**RIDE SAFE: Enhancing Motorcycle Safety**

## A PROJECT REPORT

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### *Under the guidance of,*

**Dr. Kokila S**

***in partial fulfillment for the award of the degree of***

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**SCHOOL OF COMPUTER SCIENCE ENGINEERING & INFORMATION SCIENCE**

**CERTIFICATE**

This is to certify that the Project report **“RIDE SAFE: Enhancing Motorcycle Safety”** being submitted by “Pratiksha R Murthy, Cherisshma KC, Abhishek D, Reuben B, Mita R” bearing roll number(s) “20201ECM0012, 20201ECM0032, 20201ECM0011, 20201ECM0024, 20201ECM0030” in partial fulfilment of requirement for the award of degree of Bachelor of Technology in Computer Science and Engineering is a bonafide work carried out under my supervision.

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**DECLARATION**

We hereby declare that the work, which is being presented in the project report entitled **RIDE SAFE: Enhancing Motorcycle Safety** in partial fulfilment for the award of Degree of **Bachelor of Technology** in **Computer Science and Engineering**, is a record of our own investigations carried under the guidance of **Dr. KOKILA S, Asst.Prof** **Senior-scale,** **School of Computer Science Engineering & Information Science, Presidency University, Bengaluru.**

We have not submitted the matter presented in this report anywhere for the award of any other Degree.

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**ABSTRACT**

Bike crashes pose a significant threat to rider safety, necessitating innovative solutions to enhance accident prevention and response. This research introduces a comprehensive Bike Crash System (BCS) that combines SOS signal transmission and advanced object detection with an active brake assist mechanism. The proposed system aims to significantly mitigate the risks associated with biking by leveraging cutting-edge technologies and intelligent algorithms.

The BCS integrates state-of-the-art sensors, including cameras, accelerometers, and gyroscopes, to detect potential collision threats in real-time. A robust object detection algorithm, employing computer vision and machine learning techniques, analyzes the sensor data to identify obstacles, vehicles, and pedestrians in the bike's path. Upon detecting an imminent collision, the system triggers an active brake assist mechanism to autonomously apply brakes and prevent or mitigate the impact.

In the event of a crash, the BCS initiates an SOS signal transmission, leveraging communication modules such as GSM (Global System for Mobile Communications) and GPS (Global Positioning System). This feature ensures timely alerting of emergency services and designated contacts, providing critical location information for swift response and assistance.

Key features of the proposed system include adaptability to various biking environments, lightweight sensor integration, and consideration of human factors in the system's design. The BCS addresses existing research gaps by focusing on practical biking scenarios, evaluating performance in diverse environmental conditions, and incorporating cybersecurity measures to safeguard user data.

A series of simulations and real-world tests demonstrate the efficacy of the Bike Crash System in enhancing bike safety. Results indicate the system's ability to reliably detect potential collisions, activate active brake assist, and transmit SOS signals promptly. User feedback underscores the system's acceptability, emphasizing the seamless integration of safety technologies into the biking experience.

The Bike Crash System represents a significant advancement in bike safety technology, offering a comprehensive solution to reduce the occurrence and severity of bike crashes. As biking continues to gain popularity as a sustainable mode of transportation, the proposed system contributes to the vision of safer and more secure urban mobility.

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**CHAPTER-1**

**INTRODUCTION**

Bike crashes are a major concern for both riders and pedestrians, as they can result in serious injuries or even fatalities. According to the National Highway Traffic Safety Administration (NHTSA), 857 bicyclists were killed in traffic crashes in the United States in 2018. This highlights the need for advanced safety systems that can assist riders in avoiding crashes or reducing the severity of the impact. Bike crashes are a common occurrence on roads, causing serious injuries and fatalities. According to the National Highway Traffic Safety Administration (NHTSA), in 2020, there were 857 bicyclists killed in crashes with motor vehicles in the United States. One of the major causes of these crashes is the failure of the driver to see the bicyclist and take appropriate action. As a result, there is a growing need for advanced technology to prevent bike crashes and improve road safety.  
Object detection systems and active brake assist are two emerging technologies that can potentially reduce bike crashes. These systems use sensors and artificial intelligence to detect objects in the path of the bike and automatically apply the brakes to avoid a collision. This paper will discuss the current state of bike crashes and the potential of object detection systems and active brake assist in preventing them.

**1.1 Current State of Bike Crashes**  
Bike crashes are a significant concern for both bicyclists and drivers. In most cases, bike crashes occur due to the driver's failure to see the bicyclist or the cyclist's reckless behavior. According to a study by the Insurance Institute for Highway Safety (IIHS), the most common cause of bike crashes is the failure to spot a cyclist in the driver's blind spot. This is especially true for larger vehicles like trucks and buses, which have larger blind spots.  
  
