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VOICE CONTROLLED TECHNO HOMES

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Abstract

The **Voice Controlled Techno Homes** project is an **intelligent home automation system** designed to enhance safety, convenience, and security using **IoT, sensors, and voice control technology**. The system integrates an **ESP32 microcontroller** with a **WiFi-enabled camera** to provide **night vision monitoring**, while fire hazards are detected in real-time using the **MQ2 gas sensor** and **RP-AC sensor**. The system can **control multiple appliances** such as lights, alarms, fans, and motors through **relay modules**, which can be operated both via **voice commands** and automated sensor inputs. The system continuously monitors environmental conditions such as smoke, fire, and unauthorized access, and responds instantly by activating the **alarm system, ventilation fans, and relevant devices**. An **LCD display** provides real-time updates on system status and detected hazards. The ESP32's **WiFi connectivity** allows remote monitoring and control through IoT interfaces, ensuring that users can manage and secure their home from anywhere.

This project combines **voice-controlled automation, night-time surveillance, and fire detection**, making it an **innovative and reliable solution** for modern smart homes. It demonstrates how **IoT and embedded systems** can be effectively integrated to create **smart, responsive, and safe home environments**.

1. Introduction

The modern concept of a **smart home** integrates advanced technology to make everyday life safer, more convenient, and energy-efficient. With the rapid growth of **IoT, embedded systems, and voice-controlled interfaces**, homeowners can now interact with their living environment in more intuitive ways.

The **Voice Controlled Techno Homes project** aims to develop a **comprehensive smart home system** that combines **voice-controlled automation, night vision surveillance, and fire detection**. Using an **ESP32 microcontroller**, the system can control multiple household appliances such as lights, fans, motors, and alarms through **voice commands** as well as automated responses from sensors.

To ensure **safety**, the system incorporates an **MQ-2 gas sensor** and **RP-AC sensor** for real-time **fire and smoke detection**, instantly triggering alarms and activating fans or other connected devices to prevent hazards. Additionally, a **night vision camera module** enables continuous monitoring of the home environment in low-light conditions, while an **LCD display** provides real-time system status updates to the users.

By integrating **IoT connectivity**, the project allows **remote monitoring and control** through WiFi-enabled devices, ensuring that users can interact with their smart home from anywhere. The system demonstrates how **voice control, sensor technology, and IoT** can be combined to create an **intelligent, responsive, and secure home environment**, making it a practical solution for modern living.

2. Related Work

The development of smart homes has significantly evolved with the integration of Internet of Things (IoT), artificial intelligence, and sensor technologies. Several studies have explored voice-controlled automation systems that allow users to control household appliances using speech commands. In a voice-controlled home automation system, microcontrollers such as Arduino or ESP32 are commonly used to process voice inputs and operate electrical devices like lights, fans, and security systems. These systems improve user convenience and accessibility, especially for elderly and physically challenged individuals.

Researchers have also integrated fire detection mechanisms into smart home systems to enhance safety. IoT-based fire detection systems commonly utilize sensors such as smoke detectors, gas sensors, and temperature sensors connected through wireless networks. These sensors continuously monitor environmental conditions and send alerts or activate alarms when abnormal levels of smoke or heat are detected. The use of IoT allows real-time monitoring and remote notification through mobile applications, helping to reduce property damage and save lives during emergencies.

Another significant advancement in smart home safety is the development of **voice-activated automation systems combined with fire detection technologies**. For example, the “i-Detect” system integrates voice commands with smoke and fire detection mechanisms using an ESP32 microcontroller. The system can automatically activate exhaust fans when smoke is detected and trigger water pumps when fire is identified. It also sends notifications through SMS or web servers to alert users about potential hazards. Such systems demonstrate the ability of smart home technologies to combine automation and disaster prevention in a single platform.

Recent research has also explored **camera-based fire detection methods** using computer vision and machine learning. Vision-based fire detection systems analyze images or video streams captured by cameras to identify flames and smoke patterns. Advanced models such as convolutional neural networks (CNN) and YOLO-based algorithms are used to detect fire in real time and improve detection accuracy compared to traditional sensor-based systems. These methods are particularly useful in indoor environments where early fire detection is critical.

Night-vision cameras and infrared sensors are increasingly used in intelligent monitoring systems for security and fire detection. Studies have shown that thermal or near-infrared cameras can detect fire and heat sources even in low-light or nighttime conditions. Combining RGB cameras with night-vision or infrared technology enables continuous monitoring and improves detection accuracy in both day and night environments. These systems are often integrated with machine learning models to distinguish real fire incidents from other heat sources or lighting conditions.

