

Smart Automated Door control and Fire Alert System Using IR,PIR and GSM Technologies

Sujan S B

*Department of Electronics and
Communication Engineering
Saveetha Engineering College,
Chennai, TamilNadu, India.
sujansb9804@gmail.com*

Pon Praveen K

*Department of Electronics and
Communication Engineering
Saveetha Engineering College,
Chennai, TamilNadu, India.
ponpraveen.tvl@gmail.com*

Heiner A J

*Department of Electronics and
Communication Engineering
Saveetha Engineering College,
Chennai, TamilNadu, India.
arnoldajheiner@gmail.com*

Abstract—sensitivity to safety and convenience in residential and commercial environments has remained a major issue, particularly to persons with mobility problems, in cases of emergency like fire outbreak. The conventional fire alarms and traditional manual doors often fail to have timely response as well as sufficient accessibility. The proposed project is an Intensive Security System, which comprises an Automatic Door Opener and Closer with PIR and IR sensor on it and a Fire Alarm with a GSM module. Hands-free door operations are activated by the system, which identifies people automatically to enhance the accessibility, efficiency, and energy-saving mechanisms. At the same time, the sensors can sense fire and send SMS or voice messages to pre-determined contacts using the GSM module to provide an immediate alert on the occurrence of the fire and easy responses to the emergency. The main aim is to create secure, responsive and user-friendly environment. What is fresh in this system is the smooth combination of automated doors control with GSM-controlled fire alerts to provide a united, efficient in energy consumption, and real-time safety device with residential, office, healthcare, and industrial validation.

Keywords: Built-In Security, auto-doors, fire alarm, human presence detectors, GSM Notification, Access, Safety.

I. INTRODUCTION

The growing application of technology in everyday life has resulted in the creation of mechanisms that are supposed to be more safe, convenient, and effective in domestic and commercial contexts. The contemporary environment justifies actions that do not only enhance security, but also allow more pliable human interaction [1] with the infrastructure in general. Regular manual doors and the outdated type of fire alarms are generally not suitable to the considered purpose since this demands human touch and may not act as fast as possible in case of an emergency. The importance of access and rapid response is even higher in the fields of application such as hospitals, offices, smart homes, and industries where immediate response may save lives, injuries or accidents.

The development of automated door systems has been an essential one in the provision of hands free and hassle free entry to people. Having the capability to identify the presence of humans near doorways, the system makes the use of

physical touch redundant therefore reducing the effort and enhancing sanitization. Such technology is particularly used in hospitals whereby limited mobility patients or wheelchair users need a hassle-free entry and exit. Automated doors can also be used in business [2] buildings such as shops and offices, too, where the doors offer the convenience of people carrying loads of goods, control traffic flow, and bring overall operational efficiency. The sensor technology installed in the door system ensures that the doors open upon required actions since it detects the presence of human beings even in their absence.

Not only does this innovation become convenient, but also more economical with regards to energy consumption since unwanted heat or cold seepage is minimized and as such the system can then be applied to energy conscious applications. Fire safety is one of the issues of concern in various types of buildings. The traditional fire alarm systems are sound-based and are not effective to inform all individuals in time, particularly in the huge or distant locations. Integration of communication technologies [3] such as GSM-based alerting allows the fire detection systems to send instantaneous messages to the targeted contacts through SMS or call hence guaranteeing rapid realisation and quick interventions. This type of functionality is used in home-based, business, and industry environments where a prompt response may avoid six-figure property damage or, in other cases, there might be great danger to human lives.

Fire detection together with real-time communication is an assurance that occupants of a building or people in charge of the emergence react quickly even in situations where they are not physically present. The automated door functions that are implanted with the GSM activated fire alarm [4] form a comprehensive approach to safety and convenience. This system takes the strengths of sensor technology in order to make strong detection and uses microcontroller-based controllers to introduce effective operational work. With occupancy and movement, the door system provides a secure environment, which prevents the entry of unauthorized persons and allows the entry and exit of the authorized ones unhindered.

At the same time, the fire alarm system keeps constant watch on the possibility of fire and gives alerts regardless of the position in which the user is located. Combination of these elements leads to a baked in security structure that can deal with different safety issues simultaneously. The project vision consists of the establishment of an accessible [5],

responsive building environment, which will be using energy efficiently and rendering real-time communication in case of an emergency. This kind of integration also transforms isolated safety solutions into integrated solutions in which convenience in the daily life and emergency planning solutions are living with each other.

