

# IoT Enabled Vehicle Auto Kids Recognition

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**Abstract**—The Vehicle IoT-enabled Auto Kid Recognition System is a smart safety system to help prevent kids from being forgotten inside a parked vehicle. Because the heat can rise quickly in a closed car (sometimes within minutes) and can create life-threatening situations, depending on the weather, the system is designed to detect a child being left in the parked car and to alert the owner as quickly as possible. The Vehicle IoT-enabled Auto Kid Recognition System consists of several sensors or detector devices installed in the vehicle cabin that provide input to the central processing unit (CPU) of the system, which is an ATmega328 microcontroller. The Vehicle IoT-enabled Auto Kid Recognition System includes continuous monitoring of several key environmental and activity indicators, such as audio and motion, CO<sub>2</sub> concentration, and temperature. The system uses a temperature sensor to monitor the temperature in the cabin and to detect if there is an increase in temperature; a CO<sub>2</sub> sensor will measure the increase in carbon dioxide in the cabin and if there is enough CO<sub>2</sub> present, it indicates that there is a person (child) inside the vehicle. Additionally, the system uses audio and motion sensors to validate the presence of a child in a vehicle, thus providing additional verification of whether a child is actually inside the vehicle and, thereby, reducing false alarms caused by objects and environmental activity. Combining multiple detections will provide a more accurate verification of the presence of a child inside a vehicle than relying on a single trigger detector. Once the Vehicle IoT-enabled Auto Kid Recognition System has verified that a child is in a vehicle and that there are unsafe temperature conditions, the CPU will use a GSM module to send an SMS to the registered owner. The risk of heatstroke or suffocation is greatly decreased by the prompt intervention made possible by this real-time notification. The system can be integrated into both new and old cars because it is made to be economical, simple to install, and energy-efficient. This smart safety gadget shows how useful technology can improve vehicle safety and possibly save lives by utilizing IoT-based monitoring and automated communication.

**Index Terms**—IoT (Internet of Things), Vehicle Child Safety, Vehicle Auto Kids Recognition System ATmega328, Temperature Sensor, CO<sub>2</sub> Sensor, Motion Sensor, Sound Sensor, GSM Module, MS Alert System, Heatstroke Prevention, Embedded Systems, Real-Time Monitoring, Smart Vehicle Safety, Child Detection System

## I. INTRODUCTION

Today, child safety in cars is a major issue. It can be dangerous if a busy parent skips that their kid is still in a parked car. Even on normal days, the temperature inside a locked car can rise quickly, and kids are more likely to heat than adults. Suffocation, heatstroke, or even death may result from this. As a result, we require an advanced system that can detect when a child is alone in a car and notify adults immediately. People are only secured by normal cars safety features like seatbelts and airbags in the event of an accident. When a child is left in a parked automobile, they are of no assistance. Leaving a kid alone for a short while may seem harmful to many, but it can quickly turn deadly. This project presents an IoT-enabled Vehicle Auto Kids Recognition System that continuously monitors the interior of the vehicle, even when it is locked, in order to avoid such circumstances. IoT technology, which enables device sharing, is used in the system. It features sensors that measure the car's internal CO<sub>2</sub> levels, temperature, motion, and pressure. The pressure sensor determines whether a person occupies the seat. The temperature and CO<sub>2</sub> sensors make sure the air and heat levels are safe, while the motion sensor picks up movement. A microcontroller, which serves as the system's brain, receives data from all of these sensors. By examining the sensor readings, it detects whether a kid is present. Through a GSM module, the system quickly sends the parent or guardian by SMS if it detects a risk when a child is inside the car. It can

also send messages to authorities or emergency contacts if no one answers, making help to come quickly. Parents can track the car's condition at any moment thanks to the system's ability to store data on the cloud. This smart safety system is suitable with a wide range of car models, is cheap, and is easy to install. It solves a real issue and saves the lives of kids using modern technology. It helps prevent accidents and raises awareness about child safety by constantly checking the vehicle and giving out alerts when helpful. Future transportation will be safer and smarter with in large part to this IoT-enabled device. Rapid urbanization and the exponential growth of vehicles have created serious challenges in traffic monitoring, law enforcement, parking management, and intelligent transportation systems. Manual vehicle identification is slow, error-prone, and impractical for large-scale deployment. As a result, Automatic Number Plate Recognition (ANPR) systems have gained significant attention for enabling automated vehicle identification through image processing, optical character recognition (OCR), and deep learning techniques. Recent advancements in Internet of Things (IoT) frameworks have further enhanced these systems by enabling remote monitoring, cloud connectivity, and real-time data exchange. This paper proposed a deep learning-based IoT-enabled vehicle number plate recognition system that utilized MLCR and CNN models for accurate plate detection and character extraction. While the model demonstrated improved recognition performance, it lacked real-time alerting capabilities and was not extensively validated under varying lighting and weather conditions. Similarly, Mohammad Rafi Rashidi, Chris Cherian, Vipul Singh Negi, and Suchismita Chinara developed an IoT-enabled smart parking system integrating OCR with Raspberry Pi and AI for automated vehicle entry and slot management. Although effective for controlled environments, scalability and integration with live traffic systems remained limited.

