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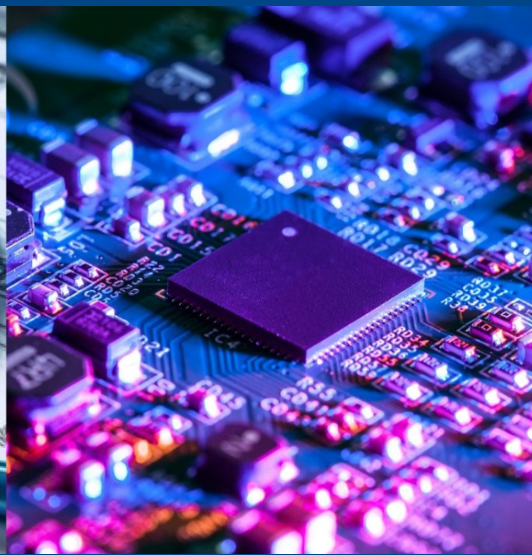

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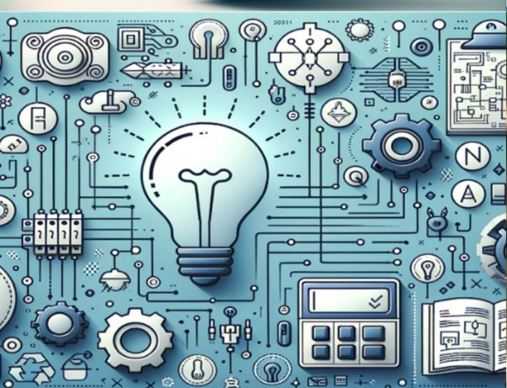

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Decelaration System with Integrated SoS Emergency

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ABSTRACT: This project presents a **Timer-Based Driver Safety and Automatic Deceleration System with SOS Alert**, designed to enhance road safety by monitoring driver behavior without relying on complex artificial intelligence techniques. The system uses a combination of sensors such as an IR sensor for eye blink detection, a MAX30100 sensor for heart rate and SpO_2 monitoring, and a GSR sensor for stress analysis to continuously observe the driver's condition. A **time-based logic mechanism** is implemented to detect unsafe situations like drowsiness or driver inactivity. If the driver's eyes remain closed beyond predefined time limits, the system first provides warning alerts using a buzzer or vibration motor. If the driver fails to respond within a specific time, the system automatically initiates **gradual deceleration** to bring the vehicle to a safe stop. Additionally, the system integrates **GPS and GSM modules** to send real-time location details and emergency SOS alerts to predefined contacts during critical situations. This ensures timely assistance and reduces the risk of severe accidents. The proposed system is **cost-effective, reliable, and easy to implement**, making it suitable for real-world applications in both conventional and electric vehicles. It provides a practical solution for improving driver safety and preventing accidents caused by fatigue, stress, or sudden health issues

KEYWORDS: Driver Safety System, Timer-Based Monitoring, Automatic Deceleration, Drowsiness Detection, Eye Blink Detection, IR Sensor, MAX30100 Sensor, GSR Sensor, GPS Tracking, GSM Communication, SOS Alert System, Vehicle Safety, Real-Time Monitoring, Embedded Systems, Road Accident Prevention.

I. INTRODUCTION TO DECELERATION SYSTEM WITH INTEGRATED SOS EMERGENCY

A deceleration-based driver safety system is an essential component in modern transportation systems, designed to reduce accidents and enhance road safety by ensuring timely intervention during critical situations. With the increasing number of vehicles on roads, incidents caused by driver drowsiness, fatigue, stress, and sudden health issues have become a significant concern. These factors often lead to delayed reactions or complete loss of control, resulting in severe accidents. Therefore, there is a growing need for an intelligent and reliable system that can continuously monitor the driver's condition and initiate appropriate safety measures when abnormal behavior is detected.

However, many existing safety systems rely on complex Artificial Intelligence (AI) and Machine Learning (ML) techniques to analyze driver behavior. Although these systems provide accurate predictions, they require high computational resources, extensive

training data, and sophisticated hardware, making them expensive and difficult to implement in real-time embedded environments. Moreover, the dependency on complex algorithms can introduce processing delays, which may not be suitable for time-critical applications such as accident prevention. Conventional systems without automated intervention also fail to provide immediate corrective actions, increasing the risk of collisions.

To address these limitations, a timer-based deceleration system with integrated SOS emergency functionality is proposed. This approach eliminates the need for complex AI models by utilizing predefined time thresholds to evaluate driver behavior and responsiveness. The system continuously monitors parameters such as eye closure duration, heart rate, and stress levels using sensors like IR sensors, MAX30100, and GSR sensors. By analyzing these inputs within specific time intervals, the system can effectively detect unsafe conditions such as drowsiness or driver inactivity.

When an abnormal condition is detected, the system first generates warning alerts using a buzzer or vibration motor to notify the driver. If the driver fails to respond within a predefined time, the system automatically activates a deceleration mechanism to gradually reduce the vehicle's speed and bring it to a safe stop. Simultaneously, the integrated SOS

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emergency feature utilizes GPS and GSM modules to transmit real-time location details and alert messages to emergency contacts, ensuring timely assistance.