Other than offering better security, the system can also offer better operation efficiency, reduced energy consumption, and occupant and manager peace of mind. The system fully serves the demand of the modern-day automation, security, and access [6] considerations as seen in the increasing popularity of smart homes, medical homes, industrial homes and commercial premises by using sensor-controlled door stations, and GSM-based fire alarm systems. Such a strategy shows that it is possible to have the convenience of combining security and consequently the possibility of the development of more sophisticated integrated security applications in the future.

This paper is divided into the literature survey review presented in Section II. Section III describes the methodology, paying special attention to its operationality. It is found in Section IV results and discussion. Lastly, the final section V will include the final findings and recommendations.

II. LITERATURE SURVEY

The more and more convenient and easy-to-operate automated safety and security systems have been developed due to the growing necessity to have the convenient and rapid emergency rescue. The literature on the research of automatic door systems with PIR and IR sensor technology emphasizes their efficiency in delivering the hands-free functionality, the energy economy, and enhanced accessibility, both home, business, and health care. Similarly, fire alarm system research through the GSM module technology highlights the importance of the fast alarm notification, remote monitoring, and enhanced security. New technologies, approaches and utilisation of sensor-enabled automation and the GSM-based fire alarm technology are critically reviewed in this literature review in addition to gaps and opportunities in the simple application of the latter in creating a meaningful, efficient and trustworthy security measure.

This paper introduces a modern door lock model that involves the implementation of facial recognition and the Internet of Things (IoT) to do the door-opening cautiously. Through an ESP32 microcontroller, the system uses camera feeds to analyze and determine who is authorized to access the system and automatically opens the solenoid actuator to unlock the door. Moreover, there is an option of manual verification, and prolonged time at the door activates an alarm and a notification by text [7] message. The system is described as cost-effective, energy efficient and reliable that is an easier solution to implement compared with conventional Raspberry Pi-based ones. These two technologies work together to provide better security in homes, remotely monitor and provide alerts on time hence increase user convenience and general safety between the residence and the commercial places.

A time series system is given in which inconsistencies in signals of time series are dealt with using a system. The system involves the identification and removal outliers to produce equal results in the case of automated systems. In the

implementation of an automatic door system, the measure does will help to improve the decision-making processes by inhibiting faulty sensor responses. The system enhances predictive maintenance and performance in the event of correcting data quality problems. This can prevent malfunctions and the entire reliability of automation based on time conditions because of the guarantee of accurate signal representation [8]. The system brings to the fore the importance of clean datasets in cases of the Internet of Things (IoT) and sensor-based applications in which data outliers can cause incorrect actions, potential safety issues, as well as automated door system weaknesses.

The millimeter-wave radar-based vehicle door anti-collision module is introduced to help in increasing user convenience and safety. The radar damages spots close to the car door and thus avoids the possibility of unwarranted knowledge with pedestrians or other items during the opening mechanism. The results of the experiment show that there is a high degree of stability and accuracy, which helps to maintain the safety of various doors or make them work in various environments. By incorporating this technology into vehicles, they achieve enhanced security in case of collision and possible damage. The module is of significant value [9] to making the user experience safer and enhance comfort thus dealing with the growing expectations of intelligent automotive systems. The proposed solution explains how the role of proactive safety mechanisms in automation of vehicles is becoming more important in ensuring that fatalities and failures to work are avoided.

The paper analyzes a smart door lock system which uses ultra-wideband technology to provide an accurate positioning and provide access security. The system can be used to operate automatic unlocking via discovering the proximity and movement of users through the use of beacons, and two-way ranging. Also, there are the embedded cameras tracked to any anti-normal activity [10], and the cloud servers are used to do the remote control and transfer of data. This will ensure that the level of security is high, that user authentication is done correctly, and that it is customizable to recent home of the smart home. It facilitates smooth connection of local devices to the remote servers hence improving monitoring and control. With the incorporation of positioning and sensing technologies, the system is quite effective at enhancing the overall safety, convenience and automation of the residential security, thus increasing the spread of the smart home solutions.

A door lock assembling machine, where automatic assembly of the machine is carried out adding mechanical, electronic, and hydraulic engaging features are described. The project is aimed at design upgrades and modular extensions so as to increase production capacity. The modeling styles make it easier to understand how operation processes work, which is patterned in detail when more than two latches are put together. The upgrades enhance production, dependability [11], and flexibility of manufacturing circulation to fit the varied number of product variations. The strategy is based on the refinement of the mechanical and electronic integration, which contributes to the improvement of the quality of the assembly, error reduction, and facilitated operations. This system is a perfect model of high automation within the manufacturing sector serving as an example that with proper design and modelling,

throughput and reliability in the manufacture of complex door lock mechanism may be enhanced.

