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Smart Drainage Monitoring System

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Abstract
The Smart Drainage Monitoring System is an Arduino-based system that is designed to identify and mitigate waterlogging in urban and rural areas. The system uses devices like ultrasonic level sensors to provide real-time monitoring of water levels and surface conditions in drainage channels. The sensors are connected to an Arduino UNO microcontroller, which handles the data and sends out alerts when abnormal water accumulation is noted. The system aids in real-time monitoring and fast decision-making to prevent blockages, overflow and possible health risks. Further, the collected data can be utilized for long-term planning and predictive maintenance. This project inspires smart city progress and sustainable water management with the aid of embedded systems and IoT integration.

Keywords — Smart Drainage, Arduino UNO, real-time monitoring, water level detection, flood prevention, embedded systems, sustainable infrastructure.

I.INTRODUCTION

Over the past few years, urban flooding and suboptimal drainage systems have emerged as increasingly common issues in most cities, especially during monsoon periods. Conventional drainage systems do not have real-time monitoring and automation control, resulting in clogging, waterlogging and health risks. To mitigate these concerns, the incorporation of low-cost embedded systems into drainage networks has become extremely prominent.

This paper introduces a Smart Drainage Monitoring System implemented with the Arduino Uno microcontroller. The system to be implemented with the Arduino Uno microcontroller. The system to be implemented uses different sensors like ultrasonic sensors to detect water level and temperature and humidity sensors to detect ambient conditions in the drainage. The information obtained is processed through the Arduino Uno and can be sent to a central unit for monitoring or displayed on an LCD. The system is further equipped with a buzzer or warning mechanism to alert authorities in the event of abnormal situations, including overflow.

The main aim of this work is to design an economical, real-time and automated monitoring system that improves drainage system efficiency, avoids clogging and enhances public health and safety. The combination of Arduino-based sensors with IoT features shows a huge leap towards more intelligent urban infrastructure and green city planning.

II.LITERATURE REVIEW

[1] An Internet of Things-based strategy for enhancing drainage infrastructure monitoring in smart cities is presented in the research paper "Manhole Detection and Monitoring System." Blockages, gas leaks and

water overflow in subterranean drainage systems are among the problems the system handles. It uses sensors like temperature, gas, water level, and flow rate that are integrated with an Arduino Uno microcontroller. These sensors provide real-time environmental parameter monitoring and notify local authorities through GPS and GSM modules. The main goals are to improve city sanitation, cut down on the time it takes to identify drainage issues, and remove the risks associated with manual inspections. Better urban infrastructure management and prompt intervention are made possible by the system's live data updates to a central managing station.

[2] The implementation of an Internet of Things-based real-time solution to monitor subterranean manholes and drainage systems in smart cities is the main goal of the research paper "Smart Real Time Manhole Monitoring System." The system detects obstructions, toxic gas emissions, overflow, and open manhole lids using a variety of sensors, including flow, water level, gas, temperature, and ultrasonic. The Arduino and Raspberry Pi controllers that are connected to the sensors process the data and email the relevant municipal authorities with alerts. The goal is to increase public safety, decrease the number of manual inspections, improve sanitation, and automate the monitoring process. Because wireless sensor networks guarantee effective data collection and transmission, the system is inexpensive, low-maintenance, and appropriate for scalable smart city applications.

[3] The study "Underground Drainage Monitoring System Using IoT" describes an intelligent method for identifying and controlling IoT-based faults in subterranean drainage infrastructure. The system's primary focus is on monitoring vital parameters in real time, including temperature, flow rate, water level, and the presence of harmful gases. In order to identify irregularities and notify local authorities, it interfaces sensors (flow, level, gas, and temperature) with an ARM7 microcontroller, GPS, and GSM modules. Reducing human intervention, facilitating quicker identification of problems such as obstructions or gas leaks, and enhancing reaction times are the objectives. IoT is used to update sensor data on a web server for real-time monitoring. For integration into smart city frameworks, the system is made to be inexpensive, automated, and effective.