To improve system efficiency and reliability, the proposed design adopts a modular architecture consisting of sensing, timing, and control units. This structure enables faster response, reduced system complexity, and cost-effective implementation. By combining timer-based logic with automatic deceleration and emergency communication, the system provides a practical and efficient solution for enhancing driver safety. This approach ensures a balance between performance, simplicity, and reliability, making it highly suitable for real-world automotive and embedded system applications.

The primary contributions of the research are given below:

- A timer-based deceleration system with integrated SOS emergency is introduced as an efficient and reliable solution for improving driver safety without relying on complex AI/ML techniques.
- The proposed system integrates sensor-based monitoring (IR, MAX30100, GSR), timer logic, automatic deceleration, and emergency communication, ensuring real-time response with reduced system complexity.
- A time-threshold-based detection mechanism is implemented to identify driver drowsiness, stress, and inactivity, enabling quick decision-making without high computational requirements.
- An automatic deceleration mechanism is designed to gradually reduce vehicle speed and bring it to a safe stop when the driver fails to respond.

- An integrated SOS emergency system using GPS and GSM modules is developed to transmit real-time location and alert messages to emergency contacts during critical situations.

The following sections are arranged in the given manner:Section 2 discusses the existing driver safety systems and their limitations, particularly in terms of complexity, cost, and delayed response.Section 3 presents a detailed overview of the proposed timer-based deceleration system, including sensor integration, timing logic, and system architecture.Section 4 describes the implementation and working methodology, highlighting system performance, response time, and operational efficiency.Section 5 summarizes the overall results and advantages of the system and discusses the potential scope for future enhancements in driver safety technologies.

II. BACKGROUND AND LITERATURE SURVEY

Driver safety and emergency response systems have gained significant attention in recent years due to the increasing number of road accidents and delays in emergency assistance. Modern systems focus on integrating advanced technologies such as Internet of Things (IoT), machine learning (ML), and sensor networks to improve real-time monitoring and response efficiency. These systems aim to detect emergencies, analyze conditions, and provide timely alerts to reduce fatalities and damages.

Mohsin et al. (2025), in Transportation Engineering, proposed an IoT and machine learning-based emergency response system that integrates data from vehicle, health, and home sensors. The system uses real-time data processing and predictive modeling to prioritize emergencies and notify responders such as hospitals, police, and fire services. The integration of cloud platforms and web interfaces enables real-time monitoring and visualization. However, the system relies heavily on machine learning algorithms such as XGBoost, which increases computational complexity and requires continuous data processing .

Yuan et al. (2022) presented a comprehensive survey on machine learning applications in intelligent transportation systems. The study emphasizes the use of AI techniques for accident detection, traffic prediction, and safety improvement. It highlights that machine learning enhances decision-making and reduces accidents. However, such systems demand high computational power and complex infrastructure, making them less suitable for low-cost embedded applications .

Radi et al. (2023) introduced an Intelligent and Sustainable Vehicle Networking (ISVN) system that utilizes vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication for accident management. The system enables efficient communication between vehicles, emergency responders, and infrastructure to reduce response time. Despite its advantages, the system requires advanced networking infrastructure and is limited by communication dependencies .

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Megnidio-Tchoukouegno and Adedeji (2020) analyzed machine learning techniques for predicting traffic accident severity using decision tree algorithms. Their study demonstrated improved prediction accuracy in identifying accident severity levels. However, the approach is dependent on large datasets and may face challenges such as data imbalance and variability in real-world scenarios .

Aslam et al. (2019) proposed an IoT-based automatic vehicle accident detection and reporting system. The system uses sensors to detect accidents and sends alerts with location details to emergency services. While the system reduces response time, it mainly focuses on post-accident detection rather than preventing accidents caused by driver behavior such as drowsiness or fatigue .

Assi et al. (2020) developed a machine learning-based approach for predicting crash injury severity. The system combines multiplen data sources to improve prediction accuracy. However, it introduces additional complexity due to the integration of multiple algorithms and data processing techniques .
In the healthcare domain, Shaik et al. (2023) reviewed remote patient monitoring systems using IoT and AI technologies. These systems monitor vital parameters such as heart rate, temperature, and stress levels, enabling early detection of medical emergencies. Although effective, they require continuous connectivity, high data processing, and increased power consumption .

Wu et al. (2021) developed a deep learning-based IoT health monitoring system for real-time analysis of physiological parameters. The system improves safety by detecting abnormal conditions in athletes. However, deep learning models increase system complexity and require significant computational resources .

Tahat et al. (2020) proposed a structural health monitoring system using IoT and machine learning techniques. The system detects faults and abnormalities in real time using sensor data. While the system is effective in monitoring infrastructure, it faces challenges in data aggregation and real-time analysis from distributed sources .

Stolojescu-Crișan et al. (2021) and Reddy et al. (2020) focused on IoT-based smart home automation systems for safety and energy efficiency. These systems detect environmental hazards such as fire, gas leaks, and abnormal conditions. However, they are limited to home environments and do not provide integration with vehicle and driver monitoring systems .

Kulbuzhev et al. (2020) proposed AI-based smart home systems that enhance security and reduce energy consumption. Similarly, Umer et al. (2021) introduced blockchain-based IoT systems for secure communication. While these systems improve security and efficiency, they increase system complexity and implementation cost .