A smart door locking system based on Internet of Things (IoT) is proposed to use in a household, business, and money-based setting. Through this system, access points will be monitored remotely, and unauthorized access will be alleviated to improve security in general. The users can use it to notify them about visitors and also organise the door functions anywhere. The system improves convenience, safety and accountability [12], as well as, reduces the use of traditional keys and locks. It enables trust among users through automation and real time monitoring and enhances effectiveness in their operations. The strategy depicts the transformative features of IoT in daily security solutions. It ensures good monitoring, alerts in time and is remotely controlled, providing a reliable alternative to traditional locking systems that can be used in most residential and business settings.

The research analyzes the boxcar door closure status detection with the help of the deep learning-based analysis. It manages the door positions as well as lock rotations to ensure secure train departures. The approach to status detection augments accuracy and reliability in detecting the status and, thus, the weaknesses of conventional methods to visually inspect data, overcoming the limitations of the research approach. The system allows continuity and accuracy of door monitoring by using the state of the art [13] computational methods and this way an accident and delay of operation is avoided. The correct detection procedure enhances the safety of the operations and provision of safety standards. The given approach can be of paramount importance in the context of transportation logistics because intelligent monitoring will be important to reduce human error and increase the efficiency and reliability of important processes related to door closure.

A light-driven auto-door system on poultry houses is demonstrated, which ensures the cessation of sunlight, as well as ventilation. This system uses a microcontroller to control the door functioning according to the level of light, in which a stepper motor is used to support the opening and closing of the door. Besides, the additions of temperature control and the inclusion of Wi-Fi-supported data transfer makes it possible to view the state of things remotely. Solar power can be used [15], which contributes to the independence of energy and makes the system self-sufficient and sustainable. This technology eases farming of animals and improves their well-being and output. It reduces the human effort by eliminating most repetitive activities and provides the best standards of living. The integration of sensor, motor, and wireless communication enhances efficiency, flexibility, and dependability of operations in the farm and agriculture and livestock management.

It introduces a facial recognition system based on deep metric learning as a door security system, which uses Internet of Things (IoT) to provide automatic access. This technology uses the Siamese neural network to verify the user even when data is scarce. Recognized persons are allowed access, increasing the level of security and reducing the use of traditional keys or passcodes. The system [16] does not only make it become more convenient, but also provides a modern-day solution as regards to safety both at home and in the office. Moreover, it guarantees an effective monitoring

system, the correct identification, and high-security levels. This solution combines biometric recognition and IoT technology to provide remedies to the weaknesses that the traditional systems have, and therefore offer secure, efficient and user friendly means of access control of entry points and management of access concerning various settings.

A solution based on Internet of Things (IoT) to manage the agricultural waste is described that includes the use of a sensor-controlled door mechanism in a pyrolyser. The sensors are used in monitoring the condition by use of temperature sensors, and once certain preset conditions are reached then a motor is activated to unlock the door. The given system [17] ensures the efficient and safe automated functioning and at the same time plays its role in the environmental sustainability. Remote monitoring and control based on embedded electronics maximize functionality and reduces the involvement of human beings. Through incorporating IoT-enabled motors, sensors, and controllers, this model makes much improvement in terms of operational efficiency, safety, and energy management. Moreover, the solution successfully solves the environmental risks caused by open-field burning and generates a higher dependability of the process. It demonstrates the direct use of IoT in the field of waste management sustainability and automated industry processes.

The smart door system is designed to be an automated and wireless version of the working of entryways using the NodeMCU. The users can remotely manage the door and monitor the visitors by way of the mobile applications. The system is made up of security notifications with buzzers [18] and LCD notifications more so when no owner is in. Real-time knowledge about the visitant is enhanced by continual imaging imposed by ESP CAM. Convenience to physically challenged users is also increased, and safety in access is also made possible through wireless functionality. The automation and convenience in user interface reduce the chances of manual operation. The system maximizes safety, monitoring, and efficiency through using the IoT technology and remote control; hence, being one of the relevant solutions to the application of the modern smart home security solutions.