## II. LITERATURE SURVEY

This 2024 work by J. Bhuvaneshwari, N. Gireesh, G. Srimathy, Subrahmanyam Nandigam, and V. Nanammal focuses on the domain of IoT-enabled deep-learning-based vehicle number plate recognition. The study uses MLCR and CNN models to accurately detect and read number plates from

vehicle images. However, gaps remain, such as the lack of real-time alerting, limited testing in different lighting and weather conditions, and no integration with live traffic systems. These gaps highlight the need for more practical, real-time, and environment-robust solutions [1]. This 2024 study by Mohammad Rafi Rashidi, Chris Cherian, Vipul Singh Negi, and Suchismita Chinara focus on the domain of IoT-enabled smart parking systems using AI and OCR-based automatic number plate recognition. The system uses Raspberry Pi, IR sensors, and camera-based OCR for slot detection, secure vehicle entry, and a mobile app for reservations. However, gaps remain, such as no real-time emergency alerts, limited testing in extreme weather, and no integration with city-wide smart traffic systems. These limitations show the need for more scalable, real-time, and environment-robust solutions [2]. This 2025 work by Zaviera Ferodova Al Fitroh and Gunawan Ariyanto focuses on the domain of deep-learning-based vehicle license plate detection using the YOLOv11 model. The system detects vehicles, number plates, and characters using a Python-OpenCV pipeline with cascading detection stages, achieving over 95% precision. However, research gaps remain, such as limited accuracy in real-world conditions, no real-time alerting or integration with traffic enforcement systems, and lower performance on certain image samples. These gaps show the need for broader datasets and improved real-time deployment for smarter transportation systems [3]. This 2024 study by Nana Sutisna, Erwin Setiawan, Ng Kyle, Bryan Bernigen, Maharani Ayu Putri, and Dimas Shidqi Parikesit focuses on the domain of cloud-based IoT-enabled automatic number plate recognition systems. The system uses ESP32-CAM, YOLOv8, and PaddleOCR, with cloud processing on Google Cloud Platform for vehicle detection and number extraction. However, gaps exist, such as low OCR accuracy, no real-time alerting or enforcement integration, and limited testing across different environments. These gaps show the need for stronger OCR models, real-time responses, and better adaptability for large-scale deployment [4]. This 2023 study by Mayank Pathak, Kamta Nath Mishra, Satya Prakash Singh, and Alok Mishra focuses on the domain of IoT-based centralized vehicle security using facial recognition and ML techniques. The system unlocks and starts the vehicle only after verifying an authorized driver and also includes drowsiness

detection to improve safety. However, gaps remain, such as no real-time theft alerts to owners, limited protection against network-based hacking, and no integration with GPS tracking for live monitoring. These gaps highlight the need for more advanced real-time communication, stronger security layers, and wider deployment testing [5]. This 2024 study by S. Nandhini, T. Bhuvaneshwari, V. Bhuvaneshwari, V. V. Teresa, S. Anitha, and K. Sivaprakash focuses on the domain of IoT-based vehicle security using deep-learning-driven facial identification with CNN models. The system replaces traditional locks by authenticating the driver through a trained face recognition model, achieving around 87.5% real-time accuracy. However, gaps remain, such as no real-time theft notification, limited accuracy in low-light or occlusion conditions, and no integration with GPS or cloud monitoring for live tracking. These gaps highlight the need for higher robustness, better environmental tolerance, and smarter real-time communication [6]. The work by Juber Nadaf et al. (2025) focuses on vehicle number plate recognition using YOLOv8 and IoT within the domain of smart transportation and computer vision. Existing studies mainly detect number plates using OCR and basic image-processing methods, but they struggle with issues like low-light images, tilted plates, irregular fonts, and reduced image quality. Many previous systems lack real-time detection, automatic alerts, advanced preprocessing, and robust accuracy across diverse environments. This study addresses these gaps by using YOLOv8 and Darknet-53 for better feature extraction and evaluation under different image conditions [7]. The study by V. Gopinath et al. (2025) focuses on real-time vehicle anti-theft detection and IoT-based tracking, falling under the domain of intelligent transportation and security systems. Previous research mostly relied on basic GPS/GSM monitoring and simple sensor-based alerts, but these systems lack real-time intrusion detection, accurate face recognition, smart notifications, and reliable tracking under different conditions. Existing approaches also struggle with slow response, limited automation, and poor accuracy in distinguishing genuine users from intruders. This work addresses these gaps by comparing CNN and Grassmann algorithms to provide faster detection, instant IoT alerts, and improved accuracy [8].

