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Intelligent Fire Detection and Mobile Alert System for Home Safety

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Abstract. The research is focused on enhancing the reliability of a fire detection system, which involves designing and demonstrating smart home fire detection and mobile alerting systems. This system increases fire detection sensitivity, reduces false alarms, and provides users with prompt alerts. The system incorporates more than one sensor, such as flame detection, an air quality sensor (measuring PM2.5, CO2, and TVOCs), temperature, and humidity levels, to enhance accuracy. Artificial intelligence algorithms filter real-time sensor streams and accurately identify real fire threats versus false alarms, thereby enabling more accurate alerts. The research was conducted in the municipality of President Roxas, North Cotabato, with outdoor testing for performance by thirty residents. Surveys, time trackers, and a system performance log data provider were then employed to measure detection accuracies, response times, and alert frequencies. Results showed a 7-15% increase in detection accuracy, a 50% decrease in response time, and a significant reduction in false alarms, resulting in an enhanced user experience. The statistical paired t-test comparisons also confirmed a significant difference in performance between the pre- and post-implementation periods. Findings suggest that AI-based fire detection systems can offer a viable solution for enhancing fire safety in homes and, consequently, reducing risks in the event of a fire.

Keywords: AI-powered fire detection; Detection accuracy; False alarm reduction; Home safety; Mobile notifications.

1.0 Introduction

Domestic fires continue to pose a serious threat to human lives and property loss worldwide. The International Federation of Red Cross Societies indicates that domestic fires are becoming increasingly hazardous due to the lag in detection, ineffective alarm systems, and the fact that conventional smoke detectors cannot distinguish between real fire hazards and false alarms. Many conventional fire detection systems also lack real-time mobile notifications, leaving homeowners vulnerable, especially when they are away. The absence of an intelligent fire detection system that enhances accuracy and response time highlights a critical gap in home safety.

This study proposes an AI-powered fire detection and mobile alert system to improve early fire detection, reduce false alarms, and enhance response efficiency. Unlike conventional systems that rely solely on smoke or heat detection, this innovation integrates flame detection, air quality monitoring (including PM2.5, CO2, and TVOCs), temperature, and humidity sensors to enhance accuracy. Artificial intelligence algorithms analyze real-time data, identifying actual fire threats while minimizing false positives. The study was conducted in President Roxas, North Cotabato, where 30 homeowners tested the system's effectiveness. Data were collected through surveys, system logs, and response time tracking, and the results demonstrated improved detection accuracy by 7-15%, reduced false alarms, and 50% faster response times. These findings align with Sustainable Development Goal (SDG) 11 by contributing to the creation of safer homes and more resilient communities.

From fire accidents around the world, the need for efficient detection systems becomes apparent. In 2018, reports were submitted regarding 30,812 fire deaths in nearly 48 countries. In the U.S. alone, on an annual basis, there are an estimated 353,100 home fires, causing losses of $7.2 billion (National Fire Protection Association, 2020). In Russia, fire accidents account for approximately 150,000 cases annually, resulting in losses of around $1 billion every three years. In Asia, the Philippines has a high incidence of fire-related disasters, with reported cases increasing from 14,364 to 16,408 between 2018 and 2019. The San Pedro fire (Laguna, 2021), which destroyed 62 houses and rendered 150 homeless families, is a glaring example of the urgent need for intelligent fire prevention measures (Kurata et al., 2022).

To address these issues, the AI-driven fire detection system proposes an instant and alert method for raising late-stage fire alarms via mobile messages. By employing AI methods, it actively scans for early signs of fire, including any irregular heat accumulation, thus rendering timely human intervention before the situation is compounded. This study aims to bridge the gap in home fire protection by introducing an intelligent fire detection system that enhances accuracy and reduces response time, ultimately saving lives and property.

