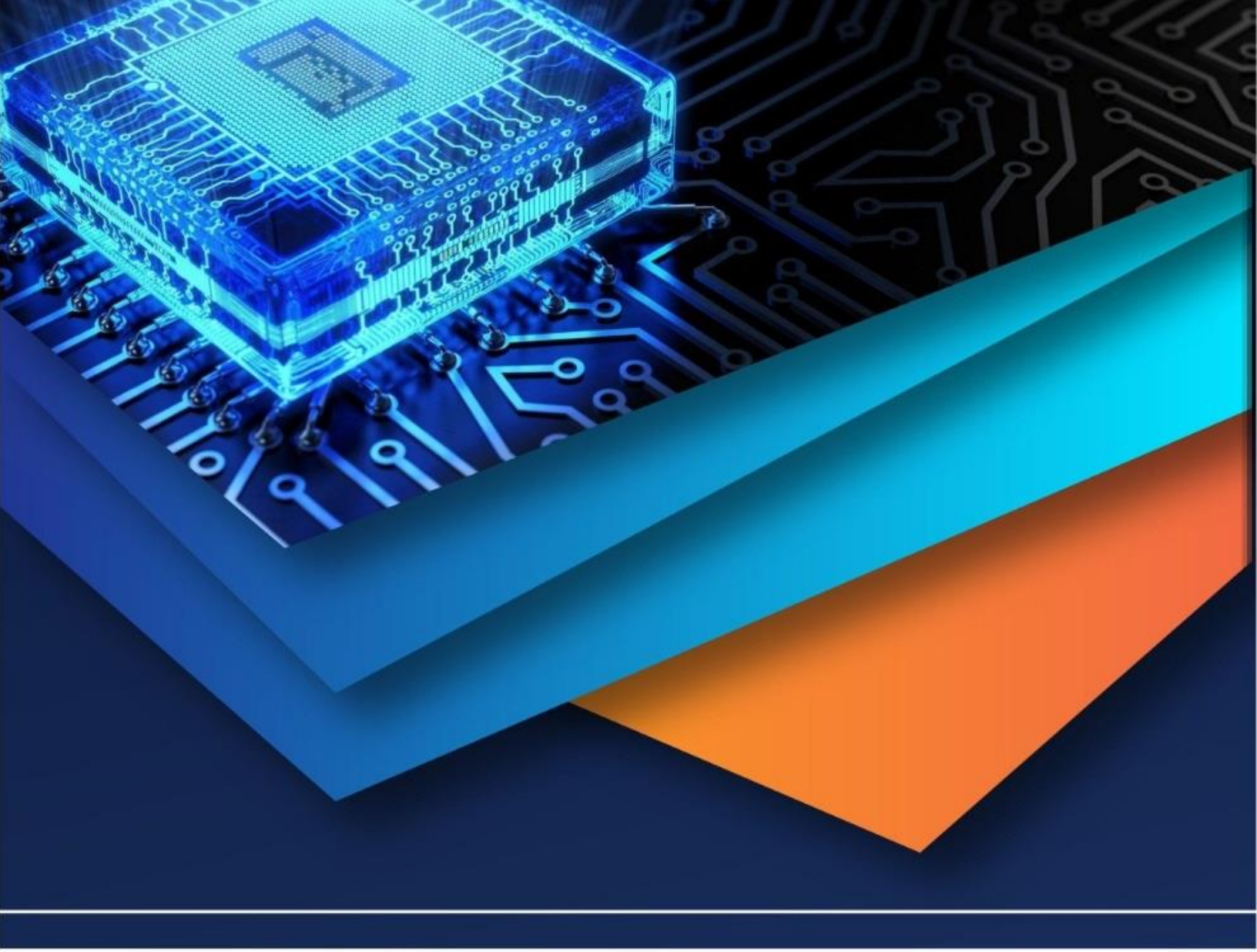
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