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IoT-Based Customer Service and Alarm System for Automatic Booking and Gas Leak Detection

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Abstract: - This paper examines the application of Internet of Things (IoT) technology to enhance automatic booking systems and gas leak detection alerts, aiming to improve customer service and safety in both commercial and residential environments. By integrating IoT platforms, businesses can streamline booking procedures, bolster security, and deploy real-time gas leak detection and notification systems. The use of IoT-enabled sensors, devices, and connectivity facilitates smooth booking workflows, secure transactions, and timely gas leak alerts, ensuring greater efficiency, convenience, and safety for customers. This study emphasizes the transformative potential of IoT in reshaping customer service and alarm systems, paving the way for a future where automation, connectivity, and smart technology are central to enhancing service delivery and mitigating risks. The Node-MCU LPG gas leakage detector, a prototype designed for detecting gas leaks, utilizes a GSM/GPRS SIM900 microcontroller and an MQ-6 gas sensor for safe and accurate leak detection. The system provides users with real-time alerts about gas leaks or empty cylinders, transmitting SMS notifications via the GSM module and offering precise data through the MQ-6 sensor. This enables remote monitoring of kitchen conditions, while also allowing automatic gas booking operations without manual intervention.

Keywords: Internet of things (IoT), LPG Gas leakage detector, Node-MCU, Real time alerts

INTRODUCTION

In today's fast-paced and interconnected world, the integration of Internet of Things (IoT) technology has significantly reshaped how businesses operate and engage with customers, as noted by Alhogail et al. (2019) [1]. A key area where IoT has made a notable impact is in the development of secure, cost-effective automated booking systems and gas leak detection mechanisms, which enhance customer service and alarm systems. By leveraging the capabilities of IoT platforms, businesses can increase operational efficiency, bolster security, and offer greater convenience, all while ensuring the safety and satisfaction of their customers. The rapid advancement of IoT technology has ushered in an era of automation and connectivity, enabling devices and systems to interact, communicate, and perform tasks autonomously (Attié et al., 2019) [2].

In the domain of booking systems, IoT-driven solutions provide a streamlined and efficient way for customers to make reservations, appointments, or bookings without requiring human involvement. Through the integration of IoT sensors, devices, and connectivity into the booking process, organizations can automate every stage—from scheduling to confirmations, payments, and reminders—minimizing the risk of errors, delays, and inefficiencies (Aram et al., 2021) [3]. Additionally, IoT technology enhances the security of automated booking systems by implementing advanced authentication, encryption, and access control protocols to protect sensitive customer data and transactions (Varma et al., 2020) [4]. By adopting secure communication methods and encryption standards, businesses can foster trust with their customers by safeguarding their information from unauthorized access, tampering, or interception.

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Beyond automated booking systems, IoT technology plays a crucial role in the development of gas leak detection and alarm systems, addressing a significant safety risk for both businesses and consumers (Syeda Bushra Shahewaz & Ch. Rajendra Prasad, 2020) [5]. Gas leaks pose serious threats to life, property, and the environment, requiring rapid detection and response to prevent catastrophic outcomes. By incorporating IoT-enabled gas sensors and detectors in both commercial and residential settings, businesses can continuously monitor for hazardous gases like carbon monoxide or natural gas and receive real-time alerts when a leak or anomaly occurs.

IoT platforms further enhance the effectiveness and efficiency of gas leak detection systems by enabling remote monitoring, control, and management of sensors and devices from virtually anywhere, at any time. Businesses utilizing cloud-based IoT solutions can access real-time data, analytics, and insights on gas levels, trends, and patterns, empowering them to take proactive steps for maintenance, troubleshooting, and decision-making to mitigate potential risks and accidents. From a customer service perspective, IoT-based gas leak alert systems offer peace of mind by sending timely notifications, guidance, and assistance during a gas leak or emergency. Through push notifications, SMS alerts, or automated calls, businesses can quickly inform affected customers, emergency responders, and key stakeholders, ensuring a fast and coordinated response to minimize risks and ensure safety.

Moreover, IoT platforms can support the development of intelligent warning systems that not only detect gas leaks but also leverage machine learning algorithms and predictive analytics to analyze data, predict patterns, and optimize responses. By integrating artificial intelligence and automation, businesses can enhance the accuracy, speed, and reliability of their alarm systems, reducing false alarms, minimizing downtime, and improving overall operational efficiency.