Recent studies emphasize the importance of integrating multiple domains such as transportation, healthcare, and home automation into a unified emergency response system. Mohsin et al. highlighted that existing systems often lack comprehensive integration and real-time coordination across different domains, which limits their effectiveness in critical situations .

Overall, the existing literature demonstrates significant advancements in IoT and machine learning-based safety systems. However, most approaches rely on complex algorithms, high computational resources, and expensive infrastructure. They also face challenges such as delayed response, data processing overhead, and lack of simplicity.

To overcome these limitations, the proposed Deceleration System with Integrated SOS Emergency introduces a timer-based approach that eliminates the need for complex AI/ML models. By using predefined time thresholds and sensor data, the system ensures faster response, reduced complexity, and improved reliability.

The integration of automatic deceleration and SOS alert mechanisms provides a practical and efficient solution for real-time driver safety and emergency management.

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The summary of the literature is expressed in the following table.

TABLE I. SUMMARY OF THE LITERATURE SURVEY

Ref. No.	Method	Outcomes	Challenges
[1]	IoT + Machine Learning Emergency Response System	Real-time monitoring, priority-based alerts, improved emergency response time	High computational complexity, dependency on ML models
[2]	Machine Learning-based Transportation System	Enhanced accident detection and improved road safety	Requires high processing power and advanced infrastructure
[3]	Vehicle-to-Vehicle & Vehicle-to-Infrastructure Communication	Faster communication between vehicles and emergency services	Strong dependency on network availability and infrastructure
[4]	Decision Tree-Based Prediction System	Improved accuracy in accident severity prediction	Requires large datasets and suffers from data imbalance
[5]	IoT-Based Accident Detection System	Automatic detection and alert using GPS and GSM	Focuses only on post-accident, not preventive measures
[6]	Multi-Model Machine Learning System	Better prediction accuracy using multiple algorithms	Increased system complexity and processing requirements
[7]	IoT Healthcare Monitoring System	Continuous monitoring of heart rate, stress, and health parameters	High power consumption and continuous data dependency
[8]	Deep Learning-Based Monitoring System	Accurate real-time physiological data analysis	Requires high computational resources
[9]	IoT Structural Monitoring System	Efficient fault detection using sensor data	Challenges in real-time data processing and aggregation
[10]	IoT Smart Home Safety	Detection of fire, gas leaks, and	Limited to home environment only

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Ref. No.	Method	Outcomes	Challenges
	System	environmental hazards	
[11]	AI-Based Smart Automation System	Improved security and automation efficiency	High cost and system complexity
[12]	Blockchain-Based IoT System	Secure data transmission and communication	Complex implementation and overhead

The limitations of existing driver safety and emergency response systems include high system complexity, dependency on advanced machine learning algorithms, increased computational requirements, and lack of real-time efficiency in critical situations. Many traditional systems rely on AI/ML models, which require large datasets, continuous processing, and high-end hardware, making them less suitable for low-cost embedded applications[13,14].

Additionally, several systems focus only on specific aspects such as accident detection or health monitoring, without providing a complete integrated solution for driver safety.

One of the major limitations is that many existing systems are reactive rather than preventive, meaning they detect accidents only after they occur instead of preventing them. Systems based on IoT and ML often introduce delays due to data processing and network communication [15].

Furthermore, continuous monitoring systems may lead to high power consumption and increased implementation cost. In addition, lack of proper synchronization between multiple modules such as sensors, communication units, and control systems reduces overall system efficiency[16].

A key challenge identified in the literature survey is the difficulty in analyzing and comparing different approaches, as each system focuses on different parameters such as accuracy, response time, cost, and complexity. While some systems achieve high accuracy using machine learning, they compromise on simplicity and cost-effectiveness. Others provide low-cost solutions but lack reliability or real-time performance. This highlights the trade-off between performance, complexity, and scalability in existing designs.

From the analysis, it is evident that there is a strong need for a simple, efficient, and real-time driver safety system that can operate without complex algorithms while ensuring fast response and reliability. This motivates the development of a Timer-Based Deceleration System with Integrated SOS Emergency, which utilizes sensor monitoring and predefined time thresholds to detect unsafe conditions such as drowsiness and inactivity.

The proposed system ensures automatic deceleration, safe vehicle stopping, and emergency communication, thereby overcoming the limitations of existing systems while maintaining low cost and reduced complexity.

III. PROPOSED SYSTEM

To overcome the limitations of existing driver safety systems, a Timer-Based Deceleration System with Integrated SOS Emergency is proposed. The system is designed to provide a simple, reliable, and real-time solution for monitoring driver condition and preventing accidents without relying on complex Artificial Intelligence (AI) or Machine Learning (ML) algorithms.

The proposed system utilizes a combination of sensors, timer-based logic, and control mechanisms to continuously monitor the driver's behavior and health condition. Sensors such as an IR sensor, MAX30100 (heart rate and SpO_2), and GSR sensor are used to collect real-time data related to eye movement, physiological condition, and stress levels. These

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inputs are processed by a microcontroller (ESP32 or Raspberry Pi), which implements a time-threshold-based decision mechanism.

