PIP2001 Capstone Project
FINAL REVIEW

AUTOMATIC DETECTION AND NOTIFICATION OF POTHOLES AND HUMPS ON ROADS TO AID DRIVERS

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Introduction

- Road infrastructure significantly impacts transportation efficiency and public safety, making its maintenance a priority for any country. However, in many developing regions like India, poorly maintained roads, potholes, and uneven humps are common, leading to accidents, vehicle wear and tear, and traffic disruptions. The problem becomes more critical during adverse weather conditions or in low-visibility scenarios, such as at night. Addressing these issues requires innovative solutions that go beyond traditional manual road inspections.
- This project proposes an intelligent system that integrates ultrasonic sensors, RF communication, and cloud-based technologies to automatically detect and notify drivers about road hazards in real time. By combining cost-effective hardware with mobile application alerts, the system not only enhances road safety but also provides actionable data for government authorities to prioritize road maintenance efforts.

Literature Review

- Pothole and Hump Detection Techniques

Guan et al. (2016) developed a pothole detection system using real-time image processing, where a mobile phone camera and GPS were used to identify potholes based on image characteristics and geographical location.
Zhang et al. (2018) proposed an approach using convolutional neural networks (CNNs) to detect potholes with high accuracy. CNNs have proven to be highly effective in recognizing road irregularities, even under challenging conditions such as low light and heavy traffic.

Existing method Drawback

Manual Inspection:

- **Time-Consuming**: Inspecting roads manually is labor-intensive and inefficient, especially for large areas.
- **Delay in Action**: Hazards may remain unattended for long periods, increasing the risk of accidents.
- Prone to human error and delays in hazard identification.

Camera-Based Systems:

- Limited performance in poor lighting or adverse weather conditions.
- High dependency on clear visibility for accurate detection.

Accelerometer-Based Methods:

- Cannot accurately differentiate between various types of road anomalies.
- **Limited Accuracy**: Cannot provide detailed information about the size or depth of the pothole.

Cloud-Dependent Systems:

- High latency in processing and delivering real-time notifications.
- Requires continuous internet connectivity, which is not always reliable in remote areas.

Existing method Drawback

- Existing methods often face challenges like limited accuracy, scalability issues, environmental sensitivity, and high costs. These drawbacks emphasize the need for innovative systems that combine affordability, real-time detection, and scalability while ensuring reliable performance under diverse conditions.
- Our project addresses these gaps by integrating low-cost sensors, RF communication, and mobile apps for efficient hazard detection and notification.

Proposed Methodology

Objective:

- Detect potholes and humps on roads automatically.
- Notify drivers in real-time to avoid accidents and vehicle damage.

Core Components:

- **Ultrasonic Sensors**:
  - Measure road surface irregularities (pothole depth, hump height).
- RF Communication:
  - RF transmitters placed near humps.
  - RF receivers in vehicles alert drivers via buzzer and LCD.
- **Cloud Integration**:
  - Data transmitted to a centralized cloud using Wi-Fi.
  - Accessible through a mobile application (e.g., Blynk app).

Proposed Methodology

System Functionality:

- Sensors detect irregularities and send real-time data to the cloud.
- Mobile app alerts drivers with hazard information:
  - GPS-based exact location of potholes and humps.
  - Pre-warning system for proactive decision-making.

Advantages:

- Cost-effective system leveraging low-cost ultrasonic sensors.
- Enhances road safety and reduces accidents.
- Supports government authorities in road maintenance with real-time data.

Objectives

Primary Goal:

- Enhance road safety by detecting and notifying drivers about potholes and humps in real-time.

Specific Objectives:

- Accident Prevention:
  - Reduce road accidents caused by poor road conditions.
- Vehicle Protection:
  - Minimize damage to vehicles due to unmarked humps and potholes.
- Driver Awareness:
  - Provide timely alerts to drivers for better decision-making.
- Real-Time Monitoring:
  - Enable continuous monitoring of road conditions using advanced sensors and IoT technologies.