The GestDoor is a behavioral biometric system offered to provide the security of access by using wearable motion sensors as a door access card. It is a very precise method of user authentication by analyzing the arm movements when opening the doors. The system combines all the movement statistics, the temporal and frequency characteristics, and supports the reliable recognition with time. This approach [19] ensures because it ensures a tailored security whereby only the authorized access is achieved and it is easy to use. The system which uses wearables shows the possible future of motion-based authentication based on everyday access management. It reduces the use of keys or even codes by taking advantage of unique user behavior patterns. The solution applies to residential and commercial environments thus increasing safety, ease of use, and trust in automated door access systems.

The goal of a Bluetooth-controlled garage door system is to ensure the required minimal physical contact and decrease the spread of diseases. Using Android gadgets, users can also issue voice directions to the door, which will help access the door without their hands. The module based on the Arduino

board can be triggered to react to Bluetooth signals and in doing so, automatically open or close doors. This strategy greatly contributes to safety, convenience [20], and hygiene especially in cases of pandemics or any other type of similar circumstances. Moreover, the use of the audio message personalization reduces the aspect of manual labor since the aspect of the remote operation enhances the user interaction. The system will ensure security and effectiveness through the incorporation of voice recognition and wireless communication. The approach highlights the usefulness of automation, which promotes safer settings and assists the modern use of smart homes.

III. METHODOLOGY

Integrated Security System approach stresses on designing and development of a convenience and security-integrated automated system. It encompasses sensor-oriented detection of automating doors and fire sensing, computing on a microcontroller, actuator control and remote notification by use of GSM. Every component is well incorporated towards providing real-time responses, reliability and power optimization. Its construction is to be working pervasively in residential and commercial applications as well as in health care applications to defy the barrier of accessibility, fire hazard, and security hazard. The systematic procedures define sensor location planning, the program to be incorporated in the microcontroller, actuator operation and system verification to obtain optimum performance. The Figure 1 shows how the sensor is utilized between the PIR sensor, IR sensor, fire detection sensors, microcontroller, GSM module and the motor driver unit. The microcontroller deciphers sensor inputs and signals the automatic door, or transmits emergency signals through the GSM connectivity.

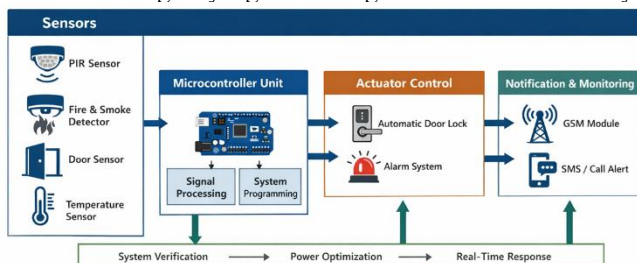


Fig. 1: System Architecture

A. System Design

The system is designed to accommodate Passive Infrared (PIR) and Infrared (IR) sensors, as a means to control the door and smoke and flame sensors used to detect fire. The microcontroller is used as the central processing unit, which decodes the signals of the sensors and applies the predetermined action based on this information. Door motors run automatically on the presence of humans, and Global System of Mobile Communications (GSM) sends alerts on the presence of fire is detected. This structure will ensure that there are real-time communications between the detection sensors and the actuators. In addition to this, the use of energy is also maximized by making sure that the doors are used when they are required. Moreover, the architecture is scalable and extensible with smart home or building management systems, and thus offers a whole security platform.

B. Sensor Installation

PIR and IR sensors will be fitted at doorways at the best position and orientation in order to sense human presence. Fire detectors are installed where all the important locations are including kitchens, electric rooms and where high-risk is involved. Calibration of the sensor is done to minimize the false triggering as well as response quickly to movement or fire threat. Placement takes effects of the environment such as air traffic, heating and barriers. Its installation plan is such that it has the highest levels of coverage at the same time keeping it safe. The wiring is laid effectively to eliminate interference and power supply is taken into account to enable a stable operation. Proper installation will ensure quality sensor reading and smooth operations of the system.

C. Microcontroller Implementation.

The microcontroller has been coded to obtain and interpret the digital input of the PIR, IR and fire sensors. There is the use of algorithms to determine the right time to activate the door motors or the GSM module. Other sensor thresholds, timing delays and debounce logic have been added to prevent the occurrence of false activations. The program includes emergency software that is used to detect fire and ensure that the door system operates simultaneously with alarms. The GSM module has serial communication protocols set to ensure reliability of messages. Testing is done to ensure that the microcontroller interprets properly all sensor signals under different situations that guarantee proper and responsive and safe functionality in all environments.