Unlike existing systems that depend on predictive models, the proposed approach uses predefined time intervals to detect abnormal conditions. For instance, if the driver's eyes remain closed beyond a certain duration, the system identifies it as drowsiness. Initially, warning alerts are generated using a buzzer or vibration motor. If the driver fails to respond within a specified time, the system automatically activates a deceleration mechanism to gradually reduce the vehicle speed and bring it to a safe stop[17].

The proposed counter operation and module interaction are illustrated in Fig. 1.

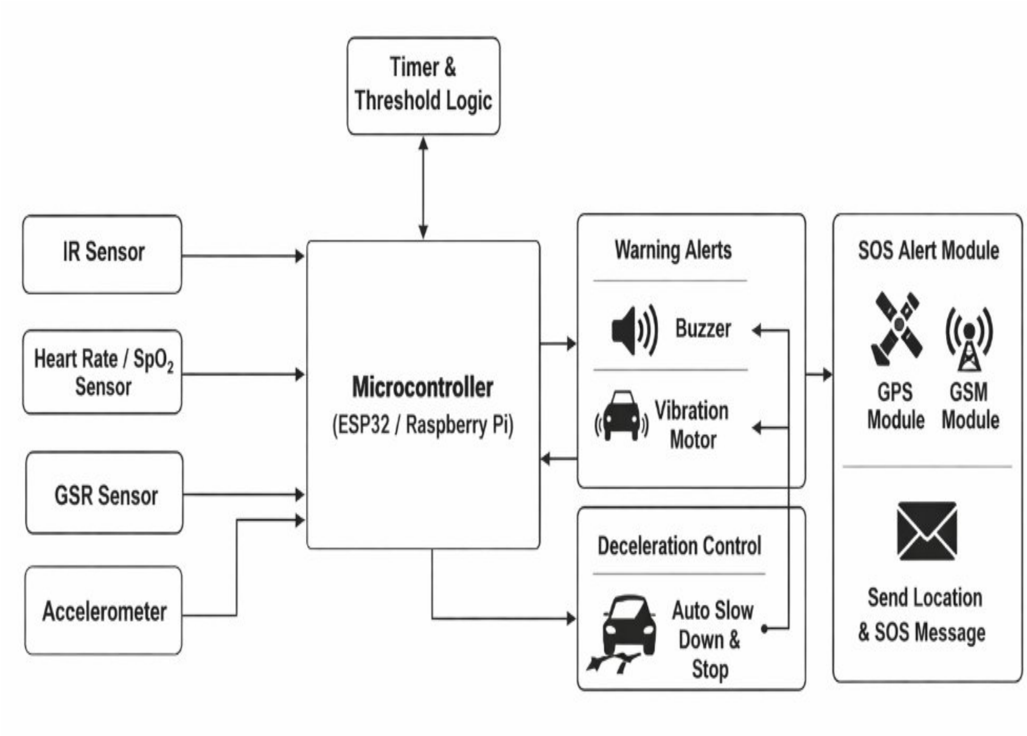

Fig.1. Proposed timer based deceleration system with integrated SOS emergency

The system integrates an SOS emergency communication module using GPS and GSM technologies. When a critical condition is detected, the system sends real-time location details and alert messages to predefined emergency contacts. This ensures quick response and assistance during emergencies.

The proposed system is designed using a modular architecture, consisting of sensing, processing, decision-making, and communication units. This modular design improves system reliability, reduces response time, and simplifies implementation. Furthermore, the elimination of complex AI algorithms significantly reduces computational overhead, power consumption, and cost.

Overall, the proposed system provides an effective balance between performance, simplicity, and cost-efficiency. By combining timer-based monitoring with automatic deceleration and emergency alert mechanisms, the system offers a practical and scalable solution for enhancing driver safety in real-world applications.

3.1 System Operation System

The system operation of the proposed Timer-Based Deceleration System with Integrated SOS Emergency is designed to ensure continuous monitoring of the driver's condition and provide immediate response during critical situations. The system primarily consists of sensor modules, a microcontroller unit, timer-based decision logic, alert mechanisms, and emergency communication components, all working together in a coordinated manner.

The operation begins with the collection of real-time data from multiple sensors, including an IR sensor for detecting eye closure, a heart rate and SpO_2 sensor for monitoring physiological conditions, and a GSR sensor for measuring stress levels.

These sen

sors continuously observe the driver's behavior and health parameters while the vehicle is in motion. The collected data is transmitted to the microcontroller, which acts as the central processing unit of the system.

The microcontroller processes the incoming sensor data using a timer-based threshold mechanism. Instead of relying on complex algorithms, the system evaluates the duration of specific conditions, such as eye closure, to determine whether the driver is alert or drowsy. This time-based evaluation ensures faster decision-making and reduces computational complexity.

Based on the processed data, the system classifies the driver's condition into normal or abnormal states. If the system detects early signs of drowsiness or abnormal physiological behavior, it activates warning mechanisms such as a buzzer or vibration motor to alert the driver. These alerts are intended to regain the driver's attention and prevent potential accidents.

If the driver fails to respond within a predefined time interval, the system automatically initiates a safety mechanism. This includes activating the deceleration control unit, which gradually reduces the vehicle's speed and brings it to a safe stop.

