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Title: AI-Driven Smart Safety framework for Community Protection

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SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS

Outline

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- Results and Discussion
- Conclusions and Future Work
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Introduction

- Community safety remains a critical challenge in the evolution of smart cities, especially in the face of increasing incidents of theft, fire hazards, gas leaks, and delayed emergency responses. A focused study conducted in residential areas of Chennai revealed that 65.2% of residents reported theft experiences—primarily in shared community spaces—and 55.6% encountered gas leaks, with 72.8% expressing high concern over safety threats.
- To address these pressing issues, we developed an AI-Integrated Home and Community Safety System, leveraging IoT sensors, real-time MQTT communication, and mobile-based dashboards for instant monitoring and alerting. The system includes flame and gas detection, medical and theft emergency buttons, and LED and buzzer-based notification mechanisms.
- Backed by a survey of 408 residents, our findings show strong support for AI-driven safety innovations, with 67.4% rating the proposed solution as highly effective and 79.7% willing to adopt it. The system aligns with Sustainable Development Goals—notably SDG 11 (Sustainable Cities) and SDG 9 (Industry, Innovation, and Infrastructure)—by enhancing urban resilience and promoting smart safety infrastructure.

Existing Approaches/Related Works

A. Limitations of Current Security Systems

- Traditional systems (CCTV, alarms, smart locks) are widely used.
- **Common issues:**
  - High cost
  - Delayed response times
  - Lack of AI-based real-time intervention

B. Smart Home Security Solutions

- Sherif et al. [1]: LoRa-based alerts, but lacks full automation.
- Alahi et al. [2]: Focused on surveillance, not active response.
- Yu & Zhang [3]: Contactless detection; AI use still in early stage.
- Nettikadan [5], Çavaş [6]: MQTT and IoT used, but no predictive AI.
- Other works included motion sensors, facial recognition, GSM alerts—but lacked AI-coordinated response.

Existing Approaches/Related Works

C. Communication & Alert Mechanisms

- Merjanian et al. [9]: Group-based safety notifications, but manual.
- Fujii et al. [10]: e-JIKEI neighborhood network—no AI prediction.
- Mobile-based apps with GPS, panic buttons, drone support (e.g., Kerning [13])—focused on individuals, not communities.

D. AI & IoT-Based Enhancements

- Ni et al. [14], Freund [15]: AI integration begins, but still fragmented.
- Long [16], Varadarajan [17]: AI for facial recognition, home automation—not for comprehensive safety.
- Dawson [18]: Real-time clusters, yet no forecasting via AI.

Identified Gaps

- **Most solutions:**
  - Are **reactive**, not predictive.
  - Focus on **individual safety**, not **community coordination**.
  - Depend on **manual input**, delaying response time.

Problems in Existing Approaches

🔒 Lack of Unified Emergency Handling

- Existing systems handle fire, gas leaks, or theft independently.
- No integrated platform for multi-hazard detection and coordinated alerting.

📞 Delayed Response and Notification

- Systems often rely on manual communication (calls, neighbors).
- GSM-based alerts have higher latency and limited reliability.

📉 High False Alarm Rates

- Many systems trigger alarms without intelligent filtering.
- False positives cause panic or reduce trust in alerts.

🚫 No AI Decision-Making

- Most traditional devices lack AI-driven filtering or pattern recognition.
- No differentiation between false alarms and real threats.

📡 Limited Communication Scope

- Alerts are sent only to owners or single homes, not to the community network.
- No multi-house alert mechanism or real-time broadcasting.