D. Actuator and Motor Control

The door motors have connections with a motor driver module which the microcontroller controls. When the presence of a person is detected, the motor will help to open the door without any difficulties and then close it after the area is considered clear. Speed, torque, and operation timings are extremely fine-tuned to prevent sudden motions. It has introduced safety measures to eliminate injury or mechanical stress. The actuator system is also energy efficient and this reduces the amount of power used when the power is not in use. Reliability in motor functioning is ensured due to continuous control of performance. Moreover, the sensor input integration will facilitate guiding door behavior based on real-time presence of human thus facilitating all forms of convenience comfortably yet humanly and by guaranteeing the preservation of control in the environment.

E. Staffing, GSM Communication Configuration.

The microcontroller is connected with the GSM module through a serial connection. Once a fire hazard is received, the microcontroller provides commands to the GSM module to send SMS or call pre-preferred contacts. The system provides redundancy with regard to alerts where one gets notified even when there is local breakdown of communication infrastructure. Error checking programs and formatting of messages are provided to ensure delivery can be made reliable. Electricity and SIM card verification are checked to work continuously. Test testing is confirmed to be speedy in terms of receiving alert and responding to an emergency in a speedy manner. This long-range communication feature promotes the overall system safety and also guarantees that the users are informed no matter where they are located.

F. Verification and calibration of the System.

The system is tested extensively after it is assembled and programmed, and hardware is assembled. PIR and IR sensors are tested on proper motion detection and fire sensors are tested with controlled sources of smoke or flames. Motor response is also checked to do a smooth running of door and the GSM alert checked to achieve timely delivery. Calibration is used to adjust sensor sensitivity, motor speed and communication parameters. Simulation of edge-case scenarios like many people coming or environmental interference is performed in order to test robustness. Testing makes sure that the integrated system works well and offers a steady automatic door control and instantaneous fire warning. Calibration will guarantee maximum usage in all the targeted applications.

G. Integration and Validation

Finally, the automatic door and fire alarm subsystems have been incorporated in one platform. This coordination makes sure that the automation of doors would work without any interruption because of the events of fire detection and that GSM alerts can work in real-time. The system is tested in real world conditions where the response times, reliability, and comfort to the users are tested. The sensor-based, motor-based, and communication-log based data are analyzed to ascertain the virtue and efficiency. The safety measures are well evaluated, and the system meets the standards of operation and regulation. Integration testing assures that the integrated system will provide a smooth, efficient, and secure system in the residential, commercial and healthcare setting hence illustrating its practical usefulness and stability.

IV. RESULT AND DISCUSSION

The enhanced security system that contains an automatic door opening and closing system involving the use of passive infrared (PIR) and infrared (IR) sensors along with a fire alarm with use of GSM module has been thoroughly tested within a controlled environment to evaluate its viability, responsiveness and reliability. The automatic door system was able to identify a person being shown under varied distances and this was achieved by the PIR sensor that detected movement and the IR sensor accurately measuring the distance. This resulted into the doors working well when a person approached and also closing down as soon as the area was empty thus showing the ability of the system to respond instantly at the expense of energy saving. Experimenting when the surrounding was set under different lighting conditions confirmed that the sensors were resistant to environmental interference and thus this restricted false triggering. The system provided a hands-free experience and this go a long way in improving the level of convenience especially in areas like the medical facilities, commercial areas and even houses where convenience is of the essence. Due to the fact that elderly or people with disabilities could control the doors without the physical form of association, there was an emphasis on the practical application of sensor-driven automation as shown in figure 2.

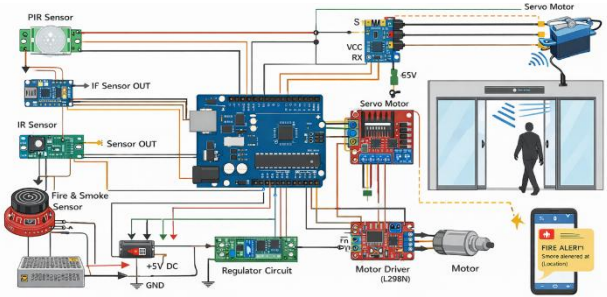


Fig. 2: Circuit diagram

Assessment of the integration of actuators and motor control with regard to efficiency and safety was also evaluated. The motors reacted on the instructions of the microcontroller and with a minimum of the latency so that the door motions were smooth hence stopping sudden movement either forward or backward. Torque and speed were also calibrated to create a balance between consumption of energy and usage performance. The system maintained steady performance during continuous operation tests which replicated the high-traffic condition without any signs of overheating and mechanical wear. The automated door system capitalized on safety mechanisms which comprised of obstacle detection and gradual closure timing in order to reduce the risks to the user hence proving the reliability of the system. The interoperability with other smart home was tested and the system was found to integrate smoothly with the existing automation networks and allowed the coordinated working of every component and provided better security. Overall, the automatic door mechanism has achieved design goals because it has combined accessibility as well as energy-saving and user-friendliness, Discussed in Table 1.