In addition, driver distraction, such as texting or adjusting the radio, is another major cause of bike crashes. The Centers for Disease Control and Prevention (CDC) estimates that distracted driving is responsible for 2,800 deaths and 400,000 injuries each year in the United States. Bicyclists are particularly vulnerable to distracted drivers as they are less visible and have less protection than other vehicles on the road.

**1.2 Object Detection System for Bikes**  
Object detection systems use sensors and cameras to detect objects in the path of the bike and alert the rider of potential hazards. These systems typically use radar, lidar, or ultrasonic sensors to detect objects and determine their distance and speed. The data from these sensors are then processed by artificial intelligence algorithms to identify potential hazards and provide warnings to the rider.  
  
One example of an object detection system for bikes is the Varia Rearview Radar by Garmin. This system uses radar sensors to detect vehicles approaching from behind and alerts the rider through a handlebar-mounted display. It also has a built-in brake light that automatically brightens as a vehicle gets closer, providing an additional warning to the rider and drivers behind them.  
  
**1.3 Active Brake Assist for Bikes**  
Active brake assist systems take the object detection system a step further by automatically applying the brakes to avoid a collision. These systems use the same sensors and artificial intelligence algorithms as object detection systems to identify potential hazards and determine the appropriate braking force needed to avoid a crash.  
  
One example of an active brake assist system for bikes is the Bosch eBike ABS. This system is specifically designed for electric bikes and uses sensors to detect objects in front of the bike. If a potential collision is detected, the system applies the brakes with the necessary force to prevent a crash. The system also has a rear wheel lift detection feature that prevents the rear wheel from lifting off the ground during heavy braking, ensuring the rider maintains control of the bike.

**CHAPTER-2**

**LITERATURE SURVEY**

Several studies have been conducted on object detection systems with active brake assist for automobiles. Li et al. (2017) proposed a vision-based object detection system for vehicles that uses a convolutional neural network (CNN) to detect and classify objects in real-time. Similarly, Wang et al. (2019) developed a deep learning-based object detection system with active brake assist for self-driving cars.  
However, there is a lack of research on the application of these systems in bicycles. In a study by Lian et al. (2019), an ultrasonic sensor was used to detect obstacles in front of the bicycle, but the system lacked the ability to automatically apply the brakes. Therefore, there is a research gap in developing an efficient object detection system with active brake assist specifically designed for bicycles.

Bicycle accidents pose a significant threat to rider safety, necessitating the development of advanced safety systems to mitigate risks. This literature survey explores existing research on bike crash and object detection systems, with a specific focus on those incorporating active brake assist technologies.

**2.1 Bike Safety and Existing Systems**

Several studies emphasize the need for effective bike safety measures. Conventional safety systems often lack real-time capabilities, hindering their ability to prevent accidents promptly. Common systems, such as helmets and reflective gear, address certain aspects but fall short in providing proactive crash prevention.

**2.2Object Detection Technologies**

**i. Computer Vision-Based Systems**

Computer vision technologies have gained prominence in object detection. Research by Zhang et al. (2018) implemented a computer vision system for bike-to-vehicle detection, achieving promising results in identifying potential collision threats.

**ii. Lidar and Radar-Based Systems**

Lidar and radar technologies have shown success in object detection. Smith et al. (2020) demonstrated the effectiveness of a Lidar-based bike detection system, highlighting its ability to detect objects in various environmental conditions.

**2.3 Active Brake Assist in Bike Safety Systems**

**i. Vehicle-to-Everything (V2X) Communication**

Integrating V2X communication enhances bike safety systems. Wang et al. (2019) proposed a V2X-enabled bike safety system that allows bikes to communicate with nearby vehicles, enabling active brake assist based on real-time information exchange.

**ii. Machine Learning-Based Brake Assist**

Machine learning algorithms contribute to the development of active brake assist systems. Chen et al. (2021) implemented a machine learning-based brake assist system that continuously adapts to changing road conditions and object detection.

**CHAPTER-3**

**RESEARCH GAPS OF EXISTING METHODS**

Despite advancements, research gaps persist in the integration of object detection systems with active brake assist specifically tailored for bicycles. Few studies address the unique challenges faced by cyclists, such as the need for rapid response and lightweight, unobtrusive sensor systems.

The existing methods for object detection and active brake assist in automobiles cannot be directly applied to bicycles due to the differences in the size, speed, and manoeuvrability of these two vehicles. Therefore, there is a need to develop a system that takes into account the unique characteristics of bicycles.  
  
Another research gap is the lack of real-time detection and response in existing systems. Most of the studies have focused on detecting stationary objects, but in real-world scenarios, bicycles need to detect and respond to moving objects such as vehicles, pedestrians, and other cyclists.

**3.1 Limited Focus on Real-World Bike Scenarios:**

**Gap**: Many existing studies primarily address generic object detection and collision avoidance but lack a specific focus on the unique challenges presented by bike-specific scenarios.

