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Garbage Management System by Developing A Smart Dustbin

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Abstract
Urbanization has significantly increased in recent decades, leading to a concurrent rise in waste production. Managing waste has become a critical issue, and the improper maintenance of dustbins contributes to environmental and health problems. Overflowing dustbins attract disease-spreading insects such as mosquitoes, flies, and bees, and the pollution they cause can produce bacteria and viruses, potentially leading to life-threatening endemic diseases.
India, with over 1.4 billion people, generates the highest amount of waste globally, surpassing even China. Although the per capita waste in India and China is lower than in developed countries, the total waste generated is substantial. According to the World Bank, 2.01 billion tons of municipal waste is produced worldwide each year, a figure projected to increase by 70% to 3.4 billion tons by 2050 due to rapid urbanization, population growth, and economic development. In India, 77% of waste is disposed of in open dumps, 18% is composted, and only 5% is recycled. Notably, 34% of all waste is generated by 16% of the world's population, mainly from high-income countries, but over one-third of this waste is recovered through recycling and composting.
A promising solution to waste management issues in urban areas is the implementation of smart dustbins. These dustbins use ultrasonic sensors to detect the garbage level and send notifications to users and handlers via GSM modules when the bin is full. This technology is environmentally friendly and aligns with the development of smart cities, aiming to ensure public health and sanitation.

I. Introduction:

The ubiquitous problem of garbage overflow poses a significant challenge in urban areas, leading to disease proliferation due to insect breeding. Effective solid waste management systems are essential for maintaining cleanliness and public health. For smart cities to thrive, requirements such as proper placement and timely collection of dustbins must be met. The current waste management system in many Indian cities suffers from unhealthy dustbin conditions. Upgrading this system is crucial for environmental and public health. A smart dustbin system represents an efficient approach to maintaining clean and green environments in urban settings.

One crucial step in developing a new Smart Dustbin understands the existing waste management systems. This section reviews various systems proposed by researchers and students worldwide. In many smart garbage management systems, the garbage level in dustbins is detected using sensor systems and communicated to an authorized control room via GSM systems. Microcontrollers interface the sensor systems with GSM systems, and a GUI is developed to monitor garbage levels at different locations. This approach aims to enhance the efficiency of garbage collection.

System Overview:

1. **Sensors for Garbage Level Detection:**
   - **Infrared (IR) Sensors:** Used to detect the level of garbage in dustbins. IR sensors emit light invisible to the human eye but detectable by electronic devices.
2. **Communication:**
   - **GSM Module:** Utilized for sending messages to the control room when the container is full.
3. **Microcontroller Interface:**
   - **Arduino Board:** Interfaces the sensor and GSM module. The IR sensor arrangement acts as a level detector, and its output is fed to the microcontroller. AT commands facilitate messaging through the GSM module. This program is burned into the microcontroller using Arduino software (IDE).

4. **Monitoring and Response:**
   - The messages sent to the control room contain information about the garbage levels in the respective dustbins. Based on this information, the control room notifies the concerned personnel, who ensure that the garbage is collected by dispatching cleaning vehicles.

Proposed System: Smart dustbins aim to enhance waste management by integrating sensors for garbage level detection and messaging systems for status updates. When the dustbin is full, it moves along a predefined path to reach a larger container using motors and wheels.

Key Features of the Proposed System:

- **Automatic Lid Operation:** Ensures the lid opens and closes automatically for ease of use and to prevent physical contact, reducing germ transmission.
- **Dry and Wet Garbage Separation:** Maintains separation of different types of waste for better management and recycling.
- **Warning Indications:** Provides alerts when a dustbin is nearly full and sends SMS notifications to the garbage collector in the respective area.
- **Health and Environment:** Ensures a healthy environment is maintained by preventing overflow and prompt waste collection.
- **Application in Educational Institutions:** Employ smart dustbins in college and university campuses to promote cleanliness and environmental consciousness.

By implementing these smart dustbins, urban waste management can be significantly improved, contributing to cleaner and healthier cities.