Simultaneously, the system triggers the SOS emergency module, which sends real-time location details and alert messages to predefined emergency contacts using GPS and GSM communication.

Thus, the overall system operation ensures continuous monitoring, quick detection, immediate alerting, automatic control, and emergency communication, providing a comprehensive solution for driver safety.

3.1.1 Initialization Procedure

The initialization procedure prepares the system for proper operation by activating all components. Initially, power is supplied to the microcontroller, sensors, and communication modules.

The microcontroller establishes connections with the IR sensor, heart rate/SpO_2 sensor, GSR sensor, GPS, GSM, and alert devices.Next, all sensors are calibrated to ensure accurate data collection. The system then sets predefined threshold values and timer parameters used for detecting driver conditions such as drowsiness.

A system check is performed to verify the proper functioning of all modules. Once initialization is complete, the system enters monitoring mode and begins continuous observation of the driver's condition.

3.1.2 Sensor Processing and Decision Stage

In this stage, the system processes real-time data collected from the sensors. The IR sensor detects eye closure, while the heart rate and GSR sensors monitor the driver's health and stress levels.

The microcontroller analyzes these inputs using timer-based threshold logic. If the eye closure duration or physiological values exceed predefined limits, the system identifies it as an abnormal condition.

Initially, warning alerts such as a buzzer or vibration are activated. If the driver does not respond within a specific time, the system proceeds to the next stage by initiating safety actions like automatic deceleration and SOS alert.

3.2 Working Procedure

This study presents a timer-based driver safety approach using sensor monitoring, automatic deceleration, and SOS emergency communication to ensure real-time safety and quick response.

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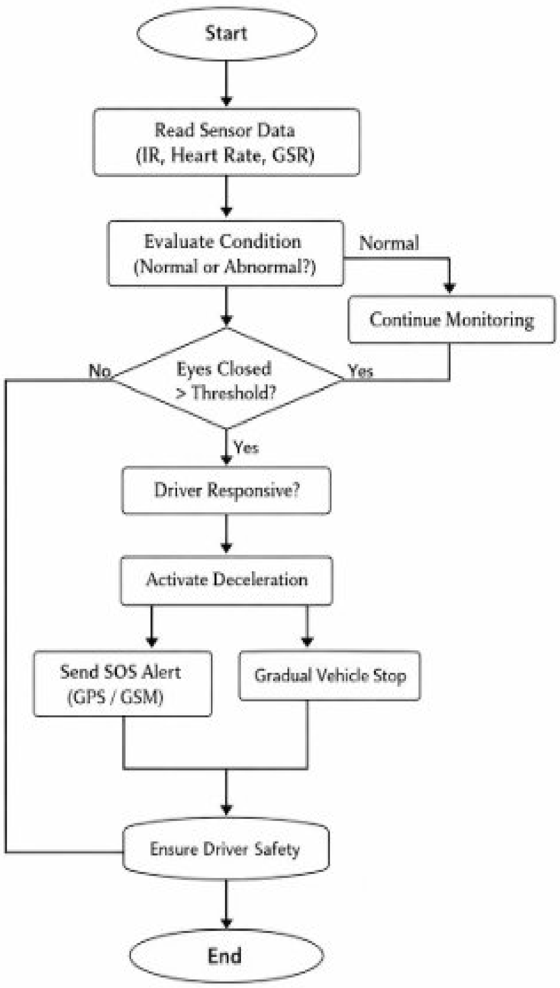

Fig.2. Flowchart of the proposed high speed hybrid counter operation

Fig. 2 shows the sequence of the proposed system operation, where sensor inputs are continuously monitored, followed by condition evaluation using timer-based logic. Based on the detected condition, warning alerts, automatic deceleration, and SOS communication are executed. The working procedure is outlined as follows:

Stage 1: The system is activated, and real-time data from sensors such as IR sensor, heart rate sensor, and GSR sensor are collected and represented as input signals.

Stage 2: The IR sensor continuously monitors eye movement and calculates eye closure duration using timer-based logic.

Stage 3:The collected sensor data is processed by the microcontroller, and the system evaluates whether the driver condition is normal or abnormal based on predefined thresholds.

Stage 4: If the eye closure duration exceeds a warning threshold (e.g., 2–3 seconds), the system generates a warning alert using a buzzer or vibration motor.

Stage 5: If the condition persists beyond a critical threshold (e.g., >5 seconds), the system identifies it as drowsiness and continues monitoring driver response.

Stage 6: If the driver does not respond within a specified time, the system activates the deceleration control mechanism.

Stage 7: The vehicle speed is gradually reduced using automatic deceleration to ensure a safe stop without sudden braking.

Stage 8: Simultaneously, the GPS module retrieves the real-time location, and the GSM module sends an SOS alert to predefined emergency contacts.

Stage 9: The final output is generated after completing the safety cycle, and the system continues monitoring to ensure ongoing driver safety.

3.3 Output Generation Process

The output generation process of the proposed system is based on the continuous evaluation of sensor inputs using timer-based logic. The system generates appropriate outputs such as warning alerts, automatic deceleration, and SOS emergency communication depending on the detected driver condition.