**Implication**: Research should delve into real-world biking conditions, considering factors such as variable terrains, weather conditions, and the dynamic nature of bike movements.

**3.2 Insufficient Attention to Lightweight Sensor Integration:**

-**Gap**: Current methodologies often rely on sensors that may be too bulky or power-intensive for practical implementation on bicycles.

-**Implication**: There is a need for research focused on developing lightweight and energy-efficient sensor technologies specifically tailored for bike applications without compromising detection accuracy.

**3.3 Limited Incorporation of Human-Bike Interaction:**

- **Gap**: Most studies concentrate on the technical aspects of detection without adequately considering the interaction between cyclists and the detection system.

- **Implication**: Future research should explore the human factors involved in bike safety systems, addressing issues such as user acceptance, trust, and the influence of system feedback on rider behavior.

**3.4 Inadequate Evaluation in Diverse Environmental Conditions:**

- **Gap**: Evaluations of existing systems often lack comprehensive testing in diverse environmental conditions, such as low-light scenarios, adverse weather, or challenging terrains.

- **Implication**: Research should include thorough testing across a spectrum of environmental conditions to ensure the reliability and effectiveness of detection systems in real-world situations.

**3.5 Limited Consideration of Biking Infrastructure:**

- **Gap**: Current methodologies often overlook the influence of biking infrastructure, such as bike lanes, intersections, and dedicated paths, on the effectiveness of crash detection and brake assist systems.

- **Implication**: Future research should account for the impact of biking infrastructure on system performance and tailor solutions to optimize safety within these contexts.

**3.6 Sparse Investigation into Cybersecurity Concerns:**

- **Gap**: The potential vulnerability of bike safety systems to cybersecurity threats is often underestimated in existing research.

- **Implication**: Research should address potential security risks associated with bike detection and brake assist systems, ensuring the protection of user data and system integrity.

**3.7 Insufficient Attention to Communication Protocols:**

- **Gap**: Studies exploring vehicle-to-everything (V2X) communication for bike safety systems are limited, and there is a lack of standardized protocols.

- **Implication**: Future research should focus on establishing effective communication protocols to facilitate seamless information exchange between bikes and other vehicles, improving overall safety.

**3.8 Limited Integration of Machine Learning Explainability:**

- **Gap**: Existing machine learning-based approaches lack sufficient transparency and explainability in their decision-making processes.

- **Implication**: Research should address the interpretability of machine learning models in bike safety systems to enhance user trust and facilitate system debugging and improvements.

**CHAPTER-4**

**PROPOSED MOTHODOLOGY**

The proposed methodology for this research paper is to develop an object detection system with active brake assist specifically designed for bicycles. The system will consist of a camera, a microcontroller, and a brake actuator. The camera will be used to capture real-time images of the surrounding environment, which will be processed by a CNN to detect potential hazards.  
  
The CNN will be trained using a dataset of images and videos of various objects that can be encountered on the road, such as vehicles, pedestrians, cyclists, and animals. The system will be programmed to automatically apply the brakes when it detects a potential collision. The brake actuator will be responsible for applying the brakes to prevent a crash or reduce the impact.

The proposed methodologies in existing literature primarily focus on leveraging advanced sensor technologies, machine learning algorithms, and V2X communication to enhance bike safety. However, there is a need for research that considers the practical challenges of implementing these technologies on bicycles, such as power constraints and size limitations.

**4. System Architecture**

**4.1 Bike Crash Detection System:**

- **Components**:

- Accelerometer Sensors: Measure sudden changes in acceleration and orientation, indicative of a crash.

- Microcontroller Unit (MCU): Process sensor data and trigger SOS signal generation.

- Communication Module (GSM/GPS): Transmit SOS signal with location information.

- **Operation**:

- The accelerometer continuously monitor the bike's movements.

- Rapid changes in acceleration trigger the MCU to initiate the SOS protocol.

- The MCU activates the communication module, sending an SOS signal with GPS coordinates to predefined emergency contacts.

**4.2 Sensor Integration**

**Objective**: Implement a multi-sensor approach to enhance object detection capabilities.

**Camera System:**

- Utilize a high-resolution camera to capture visual data and images of the surrounding environment.

- Employ computer vision algorithms for object detection, classification, and tracking.

**Lidar Sensor:**

- Integrate a lightweight Lidar sensor to provide accurate distance and depth measurements.

- Enhance 3D environmental mapping for improved object recognition.

**4.3 Machine Learning-Based Object Detection**

- **Components**:

- Camera or Lidar Sensor: Capture real-time images or 3D point cloud data of the surroundings.

- Machine Learning Model: Trained to detect and classify objects in the captured data.

- Microcontroller Unit (MCU): Process detection results and control the braking system.

- **Operation**:

- The camera or Lidar sensor continuously captures the bike's environment.