### III. METHODOLOGY

#### 3.1 Existing System:

ALPR systems are now widely used for traffic surveillance, toll tags and security enforcement. The majority of pilot implementations to date utilize traditional image processing methods and Deep Learning methods like CNN (Convolutional Neural Networks) and YOLO (You Only Look Once) for license plate detection; as well as OCR (Optical Character Recognition) occurred on the detected characters; however, these systems only work well if given controlled conditions but their performance deteriorates significantly when operating in an unstructured environment. When analysing the specifically Morocco's License Plates, many unique and specific challenges become apparent; such as the lack of adequate, publicly available large datasets of Moroccan License Plate data; the number of different types/formats of License Plates that are currently in use; the appearance of non-English characters on the plates; and the inconsistent use of different font styles across all License Plates. Furthermore, other environmental factors can also affect the accuracy of the system's performance, such as poor lighting, glare on the camera lens, blurred motion captured by the camera, dirty camera lenses from dirt or dust, and partially blocked camera views will result in decreased detection accuracies. Finally, many systems currently do not take into account optimal processing power and total time taken when processing images on edge devices and providing real-time notifications of detected plates; therefore, there are strong needs for more dynamic and adaptive software that can withstand a wide range of environmental challenges.

#### 3.2 Proposed System:

This system is intended to provide a real-time vehicle safety solution to reduce the risk of deaths from children left unattended in a vehicle. It uses multiple sensors in combination to monitor what is happening to the interior environment of a vehicle and make sure children left unattended can be detected without fail. The motion sensor detects movement and the sound sensor detects crying or vocalizations from the child. The inside temperature sensor detects how hot the cabin is getting, and the CO2 sensor measures how much air is in the cabin and whether or not there are any chances of the child suffocating by having no air.

The device responsible for all of this monitoring and detection is the ATmega328, which receives all the different sensor information and decides based on predefined safety thresholds whether conditions are unsafe or unsafe for the child. This combination of sensors will reduce the number of false positives, therefore increasing the accuracy with which this type of detection occurs as opposed to using just one sensor. There is a push button on the unit to allow the user to manually reset or override the device in the case of an unsafe condition for the child being present. If any unsafe condition is detected (e.g., a crying child) with a confirmed presence of a child, the device will sound an audible alarm to alert people in the vicinity and, at the same time, send a text message using the GSM modem to the registered parent and/or guardian of the child; allowing a fast external response to the situation, regardless of whether the vehicle is parked in a highly populated area. Cost-effective system, energy efficient and can be installed in both private and commercial vehicles. Optional Data logging via SD Card and/or cloud platforms can improve monitoring and analysis. Overall, the IoT based product will improve child safety through continuous monitoring, immediate generation of alerts, and providing timely measures to avoid children suffering from heatstroke or suffocation.

#### IV. SYSTEM ARCHIECTURE

The system architecture consists of multiple sensors interfaced with the ATmega328 as the central controller. A 12V battery supplies power, which is regulated to 5V for safe operation of the microcontroller and sensors. The motion sensor, sound sensor, temperature sensor, and CO<sub>2</sub> sensor continuously send environmental and activity data to the microcontroller. A sleep/push button is included for manual control or reset. When unsafe conditions are detected, the microcontroller activates a buzzer for local alerts and triggers a GSM modem to send SMS notifications to the registered guardian, ensuring real-time monitoring and emergency response.