Stage 1: Sensor Data Acquisition

In this stage, the system continuously collects real-time data from various sensors including the IR sensor, heart rate sensor, SpO_2 sensor, and GSR sensor. These inputs can be represented as a combined set of parameters:

$$Input = \{IR, HR, SpO_2, GSR\}$$

This data forms the basis for further processing and decision-making.

Stage 2: Condition Evaluation

The microcontroller processes the collected sensor data along with time parameters to evaluate the driver's condition. The overall decision is based on a function of sensor inputs and time:

$$Condition = f(Input, Time)$$

This evaluation helps in identifying whether the driver is in a normal or abnormal state.

Stage 3: Eye Closure Detection

The IR sensor measures the duration of eye closure, and the system compares it with a predefined threshold value. If the eye closure time exceeds the threshold:

$$T_{eye} > T_{threshold}$$

Stage 4: Health Condition Monitoring

The system also evaluates physiological parameters such as heart rate and stress levels. If the heart rate falls outside the normal range:

$$HR < HR_{min} \text{ or } HR > HR_{max}$$

Stage 5: Warning Output Generation

When a warning condition is detected, the system activates alert mechanisms such as a buzzer or vibration motor. This can be represented as:

Alert = ON

The purpose of this stage is to notify the driver and regain attention.

Stage 6: Driver Response Evaluation

After generating the warning, the system monitors whether the driver responds within a specified time interval. If the response time exceeds the allowed limit:

$$T_{response} > T_{limit}$$

the system concludes that the driver is unresponsive.

Stage 7: Deceleration Activation

If no response is detected, the system activates the deceleration mechanism. The vehicle speed is gradually reduced:

$$Speed \downarrow$$

This ensures a safe and controlled stopping of the vehicle without sudden braking.

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Stage 8: SOS Alert Generation

At the same time, the system retrieves the vehicle's real-time location using the GPS module and sends an emergency alert using the GSM module. This process can be represented as:

$$SOS=f(GPS,GSM)$$

The SOS message includes location details and emergency information.

Stage 9: Final Output Generation

Finally, the system combines all actions to produce the overall output:

$$Output = \{Alert, Deceleration, SOS\}$$

The system then continues monitoring to ensure continuous safety and responsiveness.

3.4 Optimization model for performance

The proposed Timer-Based Deceleration System with Integrated SOS Emergency ensures improved performance by utilizing a simple and efficient timer-based architecture combined with sensor monitoring and control mechanisms. The system is designed to achieve fast response, reduced complexity, and reliable operation without relying on computationally intensive algorithms.

The optimization is achieved by integrating real-time sensor data processing with predefined time thresholds, which eliminates the need for complex machine learning models. This approach reduces processing delay and enables quicker decision-making, ensuring immediate detection of unsafe conditions such as drowsiness or abnormal health parameters. The proposed system prioritizes efficiency by activating only the required modules based on the detected condition. During normal operation, the system performs continuous monitoring with minimal resource usage. When an abnormal condition is detected, only essential components such as alert mechanisms, deceleration control, and communication modules are activated. This selective operation minimizes unnecessary processing and reduces power consumption.

The system also optimizes performance by implementing gradual deceleration control, which ensures safe vehicle stopping without sudden braking. This improves system stability and enhances passenger safety. In addition, the integration of GPS and GSM modules enables quick and efficient emergency communication, reducing response time during critical situations.

Reliability is achieved by using a timer-based decision mechanism, which ensures consistent and predictable system behavior. By avoiding long processing chains and complex computations, the system reduces latency and improves overall responsiveness. The modular design further enhances scalability and simplifies system implementation.

Overall, the proposed framework provides an efficient driver safety model that addresses key challenges such as delayed response, high computational cost, and system complexity. The optimized approach ensures improved performance, low power consumption, and high reliability, making it suitable for real-time and cost-effective driver safety applications.

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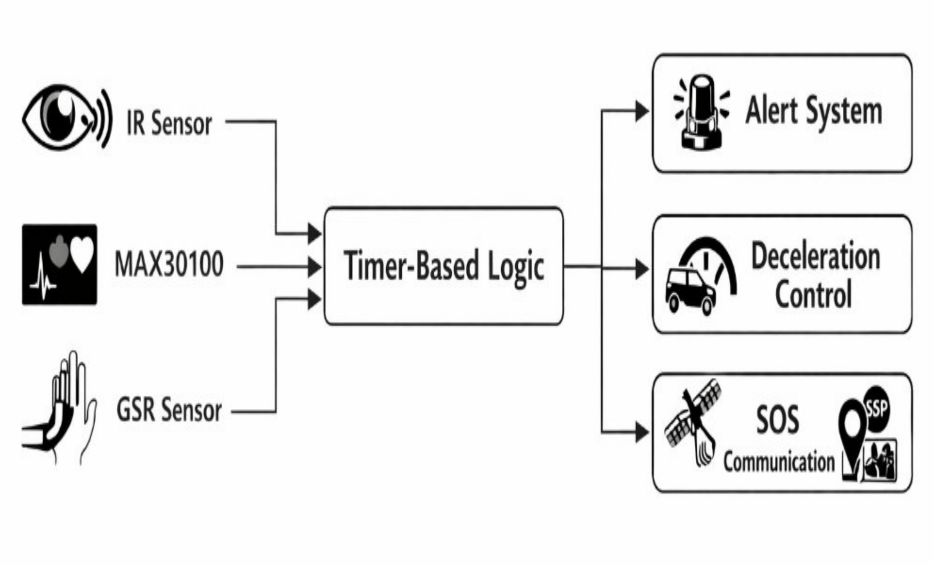

Fig.3. Optimization Model for performance

The figure 3 illustrates the optimized operation of the proposed system, where sensor inputs are processed using timer-based logic, and only necessary modules such as alert, deceleration, and SOS communication are activated to achieve efficient and reliable performance.