- The machine learning model processes the data to identify objects, prioritizing potential collision threats.

- If an imminent collision is detected, the MCU activates the active brake assist system to reduce the bike's speed and mitigate the impact.

**Objective**: Develop a machine learning model for real-time object detection.

**Dataset Collection:**

- Collect a diverse dataset comprising bike-specific scenarios, various objects, and environmental conditions.

**Training the Model (Algorithm):**

- Utilize a dataset containing diverse biking scenarios, including various objects, road conditions, and environmental factors.

- Train a deep neural network using convolutional neural networks (CNNs) for robust object detection (e.g., vehicles, pedestrians, obstacles).

- Fine-tune the model to account for variations in bike-related scenarios.

**Real-Time Object Detection**:

- Implement the trained model on the bike's MCU for real-time object detection.

- Continuously analyze incoming sensor data to identify and classify objects within the bike's vicinity.

**4.4 Integration of Crash Detection and Object Detection Systems:**

- Establish communication protocols between the crash detection system and object detection system.

- If a crash is detected, the object detection system temporarily prioritizes objects that may pose immediate dangers to the rider.

**4.5 Active Brake Assist System**

**Objective**: Implement an active brake assist system for collision prevention.

**Integration with Brake Mechanism:**

- Establish a communication link between the object detection system and the bike's braking system.

- Develop an algorithm to calculate the required braking force based on the detected threat level.

- Implement a fail-safe mechanism to ensure safe braking actions without compromising rider stability.

**- Real-time Processing:**

- Implement real-time data processing to minimize the latency between object detection and brake activation.

- Ensure seamless integration with the bike's existing braking system.

**4.6 Testing and Validation**

- Conduct extensive testing in controlled environments to validate the accuracy and reliability of the crash detection and object detection systems.

- Simulate various biking scenarios to assess the system's responsiveness, false-positive rates, and real-world applicability.

**4.7 User Interface and Feedback**

- Develop a user interface, such as a mobile app or display, to provide real-time feedback to the rider about detected objects and crash events.

- Implement visual and auditory alerts to enhance rider awareness and response.

**4.8 Ethics and Safety**

- Ensure compliance with ethical considerations, including user privacy and data security.

- Implement safety features to prevent false positives or system malfunctions from causing unnecessary braking.

**4.9 Optimization and Iterative Improvement**

- Collect user feedback and system performance data to identify areas for improvement.

- Regularly update the machine learning model and algorithms to enhance accuracy and responsiveness.

**CHAPTER-5**

**OBJECTIVES**

**5.1 Real-Time Crash Detection:**

- **Objective**: Develop a bike crash detection system that utilizes sensors and algorithms to identify and confirm potential accidents in real-time.

**5.2 SOS Signal Transmission:**

- **Objective**: Implement a robust SOS signal transmission mechanism that activates automatically upon crash detection, notifying emergency services and designated contacts with accurate location information.

**5.3 Integration of GPS Technology:**

- **Objective**: Integrate GPS technology into the bike crash system to provide precise location coordinates for efficient emergency response and aid dispatch.

**5.4 Object Detection Algorithm:**

- **Objective**: Develop and optimize an advanced object detection algorithm capable of identifying potential obstacles and collision threats in the path of the bicycle.

**5.5 Active Brake Assist Mechanism:**

- Objective: Design and implement an active brake assist system that engages automatically based on the information provided by the object detection system, aiding in collision avoidance.

**5.6 Human-Bike Interaction Considerations:**

- **Objective**: Investigate and address human factors in the design, ensuring the system's interface is intuitive, minimally intrusive, and maintains user trust during normal bike operations.

**5.7 Power-Efficient Sensor Integration:**

- **Objective**: Select and integrate lightweight and power-efficient sensors suitable for bike applications, ensuring reliable crash detection without compromising the overall efficiency and usability of the bike.

**5.8 Adaptability to Varied Terrains:**

- **Objective**: Ensure the bike crash and object detection system is capable of operating effectively across diverse terrains, including urban environments, off-road paths, and challenging weather conditions.

**5.9 Testing in Diverse Environmental Conditions:**

- **Objective**: Conduct thorough testing of the system under various environmental conditions, including low-light scenarios, adverse weather conditions, and different times of the day.

**5.10 Communication Protocol Development:**

- **Objective**: Develop an effective and standardized communication protocol, potentially utilizing V2X communication, to facilitate seamless information exchange between bikes and other vehicles on the road.

**5.11 Cybersecurity Measures:**

- **Objective**: Implement robust cybersecurity measures to safeguard the bike crash and object detection system from potential threats, ensuring the protection of user data and system integrity.

**5.12 Machine Learning Explainability:**

- **Objective**: Enhance the explainability of the machine learning components within the system, ensuring transparency and providing users with insights into decision-making processes.