System Design & Implementation

Hardware components:

- Ultra sonic sensors:Detect potholes and humps by measuring road surface irregularities.
- RF Modules:
  - RF Transmitters: Placed near humps to send signals.
  - RF Receivers: Installed in vehicles to receive alerts.
- Microcontroller (e.g., Arduino): Processes sensor data and controls alert mechanisms.
- Buzzer & LCD Display: Alerts drivers visually and audibly about road hazards.
- Wi-Fi Module: Sends collected data to the cloud for analysis and storage.

Software Components:

- Embedded Programming: Developed using Arduino IDE for sensor integration
- Mobile Application (Blynk App): Displays real-time hazard data and GPS-based locations of obstacles.
- Cloud Database: Stores and processes sensor data for drivers and government authorities.

Implementation

Hardware Setup:

- Install ultrasonic sensors and RF modules on roads and vehicles.
- Configure Microcontroller for sensor data processing

Data Collection:

- Sensors detect potholes/humps and measure their depth or height.
- Data is transmitted wirelessly to the cloud.

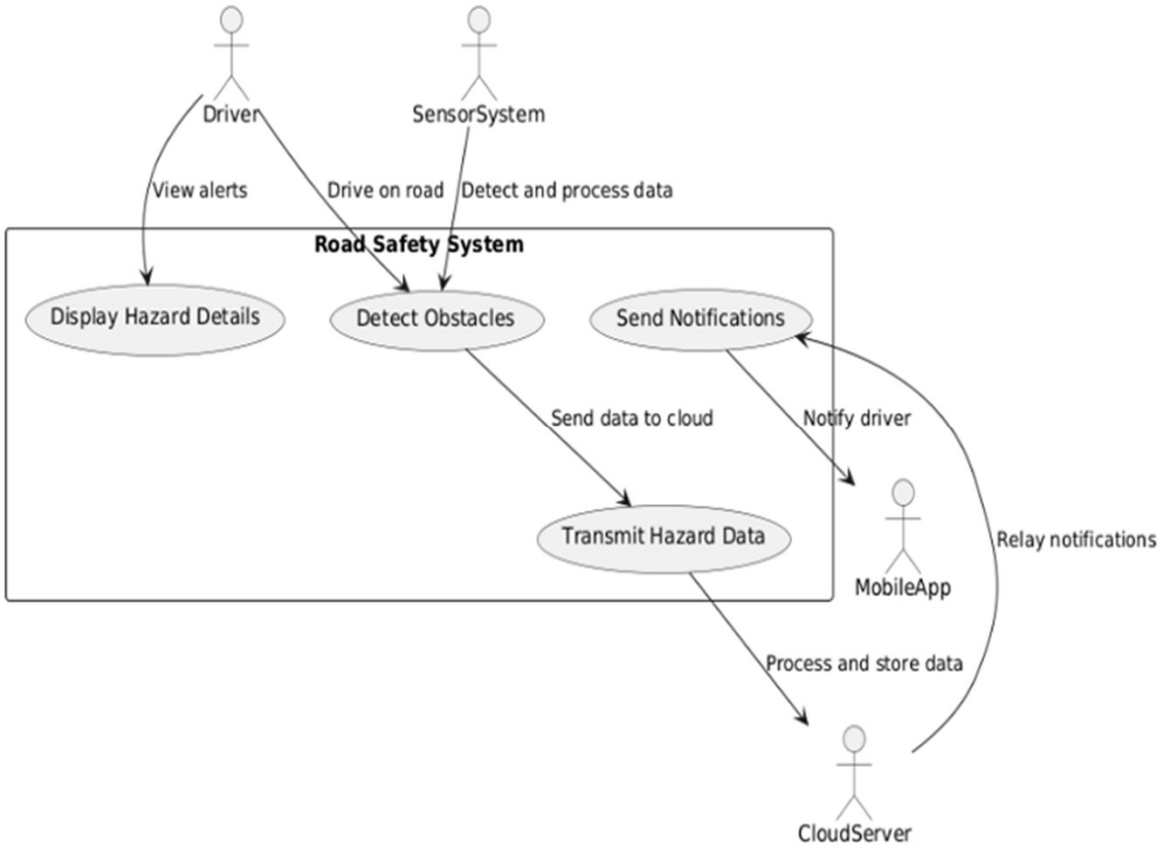
Real-Time Alerts:

- Mobile app provides GPS-based alerts about detected hazards.
- Drivers are notified via LCD and buzzer for immediate action.