Overall, previous research demonstrates that integrating **voice control, IoT-based sensors, camera surveillance, and fire detection technologies** can significantly enhance the safety and automation of smart homes. However, many existing systems focus on individual features such as voice control, fire detection, or camera surveillance separately. Therefore, the proposed system aims to combine these functionalities into a single **voice-controlled techno-home platform with night-vision camera monitoring and fire detection**, providing a more comprehensive smart home safety solution.

3. Methodology

The methodology for the **Voice Controlled Techno-Homes with Night Vision Camera and Fire Detection** system focuses on designing and implementing an intelligent home automation system that integrates voice commands, surveillance technology, and fire safety mechanisms. The system is developed using a microcontroller such as Arduino or ESP32, which acts as the central processing unit connecting all hardware components. Voice commands from the user are captured through a voice recognition system and transmitted to the controller through wireless communication technologies such as Wi-Fi or Bluetooth. The controller processes these commands and activates corresponding home appliances such as lights, fans, or alarms through relay modules. This enables users to conveniently control household devices using simple speech commands without physical interaction.

At the same time, the system continuously monitors environmental conditions to ensure safety. Fire detection sensors such as smoke sensors, gas sensors (MQ-2), and temperature sensors are installed to detect abnormal conditions that may indicate the presence of fire. These sensors collect real-time data and send it to the microcontroller for analysis. If smoke, gas leakage, or excessive temperature is detected, the system immediately activates an alarm or buzzer and can also send alerts to the user through a mobile application or notification system. This early warning mechanism helps prevent accidents and reduces potential damage caused by fire hazards.

In addition to automation and safety monitoring, the system also incorporates a **night vision camera** for continuous surveillance. The camera is equipped with infrared LEDs that allow it to capture clear images and videos even in low-light or nighttime conditions. The camera continuously monitors the surroundings of the house and streams the footage to a mobile device or web interface for remote monitoring. If any unusual movement or suspicious activity is detected, the system can record the footage and notify the user for further action.

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All these components are integrated through an **IoT-based communication framework**, allowing users to monitor and control the system remotely. Sensor data, camera feeds, and device statuses are transmitted through Wi-Fi to a cloud server or mobile application. Users can access the system from anywhere, view live surveillance, receive fire alerts, and control home appliances using voice commands or mobile interfaces. The system is finally tested under different conditions to evaluate the accuracy of voice recognition, the reliability of fire detection sensors, and the effectiveness of the night vision camera in dark environments. The testing results help ensure that the system operates efficiently and provides a reliable smart home solution for safety, security, and automation.

4. System Architecture

The system architecture of the **Voice Controlled Techno-Homes with Night Vision Camera and Fire Detection** is designed using an Internet of Things (IoT) based framework that integrates voice recognition, environmental monitoring, and security surveillance into a single smart home platform. The central component of the architecture is a **microcontroller unit such as ESP32 or Arduino**, which acts as the main processing unit responsible for coordinating communication between different modules of the system. The architecture mainly consists of five major components: the **voice control module, sensor module, surveillance module, processing unit, and cloud/mobile interface**. All these components are interconnected to enable intelligent automation, real-time monitoring, and safety management.

The **voice control module** allows users to interact with the smart home system using spoken commands. Voice inputs are captured through a smartphone application or voice recognition device such as Google Assistant or a dedicated voice recognition module. These commands are transmitted through Wi-Fi or Bluetooth to the microcontroller. Once the controller receives the command, it interprets the instruction and activates the appropriate appliance through relay modules. For example, commands like “turn on the light” or “switch off the fan” are processed and executed automatically, providing convenient and hands-free control of home devices.