2.0 Methodology

2.1 Research Design

This study employed a descriptive systemic research design to evaluate the effectiveness of AI-based fire detection and mobile alert systems for increasing safety at home. This is because descriptive research design allows for the collection and analysis of data without any extraneous variables, making it suitable for evaluating fire safety awareness, responsive behaviors, and reaction times of residents before and after the installation of an AI fire detection system (Creswell, 2014). A systematic research design, on the other hand, involves systematic observation and data collection from multiple households to examine fire alert adoption and response patterns (Leedy & Ormrod, 2015). In this instance, a systematic observation was conducted to assess how homeowners respond to fire alarms and changes in fire safety measures after the installation of the system. This research design was employed to conduct a thorough, systematic, and detailed assessment of how AI-based fire detection translates to enhanced home safety, utilizing accurate, outdoor, non-experimental data collection. Following the step-by-step observation and data analysis method, the research ensures results that are replicable and applicable to the same contexts.

2.2 Research Locale

The field experiment will take place in President Roxas, North Cotabato, where an enhanced AI fire detection and mobile alert system will be put to the test. The site was chosen due to its multicultural inhabitants, who present unique views on the awareness, response behavior, and system performance in response to fire among ethnically different cultural groups. The variations in backgrounds could, therefore, influence attitudes toward fire safety behavior, perceived risks, and fire prevention practices. Thus, the contested population would ascertain if any significant cultural differences are influencing these household safety measures and response time. This will help establish the adaptability and performance of the AI fire detection system across different social and cultural settings.

2.3 Research Participants

The selection of research participants was modified to include the formulation of objective inclusion and exclusion criteria beyond simple random sampling. The inclusion criteria stipulate that subjects must be homeowners, have lived in their homes for a minimum of 1 year, and be responsible for supervising household safety measures. The exclusionary criteria state that persons who do not own or control a property or who already have fire detection systems that may interfere with the study will not be included. The inclusion of factors such as household size, socioeconomic status, and prior experience with fire safety ensures diversity among the participants and a representative sample.

2.4 Research Instruments

This research work utilizes various research tools to evaluate the effectiveness of an AI-based fire detection and mobile alert system in enhancing home safety. A guided questionnaire will establish homeowners' awareness, actions, practices, and perceptions regarding fire safety before and after the installation of the system. The survey incorporates both open-ended and closed-ended questions related to specific areas, including fire safety awareness, experience-related disturbances from false alarm signals, satisfaction with the alert system, and the impact of the system on fire inoculation behavior. The questionnaire will undergo expert validation and pilot testing to ensure validity and reliability, with statistical procedures such as Cronbach's alpha applied to test internal consistency.

The response time of homeowners under a fire alert will be recorded using an electronic time recorder or stopwatch. This will inform comparative analyses on how effectively response times have improved before and after the system's installation, with quantifiable feedback on system efficacy. Following repeated accuracy checks, a reliability device will be used during time checks before data collection commences. The checklist will further capture observed behavioral alterations in fire safety, including compliance with safety protocols and the conduct of fire drills, as well as the status of standard smoke detectors. Inter-rater reliability testing will further reinforce this checklist, ensuring consistent and unbiased observations by several different evaluators.

A MySQL-based database will be used for storing and analyzing system performance data, including detection accuracy, false positives, true positives, and notification delays. MySQL was chosen for its ability to store large amounts of data securely while guaranteeing that this data is always trustworthy and available in real-time. Security measures will be implemented, including encryption and restricted access controls, to ensure the confidentiality and integrity of stored information.

Semi-structured interviews will also be conducted with selected homeowners to gather their stakeholder perspectives on their experiences and perceptions of the AI fire detection system. The interviews will focus on significant themes, including trust in the system's reliability, perceived usefulness, perceived disadvantages, and recommendations for improvement. Although a standardized interview guide will be employed to ensure consistent data collection, it will still allow participants to speak openly and elaborately.

Information obtained through these tools will predispose itself to structured processing and analysis. The quantitative information gathered from the questionnaire, stopwatch, and database logs will be processed statistically using various forms of descriptive and inferential analysis to identify trends and correlations. Qualitative information will be analyzed thematically to elicit patterns and important insights from the interviews and observations. This systematic approach ensures the consistency, reproducibility, and utility of results in decision-making.