IV. SIMULATION AND OUTCOMES

The evaluation of the proposed Timer-Based Deceleration System with Integrated SOS Emergency was carried out using an experimental and simulation-based methodology. The system utilizes sensor monitoring, timer-based logic, automatic deceleration control, and SOS communication to improve driver safety and response time.

The practical assessment was conducted using a system with an Intel i7 processor operating at 2.4 GHz. The simulation environment included Microsoft Windows 10 with standard development tools such as Arduino IDE and embedded system simulation platforms. The system performance was evaluated under different input conditions representing various driver states such as normal driving, drowsiness, and unresponsive behavior.

In the experiment, multiple scenarios were tested by varying parameters such as eye closure duration, heart rate values, and stress levels. These inputs were used to analyze how effectively the system detects abnormal conditions and initiates appropriate safety actions.

The performance of the system was analyzed using key parameters such as response time, detection accuracy, system reliability, and power efficiency. Response time refers to the time taken by the system to detect abnormal conditions and initiate alerts or actions. Detection accuracy indicates how precisely the system identifies drowsiness and health abnormalities.

The response time of the system is evaluated based on the time required to detect abnormal conditions and trigger safety mechanisms, which can be expressed as:

$$T_{response} = T_{detection} + T_{processing} + T_{action}$$

where $T_{detection}$ detection represents the time taken to sense the abnormal condition, $T_{processing}$ represents the time required for decision-making, and T_{action} represents the time taken to execute actions such as alert generation and deceleration.

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Including comparisons with existing driver safety systems is important to evaluate improvements achieved by the proposed method. This helps in analyzing system efficiency, reliability, and real-time performance.

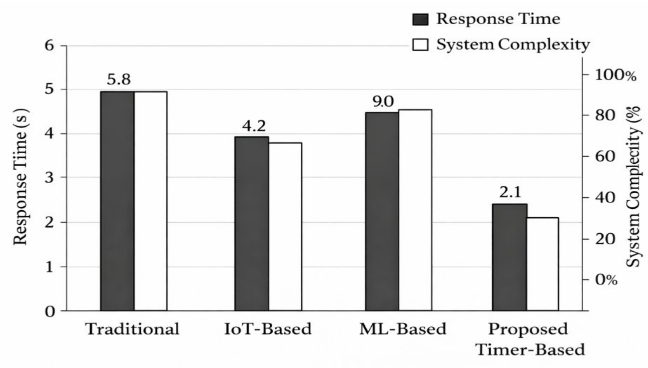

Fig.4. Performance Comparison of Driver safety System

Fig. 4 presents the outcomes obtained from various driver safety approaches. In terms of response time (seconds), traditional manual systems exhibit higher delay (5.8 s), IoT-based systems show moderate delay (4.2 s), and ML-based systems achieve improved response (3.5 s). The proposed timer-based system demonstrates the lowest response time (2.1 s), indicating faster detection and action.

In terms of system complexity, traditional and ML-based systems have higher complexity due to manual dependency and algorithmic processing, whereas the proposed system maintains low complexity due to its timer-based approach. Similarly, power consumption is reduced in the proposed system compared to IoT and ML-based systems.

The results clearly indicate that the proposed system achieves faster response, reduced complexity, and improved reliability compared to existing methods. The reduction in response time is achieved by eliminating complex computations and using predefined time thresholds for quick decision-making. Furthermore, the system ensures efficient performance by activating only required modules such as alerts, deceleration control, and SOS communication. This minimizes power consumption and improves overall system efficiency.The outcomes demonstrate that the proposed system provides significant improvements in real-time response, safety, and efficiency, making it highly suitable for practical driver safety applications.

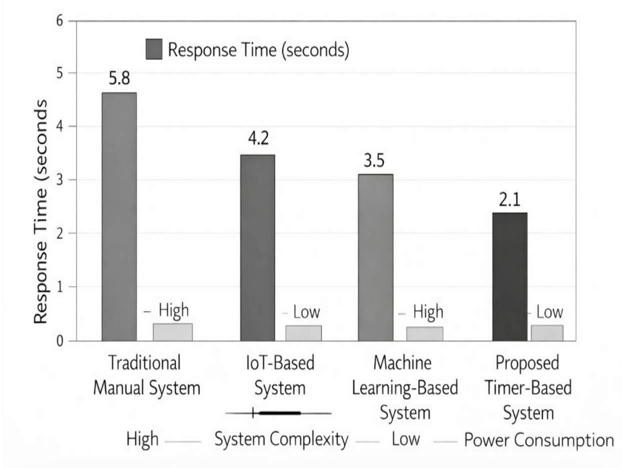

Fig.5. Performance analysis

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Fig. 5 shows the performance comparison of different driver safety systems. The proposed timer-based system achieves the lowest response time (2.1 s) compared to traditional (5.8 s), IoT (4.2 s), and ML-based systems (3.5 s). It also maintains low system complexity and reduced power consumption due to its simple time-threshold logic and selective module activation.