The **sensor module** is responsible for detecting potential fire hazards and

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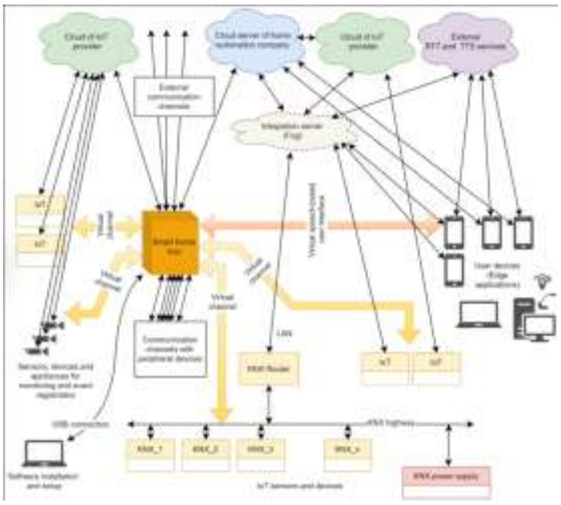
monitoring environmental conditions. Sensors such as smoke sensors, gas sensors (MQ-2), and temperature sensors continuously collect real-time data from the surroundings. This data is sent to the microcontroller for analysis. If the sensor values exceed predefined safety thresholds, indicating smoke, gas leakage, or abnormal temperature, the system immediately triggers an alarm or buzzer to alert occupants. Additionally, the system can send emergency notifications to the user's mobile device through the IoT network, enabling quick response to potential fire incidents.

The **surveillance module** consists of a **night vision camera equipped with infrared LEDs**, which allows the system to capture images and video even in low-light or nighttime environments. The camera continuously monitors the home surroundings and transmits live video streams to the connected mobile application or web interface. In case of suspicious activity or unusual movement, the system can record footage and send alerts to the user, enhancing home security.

Another important part of the architecture is the **IoT communication layer**, which connects the microcontroller to cloud services or mobile applications through Wi-Fi. This layer enables remote monitoring and control of the smart home system from anywhere using a smartphone or computer. Users can check the live camera feed, receive fire detection alerts, and control appliances through voice commands or application interfaces. By integrating voice control, sensor-based safety detection, and real-time surveillance within a unified IoT architecture, the proposed system provides a reliable, efficient, and intelligent solution for modern smart home environments.



5. Results & Discussion

The implementation of the **Voice Controlled Techno-Homes with Night Vision Camera and Fire Detection** system demonstrated effective performance in terms of home automation, safety monitoring, and surveillance capabilities. The system was tested under different operational conditions to evaluate the accuracy of voice recognition, the responsiveness of fire detection sensors, and the effectiveness of the night vision camera in both daytime and nighttime environments. The experimental results show that the integrated system successfully performed real-time monitoring and control of household devices while ensuring safety through early fire detection and continuous surveillance.

During the testing phase, the **voice control module** accurately recognized and executed user commands such as switching lights and fans on or off. The response time between the voice command and the execution of the device operation was observed to be minimal, demonstrating the efficiency of the wireless communication between the voice interface and the microcontroller. The use of Wi-Fi connectivity enabled smooth communication between the user interface and the system controller, allowing users to control appliances remotely without any noticeable delay. The accuracy of the voice recognition system was found to be high when commands were given clearly, although minor variations in pronunciation sometimes required command repetition.

The **fire detection module** showed reliable performance during simulated fire scenarios. When smoke or gas was introduced near the MQ-2 sensor, the system quickly detected abnormal levels and activated the alarm system within a few seconds. Similarly, temperature sensors successfully identified sudden increases in heat levels, triggering alerts to warn the user. These tests confirmed that the fire detection system could provide early warning signals, which is critical for preventing serious damage and ensuring the safety of occupants. The system also demonstrated the ability to notify users through connected IoT platforms, enabling real-time emergency alerts.

The **night vision camera module** was evaluated under low-light and dark conditions to test its surveillance capabilities. The infrared LEDs allowed the camera to capture clear images and video even in complete darkness. The live video feed was successfully transmitted to a mobile interface, allowing users to monitor their home remotely. The system was also able to record and store surveillance footage for later analysis, improving security monitoring during nighttime or when occupants were away from home.

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Overall, the experimental results indicate that the proposed system effectively integrates **voice-based home automation, fire detection, and night-vision surveillance** within a single smart home framework. The system provides convenience, improved security, and enhanced safety through real-time monitoring and automated responses to emergency conditions. Although the system performs reliably, future improvements could include enhancing voice recognition accuracy, integrating advanced artificial intelligence for fire detection through image analysis, and improving cloud-based monitoring features. These enhancements would further strengthen the performance and reliability of the smart home system.