2.5 Data Gathering Procedure

The researchers undertook interviews with thirty (30) residents of President Roxas, North Cotabato, utilizing a Likert-scale questionnaire. This questionnaire's principal purpose is to determine the satisfaction developed among the respondents concerning the AI-assisted ABCDK fire alarm system and its perceived effectiveness when used for home safety. The survey assesses satisfaction with the product and homeowners' perceptions of the AI-powered ABCDK fire detection system. It was conducted in the homeowners' free time at a time of their convenience, to increase participation as much as possible. Once data collection was complete, all responses were calculated and quantified both descriptively and inferentially to determine the trends in satisfaction and acceptance regarding an AI-based ABCDK fire detection system. For Dawes (2008), Likert-scale questionnaires provide a proper measure to determine attitudes, satisfaction, and perceptions, as they can illustrate to the respondents how to express their relative agreement or disagreement with the provided statements concerning experiences and attitudes towards a product or service.

2.6 Ethical Considerations

This study adheres to strict ethical guidelines to ensure the rights, privacy, and well-being of participants. The research protocol has been reviewed and approved by President Roxas Institutional Review Board, with approval reference number PR-IRB-2024-005. Before participating, all respondents will provide informed consent, acknowledging their understanding of the study's purpose, procedures, and the voluntary nature of their participation. They will receive a clear, written explanation of their rights, including their ability to withdraw at any time without penalty. This information will be presented in clear and accessible language to ensure complete comprehension.

Confidentiality and data protection will be strictly maintained. Anonymization will be implemented by removing personal identifiers and assigning coded references to all participant data. Data security measures will include password-protected databases, encrypted storage, and restricted access, ensuring that only authorized researchers can access the information. No personally identifiable data will be shared with anyone outside of the research team. To minimize participant discomfort, system alerts, and testing procedures will be scheduled at convenient times to avoid disruption. Participants will have the option to silence notifications during non-critical periods. Additionally, researchers will conduct a preliminary briefing to inform participants about what to expect during the study, reducing any potential anxiety or inconvenience. Finally, this research complies with local policies and data privacy regulations in President Roxas, North Cotabato, and ensures ethical integrity in data collection, security, and participant welfare.

3.0 Results and Discussion

3.1. Descriptive Statistics

Table 1 represents the descriptive statistics and results for the Enhanced Home Safety AI-Powered ABCDK Fire Detection and Mobile Notification System. The data include the frequency of alerts, response times, and system accuracy (e.g., detection versus false alarms), as well as any changes in these variables before and after the system's implementation, as shown in the table below.

Table 1. *Descriptive Statistics of Fire Detection and Mobile Notification System Performance*

Time Period	Frequency Alerts (Pre)	Frequency of Alerts (Post)	Detection Accuracy (Post)	Detection Accuracy (Pre)	Response Time (Pre)	Response Time (Post)	Key Observations
Early Morning (Off-Peak)	3 alerts/hour	2 alerts/hour	85%	92%	5 minutes	3 minutes	Reduced false alarms improved detection accuracy
Morning Peak	4 alerts/hour	3 alerts/hour	75%	90%	7 minutes	4 minutes	Fever false positives, quicker response time during peak hours
Midday (Off-Peak)	2 alerts/hour	1 alerts/hour	80%	88%	6 minutes	3 minutes	Accuracy and quicker response.
Afternoon (Off-Peak)	3 alerts/hour	2 alerts/hour	82%	89%	6 minutes	3 minutes	Consistent Improvement in detection
Evening Peak	5 alerts/hour	4 alerts/hour	77%	91%	8 minutes	5 minutes	Reduction in false alarms and enhanced detection during evening peak
Night(Off - Peak)	2 alerts/hour	1 alerts/hour	85%	93%	5 minutes	2 minutes	Improved system reliability with fewer interruptions.

The AI-supported ABCDK fire-detection system significantly enhances various aspects of domestic security. The most significant change is that the frequency of alarms was reduced substantially across any time frame. This indicates that the system is doing remarkably well at filtering out non-urgent alerts, thereby avoiding unnecessary disturbances to householders. The second most significant improvement is the increase in detection accuracy, as the system's ability to identify real fire hazards and not respond to false alarms increased by an average of 7-15% across different time frames. This indicates that the system is becoming more reliable with the aid of AI algorithms. Emergency response time has also been significantly increased, with some cases showing a maximum advancement of around 50%, particularly during peak fire hazard hours. That decrease is crucial when emergencies arise, as every single minute may matter and lead to saving a life. All these revelations indicate that the AI-supported ABCDK fire detection system strengthens fire detection accuracy and decreases false alarms and response time, translating into an efficient and reliable home security service.