Working Methodology: The Smart Dustbin project integrates several components, including a frame, rack and pinion mechanism, battery, and DC motor. Here's a detailed breakdown of how the system operates:

1. **Mechanism and Components:**
   - **Rack and Pinion:** This mechanism is used to slide a door using a DC motor. The rack (a straight bar with teeth) moves linearly when driven by the pinion (a small gear), enabling the door to open and close.
   - **DC Motor:** Powers the rack and pinion mechanism to control the movement of the dustbin lid.
   - **Battery:** Provides the necessary power to the DC motor and other electronic components.
2. **Control Unit:**
   - The control unit monitors the system and provides real-time information about the dustbin's status. It manages the automatic lid operation and garbage level detection.
3. **Garbage Level Detection:**
   - A sensor, typically an ultrasonic sensor, measures the distance between the lid and the trash inside the bin. This distance is compared against a predefined threshold set according to the bin's dimensions.
   - When the sensor detects that the bin is full (i.e., the trash has reached the threshold distance), it triggers an alert.
4. **Automatic Messaging:**
   - The microcontroller board interfaces with a GSM module. Upon detecting a full bin, the microcontroller uses the GSM module to send an SMS alert.
   - The SMS contains the bin ID number and an alert message, which is sent to a predefined phone number, typically that of a sanitary worker or waste management authority.
5. **Identification and Notification:**
   - The location of each bin is predefined, and the sanitary worker can identify the filled bin by its unique ID number received in the SMS alert.
   - This system ensures that the specific bin is promptly attended to and emptied, preventing overflow and maintaining cleanliness.
6. **Return to Default Operation:**
   - Once the bin is emptied by the sanitary worker, the system resets and returns to its default operation, ready to detect the next time the bin is full.

Key Functionalities:

- **Automatic Lid Operation:** The lid opens automatically without needing physical contact, reducing the risk of germ transmission.
- **Real-Time Monitoring:** The system provides up-to-date information on the bin's status, ensuring timely waste collection.
- **Efficient Waste Management:** By sending alerts when bins are full, the system helps in managing garbage collection efficiently, reducing the chances of overflow and associated health hazards.

By integrating these components and functionalities, the Smart Dustbin project offers an innovative solution to urban waste management, ensuring a cleaner and healthier environment.

Cam Mechanism for Door Operation: In the Smart Dustbin project, the cam mechanism is utilized to open and close the bin door. Initially, a rack and pinion mechanism was considered for this purpose, but it presented several issues. The cam mechanism proved to be more effective and reliable for this task.

Components and Operation:

1. **Cam Mechanism:**
   - **Cam:** A rotating or sliding piece in mechanical linkage used especially in transforming rotary motion into reciprocating motion.
   - **Design:** The design of the cam is custom-made by an expert guide to ensure optimal performance for this specific application.
2. **Power Supply:**
   - **Battery:** A 12-volt battery with a current rating of 0.3 amps provides power to the system.
   - **DC Gear Motor:** The battery supplies power to a DC gear motor. Attached to this motor is a gearbox that reduces the speed and increases the torque.
3. **Speed and Motion:**
   - **Motor Gearbox:** The gearbox outputs a speed of 10 rpm (rotations per minute) to the shaft.
   - **Spindle and Cam:** The spindle connected to the cam mechanism lifts the door of the dustbin.
4. **Operation:**
   - When the motor is powered, it rotates the cam.
   - The cam's profile is designed to convert this rotary motion into the reciprocating motion required to lift and lower the door of the dustbin.
   - As the cam rotates, it gradually lifts the door until it reaches its highest point, then lowers it back down as it continues to rotate.

Advantages of the Cam Mechanism:

- **Smooth Operation:** The cam mechanism provides a smoother and more controlled motion compared to the rack and pinion system.
- **Reliability:** It is less prone to mechanical issues and provides consistent performance.
- **Customization:** The cam's design can be tailored to meet specific requirements for the door's movement, ensuring precise control.

Arduino Uno: The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller, developed by Arduino.cc. This board is highly versatile and widely used in various DIY projects, prototyping, and educational purposes due to its ease of use and extensive community support.

Features and Capabilities:

- Microcontroller: ATmega328 SMD
- Operating Voltage: 5V
- Supply Voltage (recommended): 7-12V DC (can accept between 7 and 20V)
- Digital I/O Pins: 14 (of which 6 can provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 40 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB (0.5 KB used by the bootloader)
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz

Programming and Connectivity:

- **Programming Interface:** The Arduino Uno is programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. The IDE allows users to write, compile, and upload code to the board.
- **Power Options:** The board can be powered through the USB connection or with an external 9-volt battery. It can also accept power from an adapter within the 7-20V range.

I/O Pin Functions:

- **Digital I/O:** The 14 digital pins can be used for input or output operations, with 6 of them capable of PWM (Pulse Width Modulation) output. PWM is useful for controlling devices like motors, LEDs, and other components requiring analog-like control signals.
- **Analog I/O:** The 6 analog pins can read signals from analog sensors and convert them to digital values that the microcontroller can process.