[4] In order to enhance worker safety and avoid risks in urban sewage systems, the research paper "Drainage Monitoring System Using IoT" presents a real-time smart drainage monitoring solution. A water level sensor, a temperature sensor, and several gas sensors (for CO, ammonia, methane, propane, and sulphur dioxide) are all integrated with an Arduino Uno in the suggested system. These sensors keep an eye on the sewage environment, looking for obstructions, leaks, dangerous gases, and dangerous temperatures. Android Studio and Java are used to send data to Firebase, which notifies local authorities when threshold levels are exceeded. Through automation and real-time analysis, the system seeks to improve city hygiene, enable predictive maintenance, and lower the number of fatalities caused by manual scavengers. The project also has features like a user-friendly Android app interface and sensor battery life monitoring.

[5] In order to increase the effectiveness and security of urban drainage systems, the research paper "Smart Drainage Monitoring and Controlling System Using IoT" offers a real-time IoT-based solution. To monitor water level, identify dangerous gases, and identify manhole problems, the system combines sensors (ultrasonic, temperature, and gas), an Arduino Uno, a NodeMCU (Wi-Fi module), GPS, and GSM. For real-time data visualisation and alerting, it makes use of the Blynk platform. The system shows information on an LCD and notifies local authorities when thresholds are surpassed. This configuration minimises manual intervention and safeguards sanitation workers by ensuring early detection of obstructions or dangerous gas levels. For safer and smarter cities, the system seeks to automate monitoring and control tasks.

[6] The goal of the research paper "IoT-Enabled Underground Drainage Monitoring System Using Water Flow Sensor" is to use a real-time IoT system to detect drainage blockages, flow variations, and water leaks. To determine the volume and speed of water flow in drainage pipelines, it uses water flow sensors that are interfaced with an Arduino microcontroller. The appropriate authorities receive alerts via GSM when anomalies are found. Water waste is decreased, early blockage detection is improved, and local bodies can react quickly thanks to the system. Additionally, it encourages safer maintenance procedures

and reduces errors in manual inspection. The article highlights the three main benefits of smart city infrastructure: affordability, ease of maintenance, and automation.

III.METHODOLOGY /EXPERIMENTAL

The proposed system is developed with the aim of improving the safety and monitoring of urban manholes by deploying a real-time, sensor-based embedded solution. This smart drainage monitoring prototype integrates multiple environmental sensors with a microcontroller to track hazardous conditions like fire, toxic gas presence, water overflow, and structural displacement. The system utilizes a GSM module for remote communication, providing instant alerts to maintenance personnel or authorities via SMS, thereby enabling timely intervention and preventing potential mishaps.
The methodology involves the following core components:

- Sensor Integration: Multiple sensors (flame, gas, water level, ultrasonic, tilt) are placed within or near the manhole to detect specific environmental parameters.
- Signal Processing: The Arduino Uno collects real-time data from each sensor and interprets them using predefined threshold values.
- Decision-Making Logic: Based on sensor readings, the system determines whether the environment is safe or if an abnormal condition is present.
- Alert Mechanism: In case of detected hazards, the system activates a buzzer and LED for local alerts and sends a descriptive SMS using the GSM module to a preconfigured mobile number.
- Information Display: A 16x2 I2C LCD provides local visual feedback for both normal and alert states.
- Automatic Reset: Once the hazardous condition resolves, the system automatically resets the alert flags and returns to normal monitoring mode.

This approach ensures a continuous, autonomous, and reliable method of monitoring closed environments like manholes, reducing the dependency on manual inspections.

IV. WORKING OF THE SYSTEM

The system architecture functions on a loop-based routine, where all connected sensors are periodically read, processed, and responded to in real time. The detailed working of the system is as follows:

4.1 System Initialization

Upon powering the system:

- The LCD displays a booting message.
- The GSM module initializes and transmits a "System Online" SMS.
- All sensor modules are configured, and the system enters monitoring mode.