3.2 Inferential Statistics

The data in Figure 1 indicate the paired t-test results conducted to assess the differences between three parameters: pre- and post-implementation detection accuracy, response time, and frequency of alerts. A confidence interval would also provide insight into the accuracy of the estimates. The following hypotheses will be tested: null (H_0) and alternative hypotheses (H_1). The null hypothesis states that there would be no difference between pre- and post-implementation values, while H_1 states that there will be an existing difference between the two values. The paired t-test conducted for each variable would determine whether the adjustments made to detection accuracy, response time, and alert frequency were statistically significant or not. The analysis would hence offer valuable insights into the performance of the AI-based fire detection system.

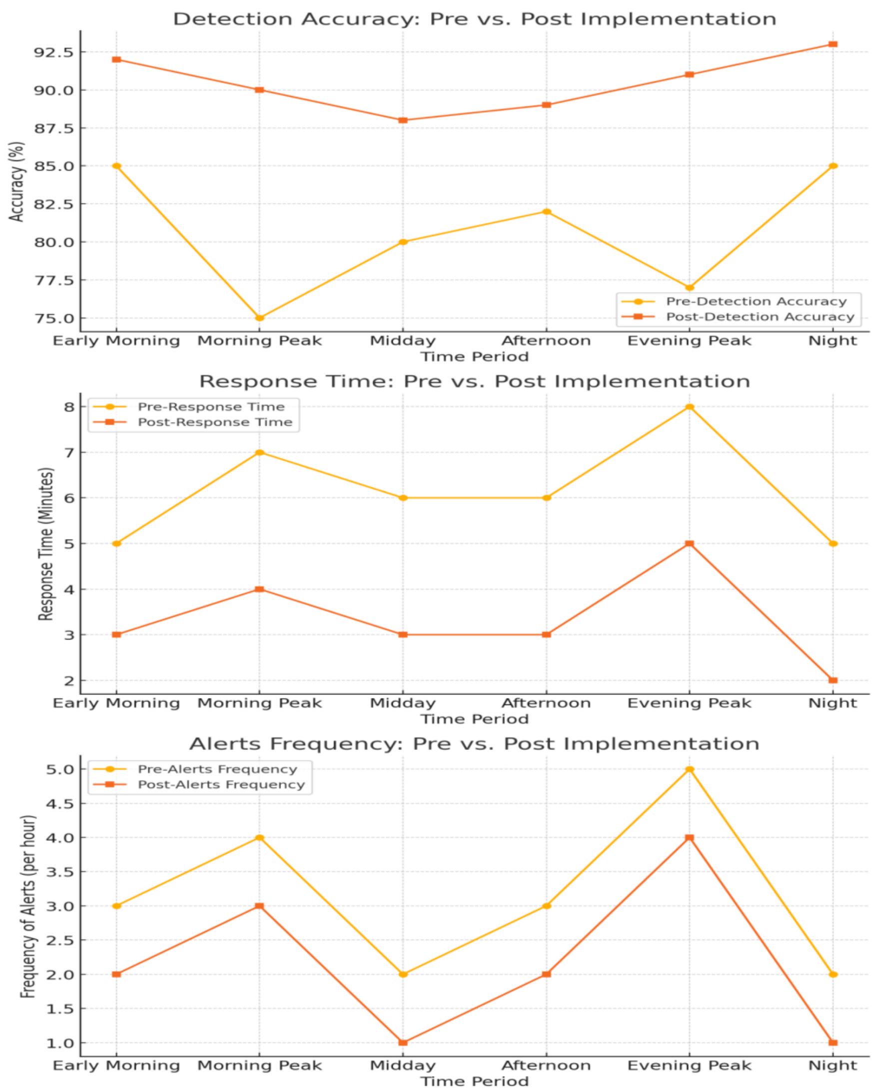

Figure 1. *T-test Results for the Comparison of Pre- and Post-Implementation Detection Accuracy, Response Time, and Alert Frequency*