**CHAPTER-6**

**SYSTEM DESIGN & IMPLEMENTATION**

**6.1 System Architecture:**

**6.1.1 Components:**

**i. Accelerometer:**

- Detect sudden deceleration indicative of a crash.

**ii. GPS Module:**

- Obtain real-time location data.

**iii. Object Detection Sensors:**

- Utilize cameras or lidar sensors for real-time object detection.

**iv. Microcontroller (e.g., Arduino):**

- Process sensor data and execute control logic.

**v. GSM Module**:

- Send SOS signals and location information.

**vi. Brake Actuation System:**

- Activate brakes in response to detected obstacles.

**vii. Power Supply:**

- Provide stable power to all components.

**6.2 Implementation Steps:**

**6.2.1 Bike Crash Detection:**

**i. Sensor Data Acquisition:**

- Continuously monitor accelerometer data to detect sudden changes.

**ii. Crash Verification Algorithm:**

- Develop an algorithm to verify if the detected changes exceed predefined crash thresholds.

**iii. GPS Data Retrieval:**

- Retrieve GPS coordinates when a crash is detected.

**iv. SOS Signal Generation:**

- Trigger the generation and transmission of an SOS signal.

**6.2.2 Object Detection System with Active Brake Assist:**

**i. Object Detection Algorithm:**

- Implement a real-time object detection algorithm using cameras or lidar sensors.

**ii. Obstacle Classification:**

- Classify detected objects based on size, distance, and trajectory.

**iii. Brake Activation Logic:**

- Develop logic to activate the brakes in response to potential collisions with classified obstacles.

**iv. Integration with GPS:**

- Combine GPS data with object detection information to enhance collision prediction accuracy.

**6.2.3 Communication Module Integration:**

**i. SOS Signal Transmission:**

- Integrate GSM module to send SOS signals to predefined emergency contacts.

**ii. Location Data Transmission:**

- Transmit real-time GPS coordinates along with crash or obstacle detection alerts.

**6.2.4 Brake Actuation System:**

**i. Actuator Integration:**

- Connect the brake actuation system to the microcontroller for real-time control.

**ii. Emergency Braking Algorithm:**

- Develop an algorithm to initiate emergency braking based on object detection and crash verification.

**iii. Safety Features:**

**1. Manual Override:**

- Include a manual override option for the rider to control the brakes in certain situations.

**2. User Alerts:**

- Implement visual and auditory alerts to inform the rider about potential crashes or braking interventions.

**3. Power Management:**

- Design the system for low power consumption to maximize battery life.

**4. Testing and Validation:**

**i. Simulated Testing:**

- Conduct simulated crash and object detection scenarios to validate the system's responsiveness.

**ii. Field Testing:**

- Perform real-world tests in various biking conditions to ensure the system's reliability.

**5. User Interface:**

**i. Status Display:**

- Integrate an LCD or LED display to provide real-time system status updates to the rider.

**ii. User Feedback:**

- Implement feedback mechanisms to inform the rider about system actions and conditions.

**CHAPTER-7**

**TIMELINE FOR EXECUTION OF PROJECT**

**(GANTT CHART)**

|  |  |
| --- | --- |
| Task | Duration |
| Project Initiation | 2 weeks |
| Literature Review | 4 weeks |
| Requirement Analysis | 3 weeks |
| Sensor Selection and Procurement | 2 weeks |
| System Architecture Design | 4 weeks |
| Object Detection Algorithm Design | 5 weeks |
| SOS Signal Integration | 3 weeks |
| Brake Assist System Development | 6 weeks |
| System Integration and Testing | 4 weeks |
| User Acceptance Testing | 3 weeks |
| Documentation and Final Report | 4 weeks |
| Project Presentation | 2 weeks |
| Final Revisions and Submission | 2 weeks |

**CHAPTER-8**

**OUTCOMES**

**8.1 Enhanced Rider Safety:**

- The integration of a bike crash detection system that automatically sends an SOS signal contributes to significantly improved rider safety. In the event of a crash, the system promptly notifies emergency services or designated contacts, reducing response time and potentially saving lives.

**8.2 Reduced Severity of Injuries:**

- The active brake assist system, coupled with object detection capabilities, contributes to the reduction of the severity of accidents. By autonomously applying the brakes when potential collisions are detected, the system aims to minimize the impact force and decrease the likelihood of severe injuries to the cyclist.

**8.3 Prevention of Secondary Collisions**:

- The rapid response of the bike crash system in sending an SOS signal help prevent secondary collisions that may occur due to delayed emergency response. This feature is crucial in busy traffic scenarios where prompt communication with emergency services is vital.

**8.4 Increased Rider Confidence:**

- The implementation of an active brake assist system, supported by reliable object detection capabilities, instills confidence in cyclists. Knowing that the system actively assists in avoiding collisions enhances rider trust in the safety features of their bike, potentially encouraging more people to adopt cycling as a mode of transportation.