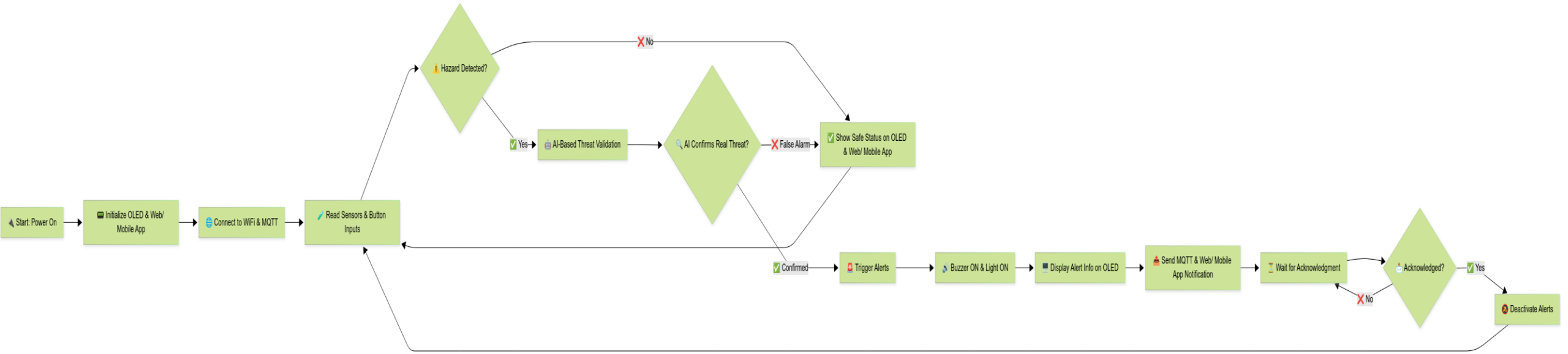
🔋 Power Dependency

- Many safety systems fail during power outages.
- Lack of solar-powered or backup energy options.

🌐 Weak Integration with Smart City Goals

- No alignment with SDG 11 (Sustainable Cities) and SDG 9 (Innovation Infrastructure).
- Low community-level automation and no data-driven governance support.

Proposed Methodology



Proposed Methodology

Proposed Methodology

1. System Architecture

- Integrated Safety Solution: Combines hardware + software for real-time home & community security.
- Core Tech: ESP8266 microcontroller + MQTT protocol + AI decision logic.

2. Hardware Components

- Sensors: Gas (MQ2), Flame, Motion
- Manual Alerts: Theft & Medical buttons (local + remote via app)
- Alert System: Buzzer, OLED display
- Power: Solar-powered backup for resilience

The proposed system offers several advantages over existing safety setups by integrating multi-trigger inputs (sensors and manual buttons), enabling AI-enhanced accuracy to minimize false alarms, utilizing faster MQTT-based communication instead of slower GSM, providing real-time control via dashboards and alerts, and supporting scalable deployment from individual homes to larger gated communities.

3. Software & AI Logic

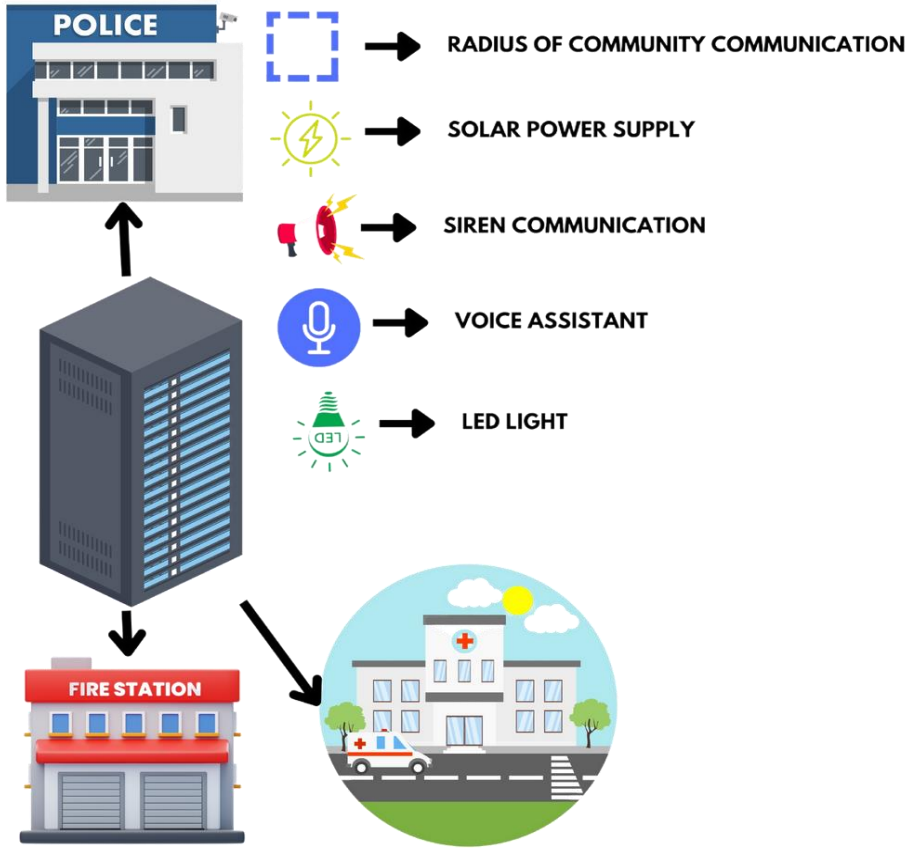
- **Communication:** MQTT (over TLS) for secure, real-time messaging
- **Interface:** Web & Mobile app dashboards
- **AI Module: Lightweight decision tree for:**
  - Real-vs-false threat filtering
  - Anomaly detection (sensor tampering/unusual patterns)