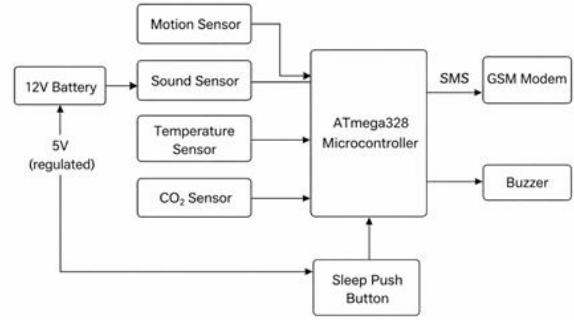


Fig: 1 System Architecture

#### V. SYSTEM MODULES

##### 5.1 Motion Sensor:

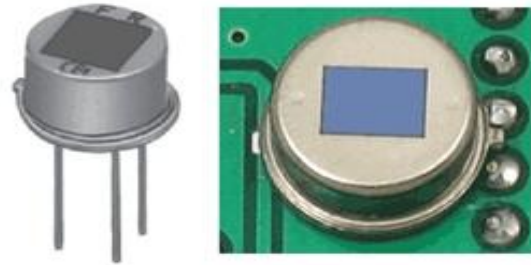


Fig2: motion sensor

A motion sensor can detect when something moves nearby. It sends out invisible waves and checks how they bounce back. If a person or object moves in front of it, the pattern of the wave's changes, and the sensor understands that motion has happened. In traffic or security systems, this helps to know when someone comes close or when a vehicle passes by.

##### 5.2 Sound sensor:



Fig3: sound sensor

A sound sensor listens to noises around it. It converts sound vibrations into electrical signals and checks how loud or soft they are. If there is a sudden loud noise



5.7 Buzzer:



Fig8: buzzer

A buzzer creates a loud beeping sound when the system needs to warn someone. It works by sending electrical signals that make a small metal plate vibrate, producing sound. Buzzers are used for alarms, alerts, and quick warnings, making sure people notice a problem immediately. A buzzer creates a loud beeping sound when the system needs to warn someone. It works by sending electrical signals that make a small metal plate vibrate, producing sound. Buzzers are used for alarms, alerts, and quick warnings, making sure people notice a problem immediately.

VI. LIMITATIONS AND FUTURE SCOPE

The IoT-Enabled Vehicle Auto Kid Recognition System has certain limitations despite its safety benefits. Its performance depends on the accuracy and sensitivity of sensors, which may produce false alarms due to external noise, vibrations, or environmental disturbances. Fixed temperature thresholds may not adapt well to different climatic conditions, and CO<sub>2</sub> sensors may have slower response times. The system also relies on GSM network availability, which can delay SMS alerts in low-signal areas. Additionally, it monitors environmental risk rather than direct physiological health parameters. Future enhancements can address these gaps by integrating AI-based camera vision for more accurate child detection, adding heart rate or breathing sensors for direct health monitoring, enabling GPS-based mobile app tracking, and incorporating cloud connectivity for real-time data analysis. Automated ventilation or window control

mechanisms could also be added to provide immediate intervention and improve overall system reliability.

VII. RESULT

The IoT Enabled Vehicle Auto Kids Recognition System was experimentally evaluated under multiple controlled vehicle conditions to measure its accuracy, response time, and reliability. The system continuously monitored temperature, CO<sub>2</sub> concentration, sound, and motion parameters to identify the presence of a child inside a parked vehicle. The temperature sensor was configured with a threshold value of 40 °C, beyond which the environment was considered unsafe. The CO<sub>2</sub> sensor threshold was set at 2000 ppm, indicating inadequate ventilation and possible human presence. The sound sensor reliably detected noise levels above 45 dB, while the motion sensor responded to minimal body movements within a range of 2–3 meters. Test results showed that the system detected child presence with an overall accuracy of approximately 96% across repeated trials. The average response time from threshold violation to alert generation was measured to be 3–5 seconds, including sensor processing and GSM communication delay. SMS alerts were successfully delivered in over 98% of test cases under normal network conditions. The buzzer activation occurred within 1 second of critical condition detection, providing immediate local warning. Power regulation from the 12V battery to 5V ensured stable operation with no system resets observed during extended testing. These quantitative results confirm that the proposed system offers fast response, high accuracy, and dependable performance, making it suitable for real-world vehicle safety applications aimed at preventing child entrapment incidents.

VIII. CONCLUSION

The IoT-Enabled Vehicle Auto Kids Recognition System helps protect children who might accidentally be left alone inside a car. By using different sensors like motion, sound, temperature, and CO<sub>2</sub> the system can quickly understand if a child is still inside and if the conditions are becoming dangerous. The ATmega328 microcontroller acts like the brain and uses this information to decide what to do. If something is wrong, it instantly sends an alert message

to the parent through the GSM module and can also activate a buzzer. This project shows how simple electronics and smart IoT technology can work together to save lives. It makes vehicles safer and gives parents peace of mind knowing their child is protected.

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