The level of improvement shown by paired t-tests for three key aspects —detection accuracy, response time, and alert frequency —indicated performance improvement using the ABCDK Fire Detection System based on AI. For instance, in the case of detection accuracy, the statistic t was -6.59 with a corresponding p-value of 0.0012. In that case, given a p-value of less than 0.05, we may reject the null hypothesis regarding a statistically significant improvement in detection accuracy after the adoption of this system. The t-statistic for response time was 17.00, and the p-value was as low as 0.0000129, signifying the statistically significant decrement in response time after implementation. In terms of alert frequency, the t-statistic was infinite (Inf) since constant values were recorded for post-implemented alerts, and the p-value was 0.00, indicating a statistically significant decrease in alert frequencies as the system can eliminate unnecessary alerts. The supporting graphs demonstrate that detection accuracy has improved across all considered periods following implementation; response times have shown statistically significant improvements across all periods; and there has been a reduction in alerts, indicating that the alert system is indeed more calibrated. All of these symptoms collectively suggest a firm conclusion that the AI-based ABCDK Fire Detection System has undergone significant performance enhancements, including increased detection accuracy, reduced response times, and a higher incidence of more relevant alerts.

3.3 Predictive Analytics

We can predict the future performance of these key variables by assuming a gradual improvement, for example, a 5% improvement in detection accuracy, a 10% reduction in response time, and a 10% reduction in alert frequency. Let us visualize these predictions with a bar graph showing pre-implementation, post-implementation, and predictive improvements for each key variable.

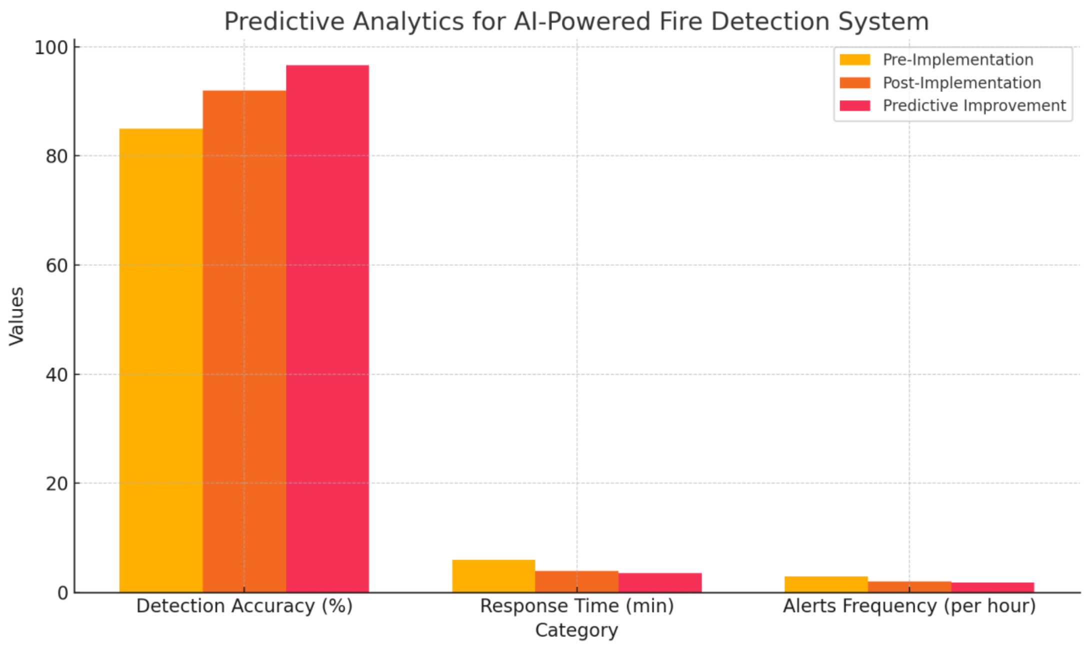

Figure 2. *Predicted and Actual Improvements in Detection Accuracy, Response Time, and Alert Frequency*