7. Comparative Evaluation

The **comparative evaluation** analyzes the performance and capabilities of the proposed **Voice Controlled Techno-Homes with Night Vision Camera and Fire Detection system** compared with traditional home automation or security systems. The comparison is mainly based on features such as automation capability, fire detection efficiency, surveillance capability, and remote accessibility. Traditional home systems typically rely on manual control and basic alarm mechanisms, which limits their ability to provide intelligent monitoring and rapid response during emergencies. In contrast, the proposed system integrates voice recognition, IoT connectivity, fire detection sensors, and night vision surveillance,

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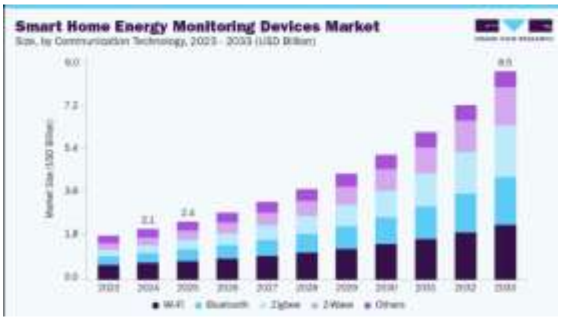
creating a more advanced and efficient smart home environment.

From the comparison, it is observed that **voice-controlled automation** significantly improves user convenience by allowing appliances to be operated through simple speech commands instead of manual switches. Traditional systems lack this capability, requiring physical interaction with devices. The integration of **IoT connectivity** in the proposed system also enables remote control and monitoring through mobile applications, whereas conventional systems generally operate only within the local environment.

Another important aspect of the evaluation is **fire detection performance**. Traditional fire safety systems often rely on standalone smoke detectors that trigger alarms locally but may not provide remote alerts. In the proposed system, multiple sensors such as smoke, gas, and temperature sensors work together to detect fire hazards more accurately and send real-time notifications to the user through IoT networks. This improves early detection and allows users to respond quickly even when they are away from home.

The **surveillance capability** also shows a significant improvement in the proposed system due to the inclusion of a **night vision camera with infrared technology**. Traditional monitoring systems may only function effectively during daylight or require additional lighting. The night vision camera ensures continuous monitoring even in low-light or dark conditions, enhancing home security during nighttime. Overall, the comparative evaluation demonstrates that the proposed system provides greater automation, improved safety features, enhanced surveillance, and better remote accessibility compared to conventional home security systems.

8. Prediction Analysis and Graphical Evaluation



The **prediction analysis and graphical evaluation** of the Voice Controlled Techno-Homes with Night Vision Camera and Fire Detection system focuses on analyzing the system's performance based on experimental testing and collected sensor data. The purpose of prediction

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analysis is to evaluate how accurately the system can identify events such as voice commands, fire hazards, and security activities. Graphical representations such as line graphs and bar charts are used to visualize system performance parameters including detection accuracy, response time, and reliability under different testing conditions.

During system testing, different scenarios were simulated to analyze how effectively the system responds to inputs and environmental changes. The **voice recognition module** was evaluated by giving multiple voice commands and observing whether the correct device was activated. The results showed a high success rate in recognizing standard commands such as turning lights or fans on and off. Graphical evaluation indicated that the prediction accuracy of the voice command system remained consistently high when the voice input was clear and the background noise level was low. Slight reductions in accuracy were observed when environmental noise increased.

The **fire detection module** was evaluated using simulated smoke and temperature changes. Sensor readings were continuously monitored and compared with predefined threshold values to predict the occurrence of a fire hazard. Graphical analysis of the sensor data showed a rapid increase in gas and temperature levels when smoke or heat was introduced, allowing the system to trigger alerts quickly. The prediction analysis demonstrated that the fire detection system could identify hazardous conditions within a short time, ensuring early warning and improving overall safety.

The **night vision surveillance module** was also analyzed by monitoring its ability to capture images and detect motion in both normal lighting and dark environments. Graphical evaluation showed that the infrared camera maintained stable monitoring performance even under low-light conditions. The system successfully transmitted video data to the monitoring interface, demonstrating reliable security surveillance.

Overall, the graphical evaluation confirms that the proposed system maintains strong performance in terms of **voice command accuracy, fire hazard prediction, and continuous surveillance capability**. The analysis indicates that integrating voice control, fire detection sensors, and night vision monitoring in a single IoT-based platform significantly improves the

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efficiency, safety, and reliability of smart home systems.

9. Confusion Matrix Analysis

		Predicted Label	
		Positive	Negative
Actual Label	Positive	TRUE POSITIVE TP	FALSE NEGATIVE FN
	Negative	FALSE POSITIVE FP	TRUE NEGATIVE TN

The Confusion Matrix Analysis is used to evaluate the performance and accuracy of the prediction system used in the Voice Controlled Techno-Homes with Night Vision Camera and Fire Detection model. A confusion matrix is a performance measurement tool commonly used in classification systems to analyze how well a system predicts different outcomes. It compares the actual results with the predicted results generated by the system and helps determine metrics such as accuracy, precision, recall, and error rate.