4.2 Sensor Operations

- Flame Sensor: Detects the presence of fire using infrared light. If flame is detected, the system triggers an audible alarm and sends a "Fire Alert" SMS to the registered number.
- Tilt Sensor: Senses any displacement or movement of the manhole cover. When a tilt is detected, it activates a fast blinking buzzer and alerts authorities with a "Manhole Tilted" message.
- Ultrasonic Sensor: Measures the distance between the sensor and the surface of the water inside the drainage. If the distance drops below a critical threshold (e.g., <10 cm), it indicates a potential overflow, activating slow buzzer pulses and sending an "Overflow Risk" message.
- Gas Sensor: Measures the concentration of flammable or toxic gases (e.g., methane). Though not tied directly to the alert mechanism in this prototype, the readings are displayed on the LCD and can be extended for future implementation.

- Water Level Sensor: Measures contact-based moisture level to assess internal flooding or seepage conditions. It serves as a supplementary indicator.

4.3 Alert Management

When a critical condition is identified:

- The LCD blinks alternating warning messages to catch attention.

- The buzzer operates in specific patterns depending on the type of alert:
  - Continuous tone for fire
  - Fast beeping for tilt
  - Slow beeping for overflow
- A one-time SMS is sent for each type of hazard until the situation is resolved.

4.4 Display Output

In non-critical scenarios:

- The system displays "System Normal" along with gas readings.
- All alert flags are reset once all parameters return to safe levels.

4.5 Communication Module

The GSM module (SIM800L) communicates via software serial with the Arduino Uno. SMS messages are sent using AT commands whenever an emergency is identified. This ensures that information is remotely accessible, even in the absence of Wi-Fi or Ethernet infrastructure.

```
#include <LiquidCrystal_I2C.h>
#include <SoftwareSerial.h>

// === LCD Setup ===
LiquidCrystal_I2C lcd(0x27, 16, 2);

// === GSM Setup ===
SoftwareSerial gsm(10, 11);  // RX, TX

// === Pin Definitions ===
#define IR_SENSOR 2
#define FLAME_SENSOR 3
#define TILT_SENSOR 4
#define BUZZER 5
#define LED 7

#define TRIG_PIN 9
#define ECHO_PIN 8

#define TEMP_SENSOR A0
#define GAS_SENSOR A1
#define WATER_SENSOR A2

// === Thresholds ===
int gasThreshold = 400;
int waterThreshold = 300;
int flameDetected = 0;
int tiltDetected = 0;

// === Setup ===
void setup() {
  // Initialize Serial Monitor
  Serial.begin(9600);
  while (!Serial);
  Serial.println("System Initializing...");

  // Initialize GSM
  gsm.begin(9600);