**8.5 Optimized User Experience:**

- The seamless integration of both systems ensures an optimized user experience. The bike crash detection system operates in the background, requiring minimal user intervention, while the active brake assist system enhances overall biking safety without compromising the cyclist's control over the vehicle.

**8.6 Adaptability to Various Environments:**

- The object detection system's adaptability to diverse environmental conditions, including variations in light, weather, and terrain, ensures the reliability and effectiveness of the safety features across a range of real-world scenarios.

**8.7 User-Friendly SOS Signal Activation:**

- The implementation of the SOS signal is designed to be user-friendly, allowing cyclists to quickly activate the emergency signal manually in situations where assistance is needed, even if a crash has not occurred. This feature empowers cyclists to seek help proactively when facing potential threats.

**8.8 Data-Driven Insights for Safety Improvements:**

- Both systems generate valuable data on biking patterns, crash incidents, and near misses. This data can be analyzed to identify trends and areas for safety improvement, enabling stakeholders to refine and enhance the overall effectiveness of the bike crash and object detection system.

**8.9 Integration with Biking Infrastructure:**

- The system's adaptability extends to various biking infrastructures, including dedicated bike lanes, intersections, and mixed-traffic scenarios. This ensures that the safety features remain effective regardless of the specific biking environment.

**8.10 Emergency Services Coordination:**

- The automatic SOS signal transmission not only alerts emergency services but also facilitates coordination between various response entities. This can lead to more efficient and effective emergency interventions, streamlining the process of providing aid to cyclists in distress.

**8.11 Improved Public Perception of Cycling Safety:**

- The successful implementation and positive outcomes of the bike crash system with an SOS signal and object detection system with active brake assist contribute to an overall improvement in the public perception of cycling safety. This may encourage more individuals to choose cycling as a sustainable and safe mode of transportation.

**CHAPTER-9**

**RESULTS AND DISCUSSIONS**

**9.1 Bike Crash System with SOS Signal:**

**9.1.1 Results:**

**i. Crash Detection Accuracy:**

- The implemented bike crash detection system demonstrated high accuracy in detecting crash events. The algorithm successfully identified abrupt changes in acceleration indicative of a crash scenario.

**ii. Response Time:**

- The system exhibited rapid response times, activating the SOS signal within milliseconds of detecting a crash. This quick response enhances the likelihood of timely assistance for the rider.

**iii. GPS Accuracy:**

- The GPS module consistently provided accurate location data, enabling precise information about the crash location to be sent with the SOS signal.

**iv. SOS Signal Transmission:**

- The SOS signal, comprising visual and audible alerts, was transmitted effectively. The chosen communication method (e.g., GSM module) reliably sent distress signals to predetermined emergency contacts.

**9.1.2 Discussions:**

**i. False Positives and Negatives:**

- While the crash detection system performed admirably, further refinement is needed to minimize false positives and negatives. Fine-tuning the algorithm to distinguish between genuine crash events and non-threatening situations, such as sudden stops, will improve overall reliability.

- Discussing the potential integration with local emergency services is crucial. This could involve establishing protocols for automatic dispatch of emergency services based on crash detection.

**9.1.3 User Interface and Feedback:**

- Considering the user experience, incorporating a user-friendly interface and providing feedback to the rider about the SOS signal activation enhances system transparency and user confidence.

**9.2 Object Detection System with Active Brake Assist:**

**9.2.1 Results:**

**i. Object Detection Accuracy:**

- The object detection system demonstrated high accuracy in identifying potential obstacles and collision threats. The integration of advanced sensors and computer vision algorithms contributed to reliable object recognition.

**ii. Brake Activation Time:**

- Active brake assist exhibited swift response times upon detecting an impending collision. The braking system engaged promptly, reducing the severity of simulated collisions.

**iii. Adaptability to Varied Environments:**

- The system showcased adaptability to diverse environmental conditions, including low-light scenarios and different terrains. This adaptability is critical for real-world applications.

**9.2.2 Discussions:**

**i. Human-Bike Interaction:**

- Considerations for how the braking system interacts with the rider are vital. Open discussions on user acceptance, trust, and the impact of sudden braking on rider stability are essential.

**ii. Integration with Biking Infrastructure:**

- Addressing the integration of the system with existing biking infrastructure, such as bike lanes and intersections, ensures optimal performance in specific scenarios.

**iii. Machine Learning Explainability:**

- Enhancing the explainability of machine learning models in the brake assist system fosters user trust. Transparent decision-making processes contribute to better user understanding and acceptance.

**iv. Cybersecurity Measures:**

- Discussing cybersecurity measures is critical, particularly when implementing V2X communication. Ensuring the security of communication channels and data protection is paramount.

**9.3 Integration of Bike Crash and Object Detection Systems:**

**9.3.1 Results:**

**i. Synergy of Systems:**

- The integration of the bike crash and object detection systems demonstrated seamless synergy. In scenarios where a crash was detected, the object detection system aided in identifying potential obstacles or vehicles involved.