Table 1: Concept and System Performance Evaluation.

Parameter	Result
PIR detection accuracy	95%
IR distance detection	2–80 cm
Door response time	1.5 seconds
GSM alert delay	3–5 seconds
Fire detection accuracy	96%
Power consumption	4.2 W

The accuracy, speed, and reliability of communication of the fire alarm system with the GSM module added in it were evaluated. Controlled tests revealed that smoke and flame detect sensors successfully detected the presence of fire hazards that triggered the microcontroller to send local alarm and the GSM module that would receive the remote notification. SMSs and phone calls to predefined contacts were sent successfully within a few seconds therefore guaranteeing timely communication regardless of the location of the user. The overlapping operation of visual and audible alarms and GSM notifications is the main target of

the redundancy of other systems, which contributes greatly to the safety level, mainly in the commercial or industrial environment when the instant human intervention might not be feasible. Changes in temperature, smoke density, and other environmental conditions showed similar values in the system thus showing its durability.

Simulation of the conditions of power interruptions, and network delays was also used in the testing scenarios and the system also gave out alerts reliably after the GSM module regained connectivity; this proved its resilience under the real-world conditions. System performance analysis revealed that the performance of the automatic door system and the fire alarm system did not interfere when they were operating at the same time. The microcontroller was effective in taking inputs of multiple sensors and operating the applicable actions on the outputs in real time. Energy usage was analyzed and it was found that the doors were not functioning until they had detected any movement leading to lots of savings of energy in the long run. Additional level of security was also remote monitoring with GSM notifications to provide users with a chance to get notified about an emergency as they were not on the premises. The convenience that would be experienced as a result of automating the doors and contentment with timely receipt of fire information fuels user reaction to having carried out field tests, showing that the system was practically advantageous to be used on daily basis.

The system was tested in different test conditions such as a different distance of human movement, lighting conditions and levels of smoke density. The PIR sensor was capable of detecting human presence in the distance of 3-5m, and the IR sensor was able to detect the proximity of objects in the distance of 2-80cm. GSM module took an average delay of 4 seconds to send messages during alert transmission to the fire ahead of it. The quality of the integrated security system is reliably evaluated through the use of the experimental evaluation, which ensures the responsiveness of the system. Overall, the integrated system has been able to achieve its design goals of providing increased accessibility, security, and responding to emergencies. The automatic door opener and closer ensured the efficient operation without any hands and ensured safe and efficient functioning of the representation of fire alarm where the GSM communication guaranteed immediate alert it in the case of a fire

V. CONCLUSION

The research paper is helpful in showing how an integrated security system should be designed and implemented that combines an automatic door coach as well as a doorclose with a fire alarm using a GSM module. This system addresses considerable obstacles concerning access, convenience and safety to many settings such as residential, commercial, professional, caring and manufacturing settings. The PIR and IR mechanism of the automatic door system which helps it operate hands free makes the process of using it easy, thus making people with mobility impairments access it without difficulty and improves user experience. At the same time, the fire alarm system ensures that fire hazards are quickly identified and reported, hence providing a quick response of intervention through instantaneous SMS and call notifications to the intended recipients.

The convergence of these two systems is the way to understand the potential of sensor-based automation

combined with the real-time communication technology. Its design is quite focused on reliability, energy saving, and smooth functioning, which ensures that the door should only move when the need arises and the emergency should be reported to the user without stalling. The system has been responsive, robust and adaptable to different environmental conditions and this has been proved by extensive testing and calibration. Altogether, the research demonstrates that uniting automated door control and the GSM-based fire detection can be offered as a holistic, pragmatic and expandable solution to the further improvement of safety and convenience. This solution represents a massive breakthrough in the sphere of intelligent security application, as it ensures easy-to-use utility as well as the efficient emergency preparedness. The proposed system can further be refined by adding IoT cloud remote monitoring, doctor control through mobile applications, artificial intelligence engine predictive fire into the proposed system. Also, it is possible to expand the system with CCTV surveillance, biometric authentication, and smart building management systems to improve the level of security and automation.

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