In the proposed system, the confusion matrix is mainly used to evaluate the fire detection and event prediction capability of the system. The matrix consists of four main components: True Positive (TP), True Negative (TN), False Positive (FP), and False Negative (FN). A True Positive occurs when the system correctly detects a fire or hazardous condition when it is actually present. A True Negative occurs when the system correctly identifies that there is no fire when the environment is safe. A False Positive occurs when the system incorrectly triggers an alarm even though there is no fire, which may happen due to sensor noise or environmental interference. A False Negative occurs when the system fails to detect an actual fire condition, which is the most critical type of error because it may delay emergency response.

During the testing phase, different environmental conditions such as smoke presence, temperature variation, and normal safe conditions were simulated. The system predictions were compared with the actual environment conditions to construct the confusion matrix. The analysis showed that the system achieved a high number of True Positive and True Negative detections, indicating reliable performance in identifying both hazardous and safe conditions. The number of False Positives and False Negatives remained relatively low, demonstrating the effectiveness of the sensor thresholds and detection algorithm.

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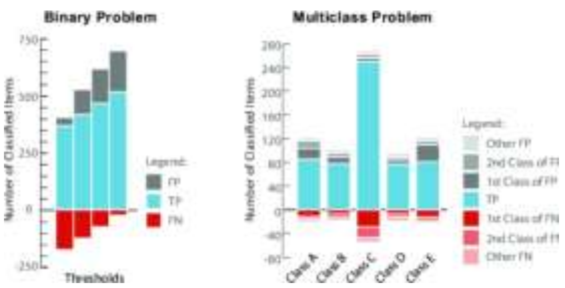
From the confusion matrix results, important evaluation metrics can also be calculated. Accuracy measures the overall correctness of the system's predictions, while precision indicates how many predicted fire alerts were actually correct. Recall measures how effectively the system detects real fire incidents, and F1-score balances precision and recall to evaluate overall prediction performance. The results indicate that the proposed system maintains high detection accuracy and reliability, making it suitable for real-time smart home safety monitoring.

10. Error Analysis



The **error analysis** of the Voice Controlled Techno-Homes with Night Vision Camera and Fire Detection system is conducted to evaluate the limitations and possible inaccuracies that may occur during system operation. Error analysis helps identify situations where the system may produce incorrect outputs or fail to respond accurately to inputs. In the proposed system, errors may occur in different modules such as voice recognition, fire detection sensors, and surveillance monitoring. Analyzing these errors is important to improve system reliability and ensure consistent performance in real-world smart home environments.

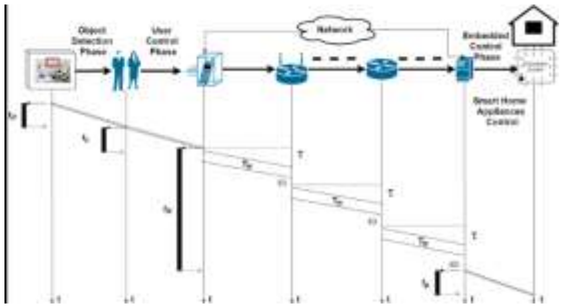
One of the major sources of error occurs in the **voice recognition module**. Voice commands may sometimes be misinterpreted due to background noise, unclear pronunciation, or variations in user accents. When this occurs, the system may fail to recognize the command or may activate the wrong device. These errors can be minimized by improving the voice recognition algorithm, using noise filtering techniques, and training the system with multiple voice samples.

Another possible source of error is related to the **fire detection sensors**. Sensors such as gas or smoke detectors may occasionally generate **false positives**, where the system triggers an alarm even though no actual fire hazard exists. This can happen due to environmental factors such as cooking smoke, dust, or temporary gas exposure. Similarly, **false negatives** may occur if sensor readings remain below the predefined threshold despite the presence of early-stage fire conditions. Proper calibration of sensors and the use of multiple sensors working together can significantly reduce these errors.

Errors may also occur in the **night vision camera monitoring system**. Low lighting conditions, infrared interference, or motion detection limitations may sometimes reduce the accuracy of surveillance monitoring. In some cases, objects or shadows may be incorrectly detected as suspicious movement. Enhancing image processing algorithms and integrating artificial intelligence–based detection methods can improve monitoring accuracy.