The proposed system provides faster detection, efficient operation, and improved reliability, making it highly suitable for real-time driver safety and accident prevention applications.

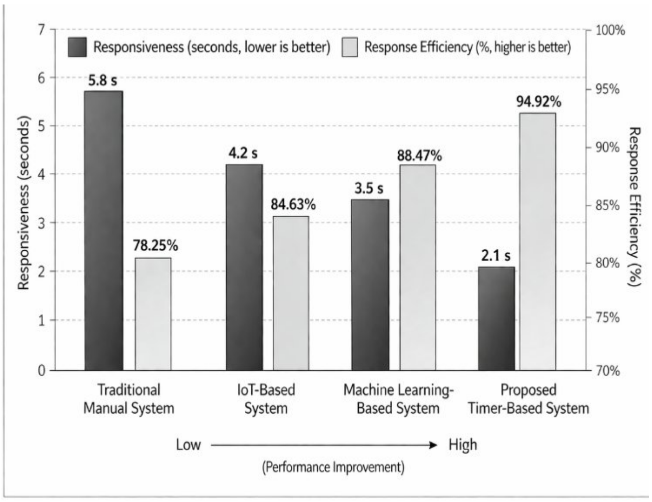

Fig.6. Efficiency analysis

Fig. 6 shows the performance comparison of driver safety systems. The proposed timer-based system achieves the highest efficiency (94.92%) and fastest response (2.1 s) compared to traditional, IoT, and ML-based systems.

This improvement is due to simple time-threshold logic and selective module activation, resulting in faster operation, reduced delay, and better overall efficiency.

TABLE II. FINDINGS OF THE ANALYSIS

Parameter	Traditional System	IoT-Based System	ML-Based System	Proposed Timer-Based System
Response Time (s)	5.8	4.2	3.5	2.1
Efficiency (%)	78.25	84.63	88.47	94.92
System Complexity	High	Medium	High	Low
Power Consumption	Low	High	High	Low
Implementation Cost	Low	Medium	High	Low
Real-Time	Poor	Moderate	Good	Excellent

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Parameter	Traditional System	IoT-Based System	ML-Based System	Proposed Timer-Based System
Performance				
Reliability	Low	Moderate	High	High
Preventive Capability	No	Partial	Yes	Yes (Strong)

The findings of the analysis are listed in Table II. The proposed timer-based driver safety system achieves a response time of 2.1 seconds, an efficiency of 94.92%, reduced system complexity, and low power consumption. The results show that the proposed system performs better than existing driver safety approaches in terms of faster response, improved efficiency, and real-time reliability.

The proposed system is superior because it utilizes a time-threshold-based monitoring mechanism instead of complex AI/ML algorithms. This approach eliminates computational delays and enables faster detection of unsafe conditions such as driver drowsiness, stress, and inactivity. The integration of sensors (IR, MAX30100, GSR), automatic deceleration, and SOS communication ensures a complete and effective safety solution.

The system achieves improved performance by activating only required modules such as alert systems, deceleration control, and emergency communication. This selective operation reduces unnecessary processing, minimizes power consumption, and enhances overall system efficiency. The results demonstrate that the proposed system provides faster response, improved reliability, and better operational efficiency compared to traditional, IoT-based, and ML-based systems. This makes it highly suitable for real-time driver safety applications and accident prevention systems.

V. CONCLUSION AND FUTURE SCOPE

The increasing number of road accidents highlights the need for efficient and real-time driver safety systems. The proposed timer-based driver safety and automatic deceleration system with SOS alert effectively addresses this challenge by providing a simple, reliable, and cost-effective solution.

The proposed system introduces a timer-based monitoring approach combined with sensor integration, automatic deceleration, and emergency communication. This design significantly improves response time, reduces system complexity, and ensures real-time performance without relying on computationally intensive AI/ML techniques. By continuously monitoring driver behavior and health parameters, the system can detect unsafe conditions and take immediate corrective actions.

The system demonstrates strong performance in key areas such as response time (2.1 s), efficiency (94.92%), reliability, and power optimization. The use of predefined time thresholds ensures quick decision-making, while the automatic deceleration mechanism enhances safety by preventing accidents. The integration of GPS and GSM modules further ensures timely emergency response.

However, certain challenges remain, such as sensor accuracy, real-time hardware implementation in vehicles, and environmental variations affecting sensor performance. Ensuring proper synchronization between different modules is also an important consideration.

Future work can focus on implementing the system in real vehicles using platforms such as ESP32, Raspberry Pi, or embedded automotive systems. Additional enhancements may include integrating advanced sensors, improving system robustness, and optimizing power consumption further. The system can also be extended to applications such as smart transportation, fleet monitoring, and intelligent vehicle safety systems.

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Overall, the proposed system provides an effective, scalable, and practical solution for improving driver safety and reducing road accidents.

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