In conclusion, the integration of IoT technology with automated booking systems and gas leak detection mechanisms presents significant opportunities for businesses to enhance operations, services, and safety standards. By harnessing the power of IoT platforms, businesses can develop secure, cost-effective, and customer-focused solutions that streamline processes, improve security, and deliver greater value to customers. As IoT continues to evolve and innovate, the potential to transform customer service and alarm systems through automation, connectivity, and intelligence increases, paving the way for a future where safety, convenience, and efficiency are prioritized in an increasingly connected world.

1. LITERATURE REVIEW

Peijiang and Xuehhua (2008) [6] introduced a “Design and Implementation of a Remote Monitoring System Based on GSM,” which enables wireless monitoring using SMS and GSM technology. The system is composed of two primary components: the monitoring center and the remote station. The monitoring center includes a PC connected to a GSM TC35 module via RS232. The remote monitoring station consists of a TC35 GSM communication module, an MSP430F149 MCU, a display unit, sensors, and a data collection and processing unit.

The software for both the monitoring center and the remote station was developed using Visual Basic. Lita et al. (2006) [7] proposed a cost-effective GPS-GSM-SMS car localization system, where a vehicle's location is sent via SMS to the driver or owner.

This system can be integrated with car alarm systems to notify the owner about any incidents involving the parked car. The system includes a GPS receiver, a microcontroller, and a GSM phone. It can also track vehicle status and alert the user when the engine starts, making it suitable for low-cost vehicle tracking and localization.

Galatsis et al. (2002) [8] pioneered the monitoring of vehicle cabin air quality using metal oxide semiconductor gas sensors. They compared M0O3-based gas sensors with commercial alternatives, finding that the M0O3 sensors performed at 74% or better than the commercial ones. The researchers developed and tested a vehicle cabin air quality monitor using carbon monoxide (CO) and oxygen (O2) sensors to improve vehicle safety. Monitoring these gases helps alert the driver to harmful gas concentrations, thus preventing drowsiness, fatigue, and potential

fatalities caused by exhaust gases. During driving, CO levels of 30 ppm and oxygen levels below 19.5% were considered hazardous. Srivastava and Prabhukar (2016) [9] presented a "GSM-Based Gas Leakage Detection System" that is both cost-effective and precise. The system detects gas leaks, alerts users, and shuts off the gas and electricity supply while sending an SMS notification. Hema et al. (2013) [10] proposed a "WSN-Based Smart System for LPG and Combustible Gas Detection," which uses sensors to detect gas leaks and triggers an alarm when hazardous gases are identified. These detection systems are capable of identifying a variety of dangerous gases, including combustible, flammable, and toxic gases that pose health risks. Mahalingam et al. (2012) [11] introduced a "Design Implementation of an Economic Gas Leakage Detector," which provides an affordable audio-visual solution for monitoring LPG leaks in homes and businesses. This system includes vocal and audible alerts for hazardous situations and uses miniaturized gas leak detection technology. The researchers also compiled statistical data on gas leak occurrences to enhance safety.

3. PROPOSED METHOD

In this gas leak detection system, the ESP8266 NodeMCU serves as both the microcontroller and the Wi-Fi module. It records the LPG leak levels on an IoT platform, such as a cloud or mobile application, and sends alert messages to the user's smartphone via Wi-Fi. The system block diagram, shown in Figure 1, includes components such as the NodeMCU ESP8266, a gas sensor, a load sensor (Load Cell L6D), a GSM module (SIMCOM 900), and one or more display units.

NodeMCU ESP8266: The NodeMCU ESP8266 is a widely used development board built around the ESP8266 microcontroller chip, designed for Internet of Things (IoT) and embedded applications. The ESP8266 chip integrates a 32-bit Tensilica microcontroller core and a Wi-Fi transceiver, offering a low-cost, low-power solution for connecting devices to Wi-Fi networks and the internet.

The NodeMCU development board includes the ESP8266 chip, along with additional features such as voltage regulators, USB-to-serial interfaces, and general-purpose input/output (GPIO) pins, making it an ideal platform for IoT projects and Wi-Fi connectivity experiments.