Cloud Integration:

- Process and store data in the cloud for long-term accessibility.
- Analyze patterns to prioritize road maintenance.

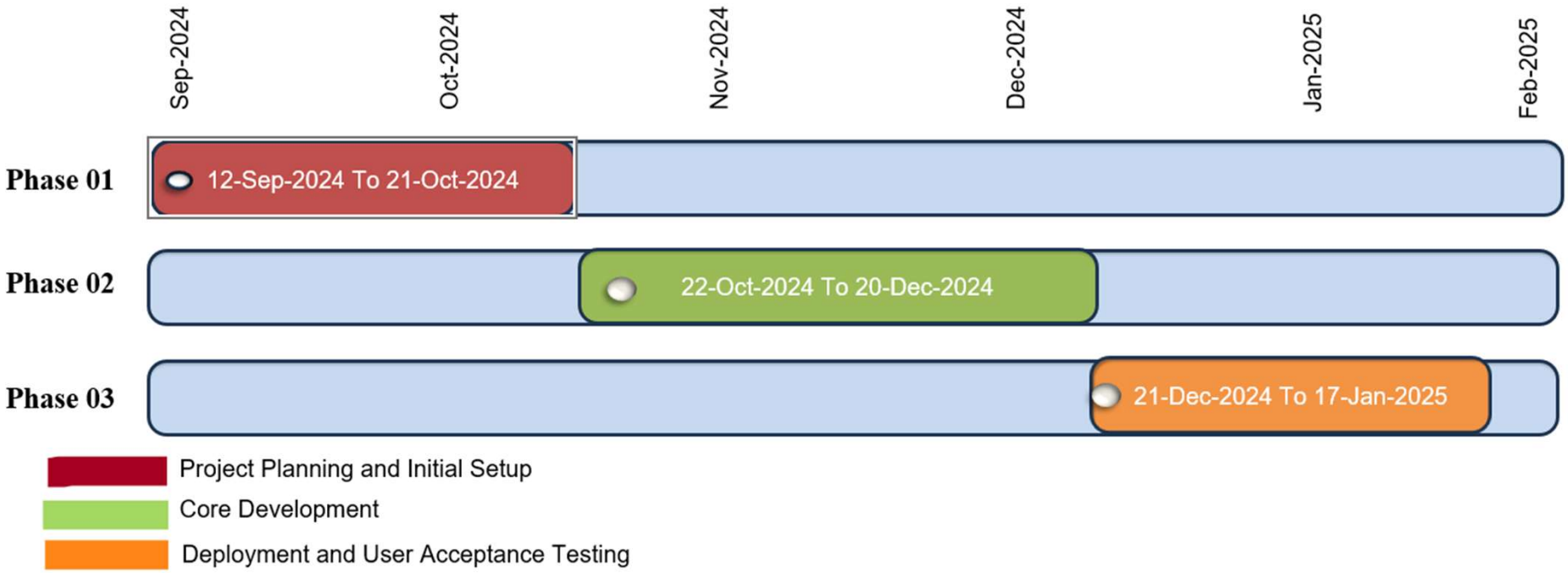
Architecture



Hardware/software components

- **Hardware components**:
- Ultrasonic Sensors
- Microcontroller
- RF Transmitter and Receiver
- LCD Module
- Buzzer Module
- Wi-Fi Module(ESP8266 or ESP32.)
- **Software components**:
- Arduino IDE
- Embedded C Programming
- Blynk Mobile Application

Timeline of Project



Expected Outcomes

Accurate Hazard Detection:

- Ultrasonic sensors successfully detected potholes and humps with high precision.
- Measurements of pothole depth and hump height were highly reliable.