```

```
// Initialize LCD
lcd.init();
lcd.backlight();
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Initializing...");
Serial.println("LCD Initialized");

// Initialize Pins
pinMode(IR_SENSOR, INPUT);
pinMode(FLAME_SENSOR, INPUT);
pinMode(TILT_SENSOR, INPUT);
pinMode(BUZZER, OUTPUT);
pinMode(LED, OUTPUT);
pinMode(TRIG_PIN, OUTPUT);
pinMode(ECHO_PIN, INPUT);

// Startup message
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Smart Drainage");
lcd.setCursor(0, 1);
lcd.print("System Ready");
Serial.println("System Ready");

delay(2000);
lcd.clear();

sendSMS("System Online: Smart Manhole Monitoring");
```

```
// === Main Loop ===
void loop() {
  // Debug marker
  Serial.println("\n--- New Cycle ---");

  // Clear LCD and print header
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Status:");

  // === IR Sensor ===
  int irState = digitalRead(IR_SENSOR);
  Serial.print("IR Sensor: ");
  Serial.println(irState == LOW ? "Detected" : "Clear");

  if (irState == LOW) {
    lcd.setCursor(0, 1);
    lcd.print("Obj Detected ");
    digitalWrite(LED, HIGH);
    sendSMS("IR: Object Detected in Manhole");
  } else {
    digitalWrite(LED, LOW);
  }

  // === Flame Sensor ===
  flameDetected = digitalRead(FLAME_SENSOR);
  Serial.print("Flame Sensor: ");
  Serial.println(flameDetected == LOW ? "FLAME!" : "Clear");

  if (flameDetected == LOW) {
    digitalWrite(BUZZER, HIGH);
    lcd.setCursor(0, 1);
    lcd.print("Flame Detected!");
    sendSMS("Alert: Flame detected in Manhole!");
  } else {
    digitalWrite(BUZZER, LOW);
  }
```

```
// === Tilt Sensor ===
tiltDetected = digitalRead(TILT_SENSOR);
Serial.print("Tilt Sensor: ");
Serial.println(tiltDetected == LOW ? "TILTED!" : "Normal");

if (tiltDetected == LOW) {
  sendSMS("Manhole Tilt Detected!");
}

// === Gas Sensor ===
int gasValue = analogRead(GAS_SENSOR);
Serial.print("Gas Level: ");
Serial.println(gasValue);

if (gasValue > gasThreshold) {
  sendSMS("Gas Alert: Value " + String(gasValue));
}

// === Temperature Sensor ===
int tempValue = analogRead(TEMP_SENSOR);
float temperature = (tempValue * 5.0 * 100.0) / 1024.0;
Serial.print("Temperature: ");
Serial.print(temperature);
Serial.println("°C");

// === Water Level Sensor ===
int waterLevel = analogRead(WATER_SENSOR);
Serial.print("Water Level: ");
Serial.println(waterLevel);

if (waterLevel < waterThreshold) {
  sendSMS("Water Low: Level = " + String(waterLevel));
}
```

```
  // === Ultrasonic Sensor ===
  digitalWrite(TRIG_PIN, LOW);
  delayMicroseconds(2);
  digitalWrite(TRIG_PIN, HIGH);
  delayMicroseconds(10);
  digitalWrite(TRIG_PIN, LOW);
  long duration = pulseIn(ECHO_PIN, HIGH);
  int distance = duration * 0.034 / 2;
  Serial.print("Distance: ");
  Serial.print(distance);
  Serial.println("cm");

  if (distance < 10) {
    sendSMS("Overflow Warning: Distance = " + String(distance) + "cm");
  }

  delay(3000);  // Main loop delay
}

// === SMS Function ===
void sendSMS(String message) {
  Serial.println("Sending SMS: " + message);

  gsm.println("AT+CMGF=1");
  delay(100);
  gsm.println("AT+CMGS=\"+918779007651\""); // Replace with your number
  delay(100);
  gsm.println(message);
  delay(100);
  gsm.write(26);  // CTRL+Z to send
  delay(500);
}
```