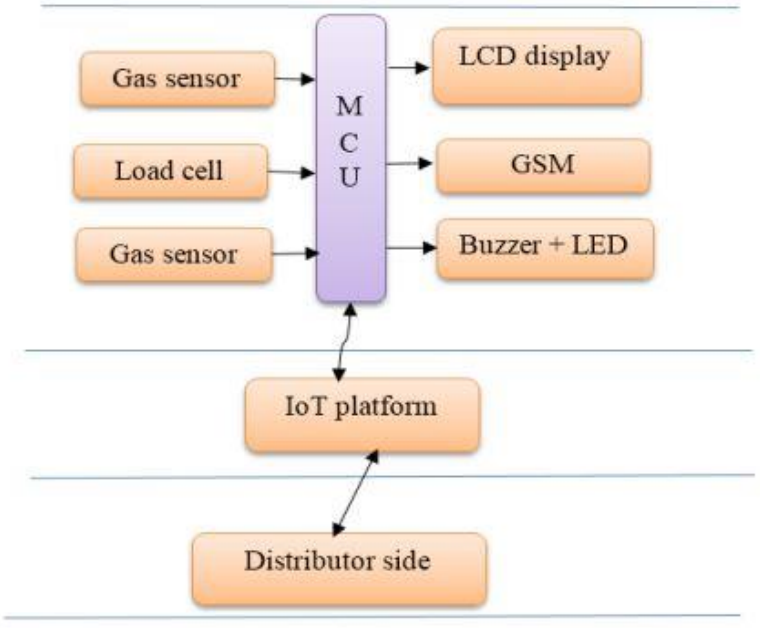

Figure 1: Block diagram of the system

Gas Sensor: Gas sensors are specialized devices used to detect the presence of gases in the atmosphere. They are frequently employed in industrial environments, safety monitoring, environmental assessments, and even consumer products like carbon monoxide detectors and air quality monitors. The detection method varies depending on the type of gas being measured. Common technologies include electrochemical, semiconductor, infrared, and catalytic bead sensors. In this system, the **MQ-6 gas sensor** is used, a semiconductor-based sensor designed to detect a range of gases such as LPG (liquefied petroleum gas), butane, propane, methane, alcohol, hydrogen, and smoke. The sensor works by detecting changes in resistance when exposed to target gases.

Load Cell: A load cell is a type of sensor used to measure weight or force. These sensors are essential in applications that require precise force measurement, such as industrial scales, force testing machines, and material testing equipment. Typically made from metal or piezoelectric crystals, load cells function based on principles like strain gauge measurement or the piezoelectric effect. They are sensitive to mechanical deformation, which is then converted into an electrical signal proportional to the applied force.

GSM Module: The GSM (Global System for Mobile Communications) module is a hardware component that allows devices to communicate over cellular networks. GSM modules are widely used for data transmission, voice calls, and SMS (Short Message Service) functionality in various applications. The SIM900 module, developed by SIMCom, is a popular GSM/GPRS modem that enables remote communication with mobile networks. It is frequently used in IoT devices, remote monitoring systems, and SMS-based control systems. The SIM900 module supports both sending and receiving SMS messages and making voice calls. It follows the AT command set, enabling simple integration with microcontrollers and other devices, and can be used for tasks such as sending alerts, notifications, or control commands.

Buzzer: A buzzer is an electronic device that produces a buzzing or beeping sound, typically used to signal or alert users. It is commonly incorporated into systems to provide audible notifications for various purposes, including alarms and warnings.

4. EXPERIMENTAL RESULTS

This section details the tests conducted to meet the objectives of the study and provide accurate data on smart gas detection systems. Accuracy is a key factor, and testing ensures the system's efficiency. Theoretical and experimental results align due to the gas leakage-based design of the system, although any discrepancies may point to hardware issues during the manufacturing process.

Consumer End (Gas Leakage Detection):

The prototype focuses on detecting gas leaks, with the MQ-6 sensor placed near the gas cylinder. When a leak occurs, the sensor’s resistance decreases, causing an increase in conductivity. This triggers a logic high pulse sent to the Node-MCU microcontroller, which in turn activates the buzzer and exhaust fan. The microcontroller also sends an emergency alert to designated mobile numbers via the GSM module, and displays the alert on the LCD screen. The buzzer can be manually reset. Figure 2 illustrates the gas monitoring prototype, showing all its components, while Figure 3 displays the gas leakage notification sent via SMS, indicating the gas levels in the cylinder.