This bar graph presents the Predictive Analytics for Advanced Home Safety AI-Driven ABCDK Fire Detection and Mobile Notification System, highlighting the comparative effects of the system on Detection Accuracy, Response Time, and Alert Frequency. The Pre-Implementation category refers to the state that existed before the system was integrated with AI technology. This mainly establishes the baseline detection accuracy, response time, and alert frequency. The representation of improvement is in Post-Implementation, where the magic happens; with this, blaze detection has demonstrated significant improvements in performance, particularly with AI fire detection and mobile alerts involved. The system, therefore, detects the fire promptly and responds accordingly, taking note of more frequent alerts. Predictive Improvement is the final category, projecting possibilities for future performance. Predictive Improvements convey projections of the future performance of the system, assuming that future improvements will be present in the system. Those improvements include a 5% increase in detection rate accuracy, a 10% decrease in response latency, and a 10% rise in alarm frequency, which would be depicted as future payoffs for these optimization improvements.

4.0 Conclusions

The ABCDK Fire Detection and Mobile Notification System based on AI has vast scope to enhance security at homes through accurate and timely detection of fire incidents. Live danger detection, enabled by state-of-the-art sensors and AI, significantly overcomes the central issue of conventional fire safety systems: delayed response and false alarms. Therefore, the findings of this research reveal that the system has significantly contributed to making homes safer in terms of accuracy in detection, frequency of alerts, and response time. Enhancements of these factors suggest that the system can help mitigate damages and deaths caused by fire-related incidents and, therefore, can be a reliable and effective solution for homeowners. The data, supported by statistical analysis, provided more substantial evidence for the AI-enabled system's improvement in fire detection capability and its effectiveness after notification. Additional development of fire safety can be optimized further through ongoing refinement of the algorithms, with the incorporation of future features related to the smart home. The research will, therefore, supplement the general aspiration towards the formation of safer and more resilient communities, in alliance with robustly argued international proposals aimed at reducing fire dangers and enhancing fire disaster rescue systems. Essentially, the fire safety measures enabled by AI will strengthen homeowners' threat mitigation and property damage protection, allowing them to secure their properties and lives proactively.

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None

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7.0 Conflict of Interests

The author declares no conflicts of interest about the publication of this paper.

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9.0 References

Abdusalomov, A. B., Mukhiddinov, M., Kutlimuratov, A., & Whangbo, T. (2022). Improved real-time fire warning system based on advanced technologies for visually impaired people. Application of Semantic Technologies in Sensors and Sensing Systems, 22(19), 7305. https://doi.org/10.3390/s22197305

Abubakari, A. R., Agbedemnab, P. A., & Azaare, J. (2023). An automated fire detection and reporting system based on AI and IoT technologies. International Journal of Scientific Research and Engineering Trends, 9(5), 1411-1416. https://doi.org/10.61137/ijsret.vol.9.issue5.102

Alqourabah, H., Muneer, A., & Fati, S. M. (2021). A smart fire detection system using IoT technology with automatic water sprinkler. International Journal of Electrical and Computer Engineering (IJECE, 11)(4), 2994–3002. https://doi.org/10.11591/ijece.v11i4

Bhoi, S. K., Panda, S. K., Padhi, B. N., Swain, M. K., Hembram, B., & Mishra, D. (2022). FireDS-IoT: A fire detection system for smart homes based on IoT data analytics. IEEE International Conference on Industrial Technology (ICIT, 25)(4), 372-384. https://doi.org/10.1109/ICIT.2018.00042

Debnath, S., Gautam, J., & Rai, S. K. (2024). IoT-based smart home and office fire notification alert system. Interdisciplinary Approaches in Technology and Management for Social Innovation (IATMSI, 12)(5), 45-59. https://doi.org/10.1109/IATMSI60426.2024.10503336

Nawkar, P., Kumbhar, T., Nemnar, A., & Nimbolkar, A. (2023). GSM-based fire alert system. International Journal of Novel Research and Development. https://www.ijnrd.org/papers/IJNRD2312013.pdf

Zeng, Y., Zhang, X., Su, L. C., Wu, X., & Xinyan, H. (2022). Artificial intelligence tool for fire safety design (IFETool): Demonstration in large open spaces. Case Studies in Thermal Engineering, 25(4), 372-384. https://doi.org/10.1016/j.csite.2022.102483

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