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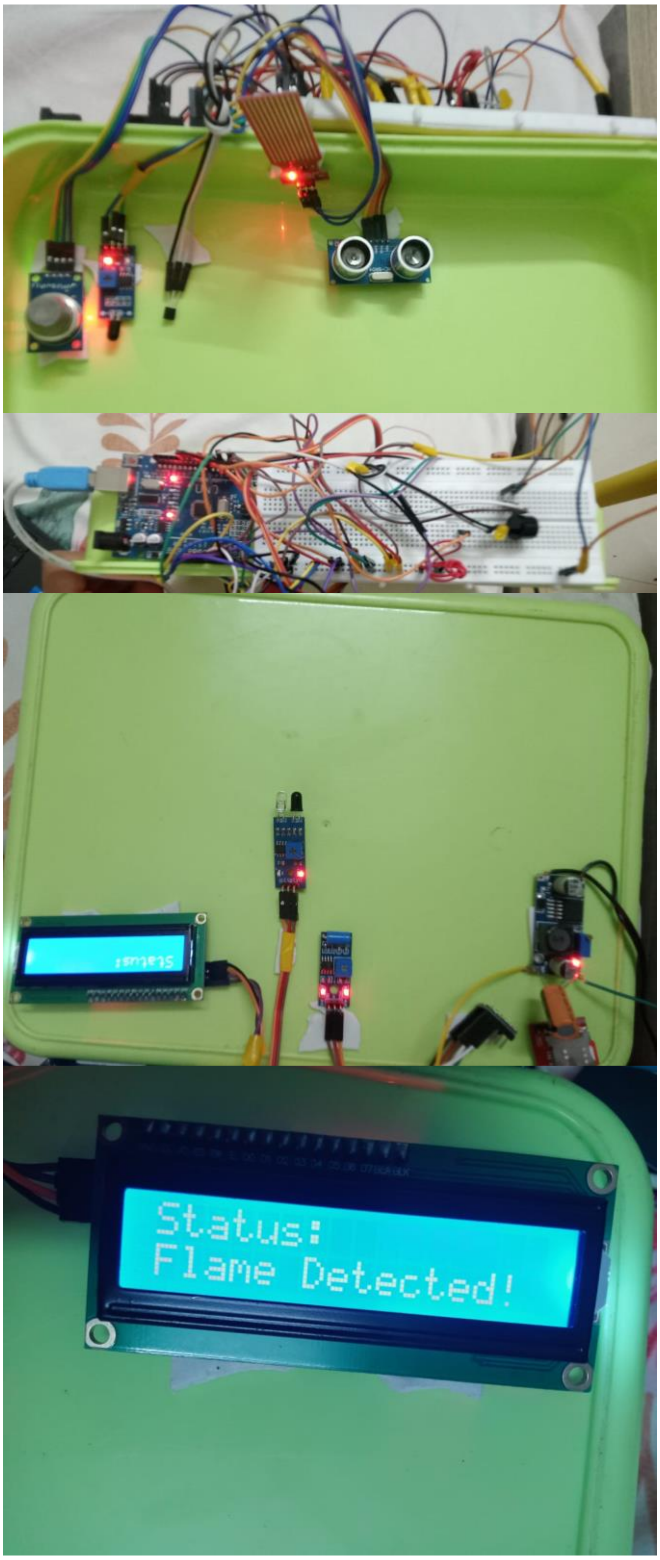
*IV.*RESULTS AND DISCUSSIONS



Results:

The Smart Drainage Monitoring System effectively utilised a range of sensors including water level, ultrasonic, temperature, gas ,flame,IR, and tilt sensors connected to an Arduino Uno microcontroller to monitor environmental conditions in drainage systems.The system was powered by a regulated 12V power supply and used an 12C LCD for real-time data display, along with the SIM800L GSM module for sending SMS alerts during abnormal conditions such as high water levels or gas leaks.The sensors provided continuous, real-time measurements, which allowed the system to detect overflow risks, gas accumulation, and other hazards efficiently.Visual indicators such as LEDs and audible buzzers successfully alerted users of warning or danger conditions.The system performed as expected during testing ,showing accurate sensor responses and timely alert transmissions.The modular nature of the system allowed easy integration and scalability ,making it suitable for both urban and rural environments

Discussion:
The results demonstrate the system's practical applicability in addressing the shortcomings of traditional drainage systems, particularly the lack of real-time monitoring and proactive response.The integration of multiple sensors enabled comprehensive surveillance of environmental parameters, contributing to enhanced safety and maintenance efficiency.The GSM module played a key role in ensuring quick communication with authorities, thus enabling immediate action.Despite its success, some challenges were observed such as the dependence on consistent power supply and mobile network signal strength for GSM-based alerts .Furthurmore,the sensors used, while cost-effective, may face accuracy and durability issues in moist and contaminated drainage environments.The system also lacks default data logging capabilities, which limits long-term trend analysis.Nevertheless ,its low cost, ease of assembly, and effectiveness in real-time monitoring make it a viable solution .Future improvements could include cloud-based data storage ,solar power integration, and AI-driven predictive features to enhance its functionality and sustainability.