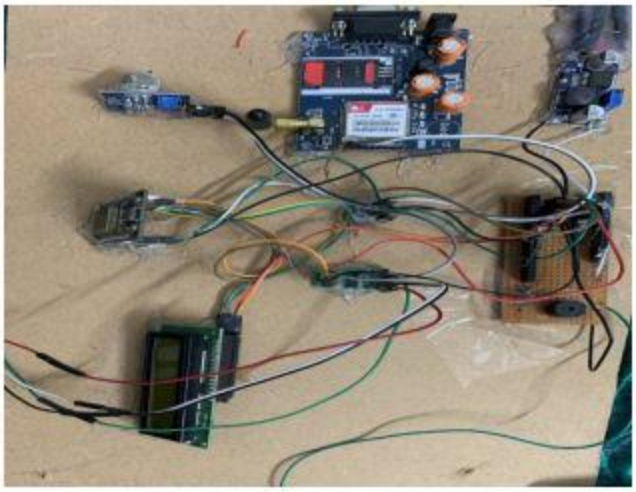

Figure 2: Gas monitoring kit

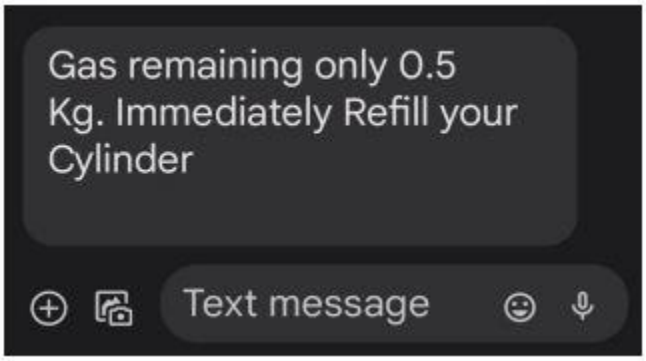

Figure 3: Notification of gas text message

Automatic Gas Reservations:

The automatic gas booking system uses an LCD to monitor the weight of the gas cylinder. When the weight drops below 10 kg, a logic-high pulse is triggered on a microcontroller port, which sends a booking request to the distributor. The LCD will display the message "Booking Cylinder." If the gas weight falls below 0.5 kg, a second logic-high pulse is sent to another port, triggering the message "Gas remaining only 0.5 kg." Additionally, the system alerts users to refill their cylinder via the GSM module, displaying the message "Cylinder Empty, Please Refill."

Distributor Agency:

The LPG distribution office has set up a website to track the weight of each consumer's gas cylinder. Each consumer's module will access this website to update their cylinder's weight whenever it falls below the specified threshold value.

5. CONCLUSION AND FUTURE SCOPE

IoT-powered automatic booking systems offer customers a seamless, convenient experience by reducing the need for manual input, minimizing errors, and improving overall operational efficiency. The implementation of secure communication protocols and encryption standards in these systems ensures the protection of sensitive customer information, building trust and confidence among users. Similarly, IoT-based gas leak detection systems provide essential safety measures for both businesses and consumers.

By integrating IoT sensors and detectors, businesses can continuously monitor gas levels, detect leaks in real-time, and send instant alerts to prevent potential hazards.

The remote monitoring and management features of IoT platforms allow businesses to respond quickly to emergencies, coordinate with relevant parties, and ensure the safety of those involved. Additionally, IoT systems use predictive analytics and machine learning algorithms to optimize alarm systems, reducing false alarms and enhancing response times. This enables businesses to take proactive measures against gas leaks, mitigate risks, and improve overall operational performance.

The integration of IoT in both automatic booking and gas leak detection systems marks a move toward smarter, more connected service delivery and risk management. As businesses increasingly adopt IoT solutions, significant innovations in customer service and alarm systems are expected. Future advancements in IoT technology will further automate booking processes and gas leak detection, with intelligent algorithms and machine learning enabling better decision-making, resource allocation, and system efficiency.

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