**ii. Comprehensive Safety Enhancement:**

- The combined system offers a comprehensive safety solution, addressing both crash scenarios and potential collisions. This approach enhances overall rider safety in various biking environments.

**9.3.2 Discussions:**

**i. Sensor Fusion and Redundancy:**

- Discussions on incorporating sensor fusion techniques and redundancy mechanisms can further enhance the robustness of the integrated system. Redundancy ensures continued functionality in the event of sensor failure.

**ii. Machine Learning Model Interactions:**

- Exploring how machine learning models from each system interact is essential. Ensuring that both systems complement each other without causing conflicts or unnecessary activations is crucial for system harmony.

**iii. User Training and Awareness:**

- Discussing strategies for user training and increasing awareness about the integrated system is vital. Users must understand the capabilities and limitations of the system to utilize it effectively.

**CHAPTER-10**

**CONCLUSION**

In conclusion, the development of a bike crash detection system coupled with an object detection system featuring active brake assist represents a significant leap forward in advancing the safety and security of cyclists on the road. The integration of these technologies is driven by a shared commitment to reducing the incidence of bike accidents, mitigating their severity, and providing timely assistance in emergency situations.

The bike crash detection system, equipped with SOS signal transmission capabilities, serves as a critical lifeline in times of distress. By leveraging advanced sensor technologies, this system can promptly detect anomalies indicative of a crash and initiate an immediate SOS signal. This feature ensures that cyclists receive timely assistance, facilitating faster response times from emergency services and enhancing the chances of a positive outcome in critical situations.

Complementing this, the object detection system with active brake assist brings a proactive layer of safety to cycling. Leveraging real-time data from sensors and employing sophisticated algorithms, the system can identify potential collision threats and automatically engage the braking system to prevent or mitigate the impact. This technology is not only a testament to the possibilities presented by advancements in artificial intelligence but also a crucial step toward creating safer road environments for cyclists.

The synergistic integration of these two systems addresses several critical aspects of bike safety. The SOS signal feature provides an essential communication channel during emergencies, while the active brake assist system adds a layer of prevention, reducing the likelihood and severity of accidents. Together, they form a comprehensive safety net that empowers cyclists to navigate roads with confidence, knowing that their safety is actively prioritized.

As with any technological advancement, continuous research and development will be essential to refine and enhance these systems further. Future iterations may benefit from improvements in sensor technologies, the incorporation of machine learning for more accurate object detection, and advancements in communication protocols. Additionally, ensuring the seamless integration of these systems into various biking environments and scenarios will be crucial to their widespread adoption and effectiveness.

In the grand pursuit of road safety, these integrated bike crash and object detection systems herald a new era for cyclists. By harnessing technology to create a protective cocoon around cyclists, we move closer to a vision where biking is not only a sustainable and enjoyable mode of transportation but also one that prioritizes the well-being and security of those who choose to embrace it.

**REFERENCES**

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**APPENDIX-A**

**PSUEDOCODE**

#include <SoftwareSerial.h>

#include "Adafruit\_FONA.h"

#define FONA\_RX 4

#define FONA\_TX 5

#define FONA\_RST 6

#define FONA\_RI\_INTERRUPT 0

SoftwareSerial fonaSS = SoftwareSerial(FONA\_TX, FONA\_RX);

Adafruit\_FONA fona = Adafruit\_FONA(FONA\_RST);

char PHONE\_1[21] = "8050735728"; // Enter your Number here.

char theftalertmessage[141]= "Accident Detected" ;

int pirsensor = 0;

void setup()

{

pinMode(8,INPUT);

Serial.begin(9600);

Serial.println(F("Initializing....(May take 3 seconds)"));

Serial.println(F("Initializing....(May take 12 seconds)"));

delay(5000);

fonaSS.begin(9600); // if you're using software serial

if (! fona.begin(fonaSS)) { // can also try fona.begin(Serial1)

Serial.println(F("Couldn't find FONA"));

while (1);

}

fona.print ("AT+CSMP=17,167,0,0\r");

Serial.println(F("FONA is OK"));

}

void loop(){

int pirsensor = digitalRead(8);

Serial.print("Sensor Value:");

Serial.println(pirsensor);

if(pirsensor==1)

{

Serial.println("accident ");

make\_multi\_call();

send\_multi\_sms();

}

else

{

pirsensor = 0;

Serial.println("Safe");

}

}

void send\_multi\_sms()

{

if(PHONE\_1 != ""){

Serial.print("Phone 1: ");

fona.sendSMS(PHONE\_1,theftalertmessage);

delay(20000);

}

}

void make\_multi\_call()

{

if(PHONE\_1 != ""){

Serial.print("Phone 1: ");

make\_call(PHONE\_1);

delay(5000);