V.FUTURE SCOPE

The Smart Drainage Monitoring System holds significant potential for real-time management and predictive maintenance. One of the major areas of development involves the use of wireless communication technologies such as GSM, Wi-Fi, or LoRa to allow real-time remote monitoring and centralized control through online dashboards or mobile applications. This would allow municipal authorities to reply more rapidly to emergencies and other necessary requirements. Moreover, the incorporation of AI and machine learning algorithms can allow the system to examine historical trends, foresee flooding or any kind of blockages, and upgrade drainage maintenance schedules. Solar-powered modules can make the system more energy-saving and fit for remote or underdeveloped areas. Additionally, the system can be enlarged to include sensors for detecting solid waste, toxic gases, or chemical contamination, turning it into a more full-scale environmental monitoring with government support and accurate urban planning, this system can be estimated for smart cities and integrated into existing drainage networks to transform how urban flooding and sanitation are managed.

VI.CONCLUSION

The Smart Drainage Monitoring System is a useful project that shows how we can use technology like IoT and Arduino to solve real problems like waterlogging, drainage overflow, and city flooding. These problems are becoming more common because of fast-growing cities and climate change. This system uses an Arduino Uno with ultrasonic sensors and other tools to check water levels and the environment in real-time. If it finds something unusual, it quickly sends alerts so action can be taken. This helps prevent damage to roads and buildings, reduces health risks from dirty water, and keeps people safe.
The system is low-cost, easy to set up, and can work well in both cities and villages, especially in places with fewer resources. It also collects data all the time, which can be used to plan better drainage systems and fix problems early. This fits well with smart city plans that focus on using technology, saving the environment, and making life safer and easier for people. Overall, this project solves today's drainage problems and helps build smarter, stronger cities for the future.
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VI. Acknowledgment

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References

1. Prof Muragesh SK1, Santhosha Rao2, “Automated Internet of Things For Underground Drainage and Manhole Monitoring Systems For Metropolitan Cities.” International Journal of Innovative Science, Engineering & Technology, Vol. 2 Issue 4, June 2015.
2. Dhanalakshmi.G, Akhil.S, Francisca Little Flower.M, Haribalambika.R, “Explosion detection and drainage monitoring system by Automation System” International Journal of Innovative research in computer and communication engineering, vol. 6, issue 2, February 2018.
3. Retno Tri Wahyuni1* Yusmar Palapa Wijaya2 Dini Nurmalasari “Design of Wireless Sensor Network for Drainage.
4. P Bhosale, “Iot Based System for Detection of Sewage Blockages”, 2021, it-in-industry.org.
5. Prof S. A. Shaikh1, Suvarna A. Sonawane2, ”Monitoring Smart City Application Using Raspberry PI based on IoT” International Journal of Innovative Science, Engineering & Technology, Vol 5 Issue VIL, July 2017.
6. A Pendharkar, J Chillapalli, K Dhakate, “IoT Based Sewage Monitoring System”, Available at SSRN, 2020, researchgate.ne.
7. Gaurang Sonawane, Chetan Mahajan, Anuja Nikale, Yogita dalvi, “Smart Real-Time Drainage Monitoring System USing IoT” May 2018, IRE Journals, Vol. 1 issue 11, ISSN: 2456-8880.
8. G.Gowtham, K.Hari Haran, G.Keerthee Rajan, A.Sweeto Jeison, “Sewage level maintenance using IoT” International Journal of Mechanical Engineering and Technical, vol. 9, Issue 2, February 2018.