Real-Time Alerts:

- Drivers received immediate notifications about road hazards via:
  - Audible alerts (buzzer).
  - Visual alerts (LCD display and mobile app).

Improved Road Safety:

- Reduced accidents and vehicle damage by alerting drivers in advance of hazards.
- Enabled safer driving conditions, even in adverse weather or low-visibility situations.

Cloud-Based Data Storage:

- Road condition data was effectively stored and processed in the cloud for long-term use.
- Provided actionable insights for road maintenance planning.

Cost-Effectiveness:

- Achieved high performance using low-cost components like ultrasonic sensors and RF modules.
- Made the system affordable and scalable for widespread adoption.

Conclusion

- Developed a cost-effective system for detecting and notifying drivers about potholes and humps.
- Combined advanced sensor technology, RF communication, and cloud-based data processing to enhance road safety.
- Successfully alerted drivers in real-time, reducing accidents and vehicle damage.

- **Key Benefits:**
- Road Safety**:** Improved driver awareness and reaction times.
- Infrastructure Support: Assisted authorities with real-time data for efficient road maintenance.
- Scalability: Affordable and easily implementable across diverse regions.

- This system bridges a critical gap in road safety by proactively addressing hazards, ensuring safer journeys for drivers, and supporting sustainable infrastructure development.

Github Link

The Github link provided should have public access permission.

https://github.com/Bhushann0217/Automated-Adverse-Road-Condition-Detection

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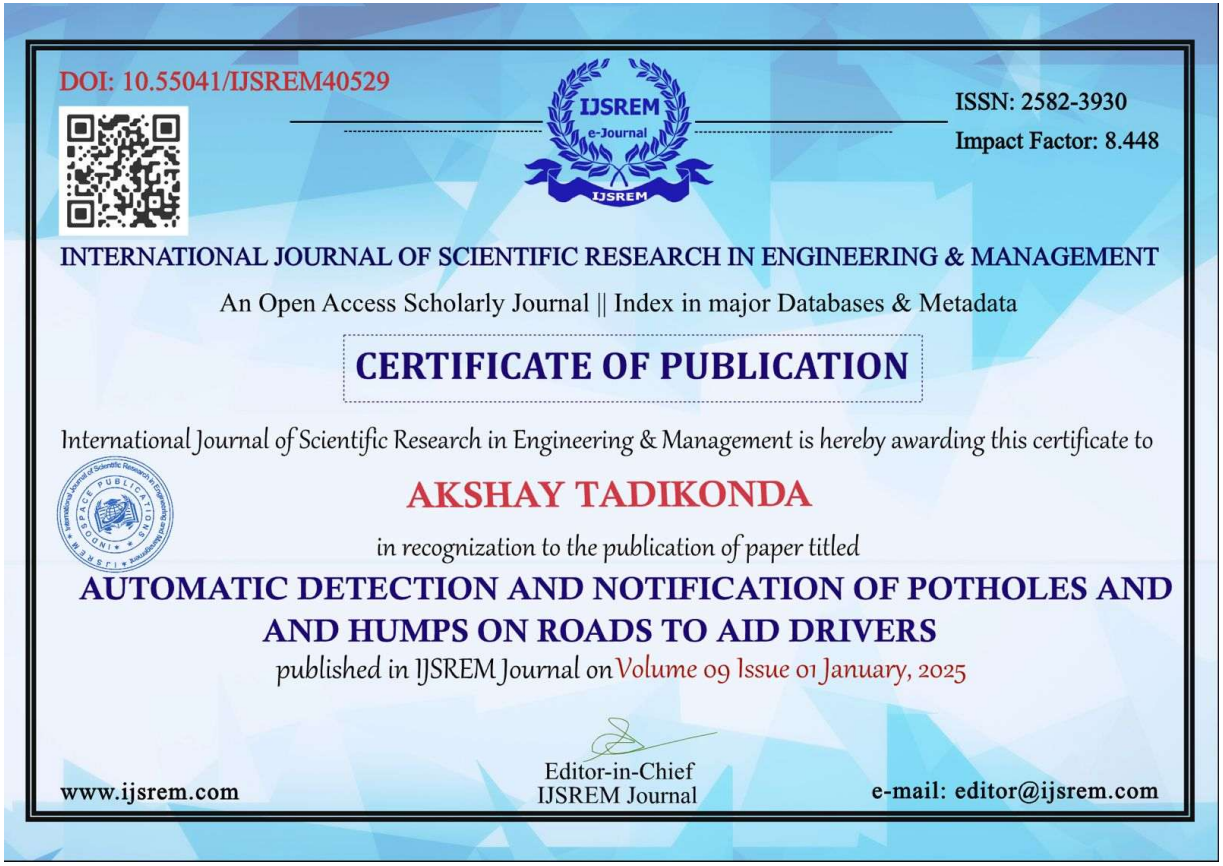