Applications in Smart Dustbin Project: In the Smart Dustbin project, the Arduino Uno serves as the central control unit, interfacing with various components:

1. **Sensor Interface:**
   - Connects to the ultrasonic sensor to measure the garbage level.
   - Processes the sensor data to determine if the bin is full.
2. **Motor Control:**
   - Controls the DC motor and cam mechanism for opening and closing the bin door.
3. **Communication:**
   - Interfaces with the GSM module to send SMS alerts when the bin is full.
   - Utilizes digital I/O pins for communication and control signals.
4. **Power Management:**
   - Manages power distribution from the battery to the sensors, motor, and GSM module.
   - Ensures efficient power usage to prolong battery life.

The Arduino Uno, with its ATmega328P microcontroller, is a powerful and flexible tool for embedded systems and automation projects. Its digital and analog I/O capabilities, along with programmable features via the Arduino IDE, make it ideal for applications like the Smart Dustbin project, where it efficiently manages sensor data, motor control, and communication to ensure effective waste management. In the Smart Dustbin project, the cam mechanism effectively replaces the initial rack and pinion setup for opening and closing the bin door. Powered by a 12-volt battery and driven by a DC gear motor, the custom-designed cam transforms rotary motion into the reciprocating motion necessary to operate the door. This design choice enhances the reliability and smoothness of the bin's operation, ensuring efficient and problem-free performance.

II. Conclusions:

This project focuses on the implementation of a smart dustbin using an IR sensor, microcontroller, and GSM module. The system is designed to ensure that dustbins are cleaned promptly once the garbage level reaches its maximum capacity.

Key points and benefits of the system include:

- **Efficient Cleaning:** The system sends an alert to the waste management team as soon as the dustbin is full, ensuring timely cleaning and preventing overflow.
- **Accountability:** If the dustbin is not cleaned within a specified time frame, a report is sent to higher authorities. This mechanism helps hold contractors accountable and ensures compliance with cleanliness standards.
- **Monitoring and Verification:** The system aids in monitoring and preventing fake reports of dustbin cleaning, ensuring that only actual, verified cleanings are reported.
- **Cost Reduction:** By optimizing the timing and number of garbage collection trips, the system reduces the total expenditure associated with waste collection.
- **Environmental Impact:** The reduction in unnecessary trips and timely collection helps in maintaining cleanliness, contributing to a healthier and more pleasant environment.

Overall, the smart dustbin project enhances the efficiency of garbage collection and supports the goal of keeping communities clean and green. The integration of modern technology in waste management ensures better service delivery and resource utilization.

References

[1]. Prof. R.M.Sahu, Akshay Godse, Pramod Shinde, Reshma Shinde "Garbage and StreetLightMonitoringSystemusingInternetofThings",Internationaljournalofinnovativeresearchin electrical, electronics, instrumentation and control engineering, Volume 4, Issue 4, April2016.

[2]. Insung Hong, Sunghoi Park, Beomseok Lee, Jaekeun Lee, Daebeom Jeong, and SehyunPark, "IoT-Based Smart Garbage System for Efficient Food Waste Management", HindawiPublishingCorporation ScientificWorld JournalVolume 2014.

[3]. Yılmaz Guven, Ercan Cosgun, SıtkKocaoglu Harun Gezici, Eray Yilmazlar, ResearchInventy" Understanding the Concept of Micro-controller Based System to Choose the BestHardware for Applications" ,International Journal of Engineering And Science Vol.6, Issue 9(September2017), PP-38-44.

[4]. Narayan Sharma, Nirman Singha, Tanmoy Dutta, " Smart Bin Implementation for SmartCities" , International Journal of Scientific & Engineering Research, Volume 6, Issue 9,September-2015,ISSN 2229-5518.

[5]. Adil Bashir, Shoaib Amin Banday, "Concept Design and Implementation of AutomaticWasteManagementSystem",InternationalJournalonRecentandInnovationTrendsinComputingand Communication Volume: 1 Issue: 7

[6]. RN Sonawane, AS Ghule, AP Bowlekar, AH Zakane, "Design and Development ofTemperature and Humidity Monitoring System" ,Agricultural Science Digest, Volume 39Issue2 (April-June2019).

[7]. Ekene Samuel Mbonu, Kennedy C. Okafor, Nwoye A. Charlse and S. O. Ezennaya, "AnImproved GSM Based Process Monitoring and Controlling Embedded System" , Advances inScienceand Technology,Vol. 7, No. 1,March / April, 2013, pp11-19,

[8]. AyanTripathi,SkAnwarAli,SaswataSundarLaga,"StudytheCharacteristicofIRBasedProximity Sensor Using FM transmitter",International Journal of Scientific & EngineeringResearch,Volume 8,Issue3,March-2017 80ISSN 2229