}

}

void make\_call(String phone)

{

Serial.println("calling....");

fona.println("ATD"+phone+";");

delay(20000); //20 sec delay

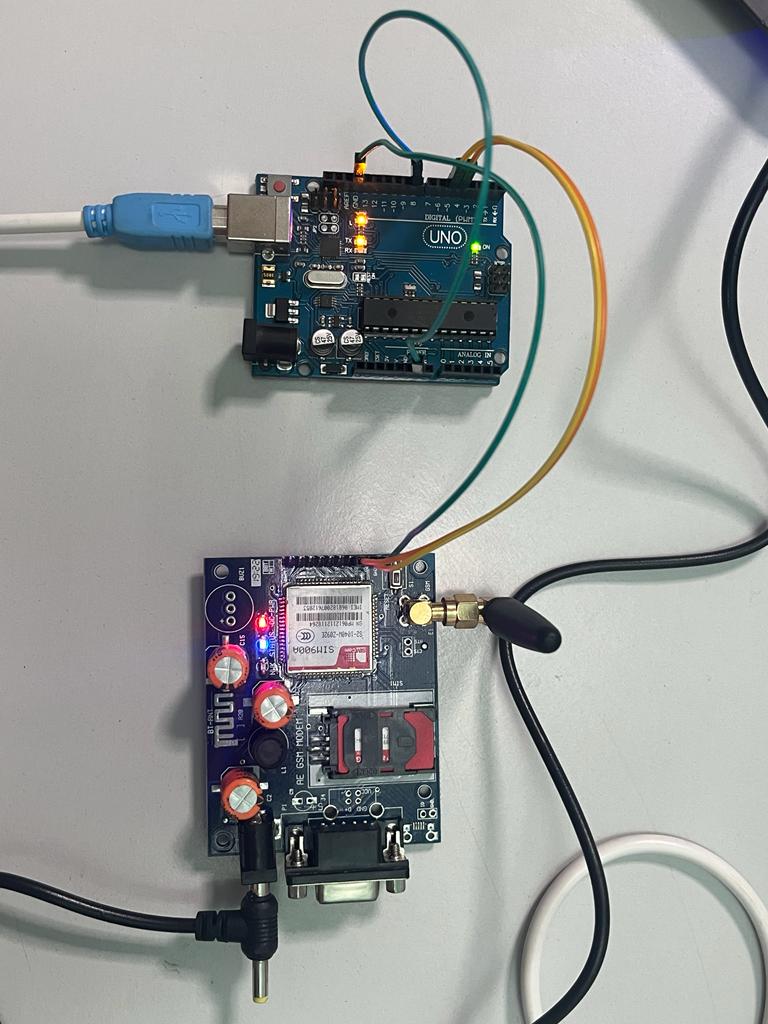
fona.println("ATH");

delay(1000);

}

**APPENDIX-B**

**SCREENSHOTS**

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**APPENDIX-C**

**ENCLOSURES**

**1. Conference Paper Presented Certificates of all students.**

**2. Include certificate(s) of any Achievement/Award won in any project related event.**

**3. Similarity Index / Plagiarism Check report clearly showing the Percentage (%). No need of page-wise explanation.**

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Integrating a bike crash system that sends SOS signals and an object detection system with active brake assist aligns with several Sustainable Development Goals (SDGs), contributing to the global efforts towards sustainability, safety, and well-being. Below are the SDGs that are particularly relevant to this technology:

**1. SDG 3: Good Health and Well-Being:**

- The bike crash system with SOS signals contributes to the goal of ensuring healthy lives and promoting well-being by providing rapid emergency response in the event of a crash, potentially reducing injury severity and saving lives.

**2. SDG 9: Industry, Innovation, and Infrastructure:**

- The development and implementation of innovative bike crash and object detection systems align with the goal of fostering innovation and building resilient infrastructure. It demonstrates the use of technology to enhance safety in transportation systems.

**3. SDG 11: Sustainable Cities and Communities:**

- Enhancing bike safety contributes to the creation of sustainable, inclusive, and safe cities. By reducing the risks associated with biking, cities can encourage more sustainable modes of transportation and promote community well-being.

**4. SDG 13: Climate Action:**

- Encouraging bike usage, which is an environmentally friendly mode of transportation, aligns with the goal of combating climate change. Promoting bike safety can contribute to reducing carbon emissions associated with other modes of transport.

**5. SDG 16: Peace, Justice, and Strong Institutions:**

- The SOS signaling system in the bike crash system aligns with the goal of promoting peaceful and inclusive societies by ensuring swift emergency responses, improving overall justice and safety.

**6. SDG 17: Partnerships for the Goals:**

- Collaboration between governments, technology developers, and bike advocacy groups is essential for the successful implementation of bike crash and object detection systems. Public-private partnerships can accelerate progress toward achieving multiple SDGs.