4. Communication Flow

- **Sensor data → ESP8266 → MQTT Broker →**
  - Nearby Homes
  - Authorities
  - Web/App Interfaces
- **Community-wide alerts for theft, fire, gas leaks & medical emergencies**

Proposed Methodology

PROJECT WORKING MODEL



Results and Discussion

Case Study:

This case study shows MQTT communications system operation between two houses in a community setting, including fire, gas, theft, and medical alarms.

Case Study 1: Fire Detection and MQTT-Based Alert Propagation

House 1 : Mobile remote Control

House 1 Prototype (OLED Display)
Alert Sending

House 2 Prototype (OLED Display)
Alert received

Case Study 2: Gas Leak Detection and MQTT-Based Alert Propagation

House 2
Prototype (OLED Display)
Gas Leak Detected

House 1
Prototype (OLED Display)
Alert Sending

Case Study 3: Theft Detection and Emergency Response

House 1 : Mobile remote Control

House 1 Prototype (OLED Display)
Alert Sending...

House 2 Prototype (OLED Display)
Alert Received

Case Study 4: Medical Emergency Detection and Response

House 2 : Mobile remote Control

House 2 Prototype (OLED Display)
Alert Sending...

House 1 Prototype (OLED Display)
Alert received

Case Study 5: False Alarm Detection and Acknowledgment Mechanism

House 2
Prototype (OLED Display)
Sending False Alarem

House 1
Prototype (OLED Display)
False Alert Message received

Results and Discussion of Survey of 408 Residents houses

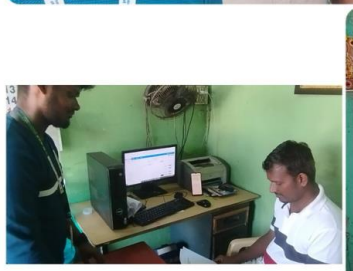
Willingness to participate in further testing or provide additional feedback

Unaware of these UN SDG Goals

Patent Published

Sr. No.	App. Number	Ref. No./Application No.	Amount Paid	C.B.R. No.	Form Name	Remarks
1	202441007573	TEMP/E-1/8829/2024-CHE	1600	7313	FORM 1	AI INTEGRATED COMMUNITY SAFETY GADGETS

Survey Sample Photos



Conclusions and Future Work

Conclusion:

- The proposed AI-Based Home & Community Safety System effectively addresses real-time emergencies (gas leaks, fire, theft, and health issues).
- Integrates MQTT-based IoT alerts, local display, mobile & web interface for timely community response.
- Promotes user-friendly emergency detection and neighborhood-wide awareness, enhancing urban resilience.

🌐 **Scalability for Smart Cities:**

- Supports multi-home and community-wide integration.
- Enables city-scale deployment through improved network coordination and alert sharing.
- Future-ready for integration with municipal emergency services.

🔮 **Future Enhancements:**

- AI-based threat filtering to reduce false alarms (e.g., pets, smoke).
- Smart city integration with law enforcement, fire & medical services for auto-response.
- Data security upgrades with MQTT-TLS, encrypted logs, and access control.
- Expand system to multi-unit buildings, aligned with SDG 11 (Sustainable Cities) & SDG 9 (Innovation & Infrastructure).

📊 **Key Survey Insights:**

- Theft: 65.2% experienced; 83.5% in community spaces.
- Gas Leaks: 55.6% had experiences; cylinder leaks most common (38%).
- AI Devices: 67.4% rated highly effective; 79.7% want to test/engage.
- SDG Awareness: Only 14.7% aware → need stronger community outreach.

References

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[2] M. E. E. Alahi, A. Sukkuea, F. W. Tina, A. Nag, W. Kurdthongmee, K. Suwannarat, and S. C. Mukhopadhyay, "Integration of IoT-enabled technologies and artificial intelligence (AI) for smart city scenario: Recent advancements and future trends," Sensors, vol. 23, no. 11, p. 5206, May 2023 https://doi.org/10.3390/s23115206.

[3] X. Li, R. Lu, X. Liang, X. (S.) Shen, J. Chen, and X. Lin, "Smart community: An Internet of Things application," IEEE Communications Magazine, vol. 49, no. 11, pp. 12-13, Nov. 2011. doi: 10.1109/MCOM.2011.6069779.

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