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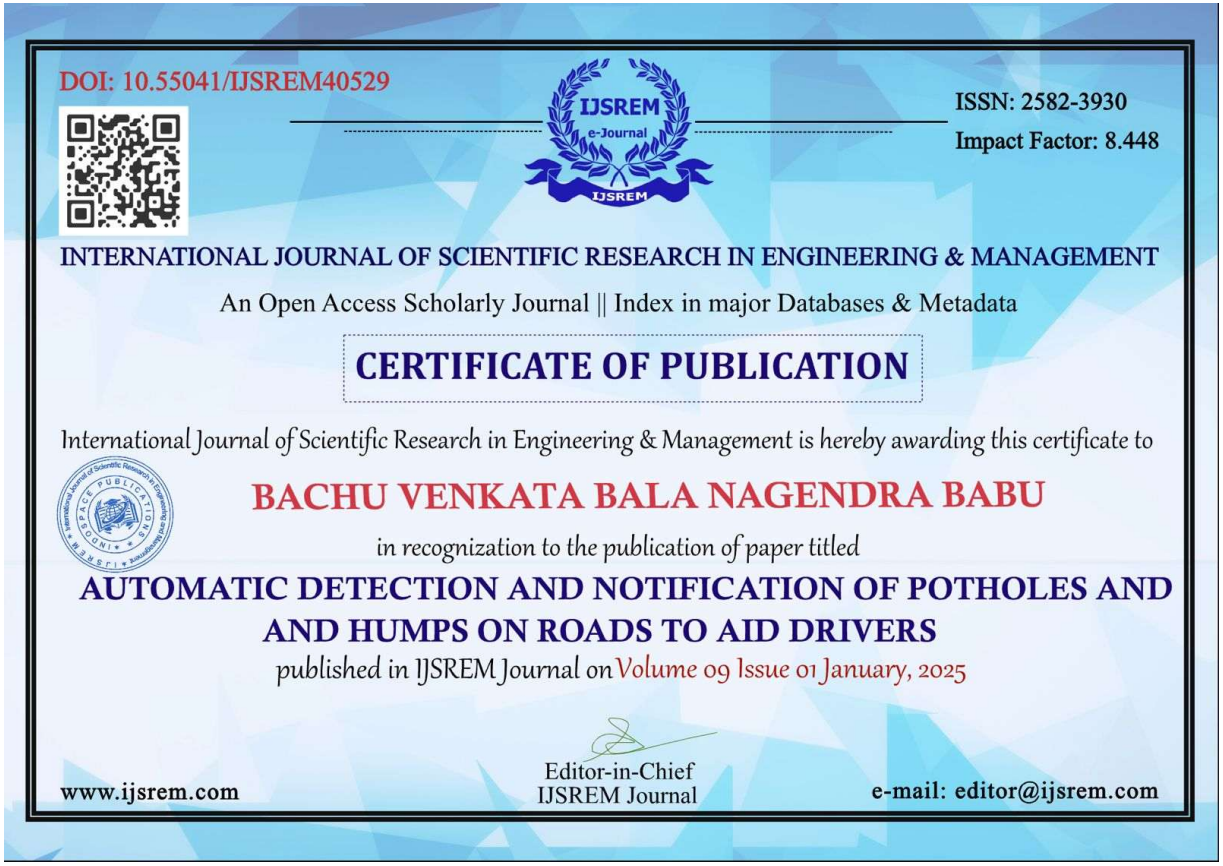