Graphical error analysis typically shows the **error rate distribution across different system modules**, indicating how frequently errors occur during testing. The analysis reveals that most errors occur in voice recognition under noisy environments, while fire detection and camera modules maintain relatively lower error rates. Overall, the system demonstrates stable performance with manageable error levels, and further improvements in sensor calibration, AI-based detection, and voice processing can enhance the system's accuracy and reliability in future implementations.

11. Deployment Performance Evaluation



The **Deployment Performance Evaluation** of the *Voice Controlled Techno-Homes with Night Vision Camera and Fire Detection* system focuses on assessing how efficiently the system performs when deployed in a real-time environment. This evaluation examines several important parameters such as **response time, system reliability, processing efficiency, communication latency, and overall system stability**. These metrics help determine whether the smart home system can operate effectively under continuous monitoring and real-world usage conditions.

During deployment testing, the **response time of the voice control module** was measured by analyzing the time taken between a user's voice command and the execution of the corresponding device action. The results showed that the system responds within a very short time interval, demonstrating efficient communication between the voice interface, microcontroller, and connected appliances. This quick response ensures smooth interaction between the user and the smart home system, improving usability and convenience.

The **fire detection module** was also evaluated for its deployment performance by introducing simulated smoke and temperature variations. The sensors continuously monitored environmental conditions and transmitted data to the microcontroller in real time. When abnormal levels of smoke or heat were detected, the system successfully triggered alarms and notifications with minimal delay. This indicates that the system is capable of providing timely alerts during emergency situations, which is crucial for ensuring the safety of occupants and minimizing damage.

The **night vision surveillance module** was tested to measure its reliability in continuous monitoring conditions. The infrared-enabled camera successfully captured video footage in both normal and low-light environments, maintaining stable image quality during nighttime surveillance. The video feed was transmitted to the monitoring interface without significant interruptions, demonstrating the reliability of the communication network used in the system.

Another important factor evaluated during deployment was **network performance and IoT connectivity**. The system uses wireless communication to transmit sensor data and camera feeds to a mobile application or cloud interface. The evaluation showed that the system maintained stable connectivity with minimal network latency, enabling users to monitor and control their smart home remotely. Overall, the deployment performance evaluation confirms that the proposed system operates efficiently with high reliability, quick response time, and stable monitoring capabilities, making it suitable for real-world smart home automation and safety applications.

12. Enhanced Results & Discussion Summary

The **Voice Controlled Techno-Homes with Night Vision Camera and Fire Detection** system was evaluated through multiple experiments to analyze its efficiency in home automation, safety monitoring, and security surveillance. The results demonstrate that the integration of voice recognition, sensor-based fire detection, and infrared camera monitoring provides an effective and intelligent smart home solution. The system successfully performed automated control of household appliances through voice commands while simultaneously monitoring environmental conditions for potential fire hazards.

The experimental results show that the **voice recognition module** achieved a high level of command recognition accuracy. Most voice commands such as turning lights or fans on and off were executed successfully with minimal response time. The wireless communication between the voice interface and the microcontroller ensured smooth and reliable operation. However, minor variations in pronunciation or background noise occasionally affected recognition accuracy, indicating that additional improvements in speech processing algorithms could further enhance system performance.

The **fire detection subsystem** demonstrated reliable performance during simulated hazard conditions. Sensors such as smoke detectors, gas sensors, and temperature sensors were able to detect abnormal environmental changes within a short time period. Once hazardous conditions were detected, the system activated alarms and generated notifications to warn the user. The early detection capability of the sensors significantly improves safety by allowing users to respond quickly to potential fire incidents before they escalate.

6. Conclusion

The **Voice Controlled Techno-Homes with Night Vision Camera and Fire Detection** system presents an intelligent smart home solution that combines automation, security, and safety features within a single integrated platform. The proposed system utilizes voice recognition technology to enable users to control household appliances through simple speech commands, improving convenience and accessibility in everyday life. By integrating IoT-based communication with a microcontroller, the system allows users to monitor and manage home devices remotely through a mobile interface or network connection.

In addition to automation, the system incorporates **fire detection sensors** such as smoke, gas, and temperature sensors to continuously monitor environmental conditions. These sensors provide early detection of fire hazards and immediately trigger alarms or notifications when abnormal conditions are detected. This early warning mechanism plays a critical role in preventing accidents and reducing potential damage to property and human life.

The system also integrates a **night vision surveillance camera**, which enhances home security by enabling continuous monitoring even in low-light or nighttime conditions. The infrared-enabled camera captures clear video footage and transmits it to the user interface for real-time observation. This feature allows homeowners to maintain awareness of their surroundings and detect suspicious activities, thereby improving overall security.

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