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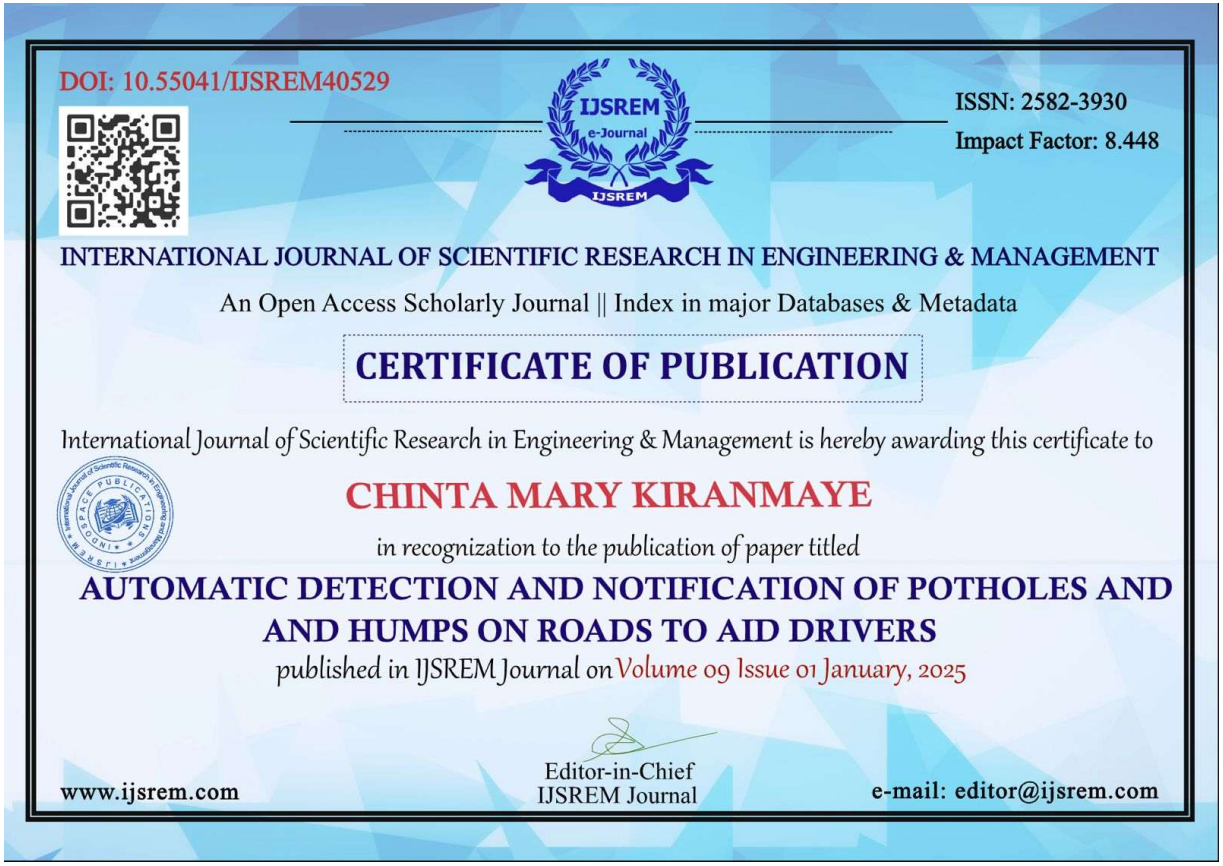

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Project work mapping with SDG

The Project work carried out here is mapped to SDG-3 Good Health and Well-Being.

The project work carried here contributes to the well-being of the human society. This can be used for Analyzing and detecting blood cancer in the early stages so that the required medication can be started early to avoid further consequences which might result in mortality.

Thank You