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Department of Mechanical Engineering

Project Review - I Synopsis

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Title of the Project:	**IOT based wobbling motion detector for motorcycle, light and heavy duty vehicle**
Project Category:	**Engineering Design**

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Title: IOT based wobbling motion detector for motorcycle, light and heavy-duty vehicle

1.Introduction:

In an era marked by continuous advancements in transportation and mobility, the paramount concern for vehicle safety remains undiminished. Safety on the roads, highways, and byways is not merely a matter of paramount importance; it is a moral and legal imperative. Recognizing the urgency of enhancing the safety of both light and heavy-weight vehicles, we introduce a groundbreaking solution that combines the power of the Internet of Things (IoT), real-time data analysis, and proactive maintenance measures. The result is the "IoT-Based Wobbling Motion Detector for Vehicle Safety."

The core objective of this project is to address one of the critical yet often underestimated factors contributing to vehicle accidents and efficiency-related issues: wheel wobbling. The phenomenon of wheel wobbling, whether due to misalignment, wear and tear, or external factors, can undermine the safety of vehicle occupants, result in inefficient operation, and impose financial burdens through increased maintenance and repair costs. To tackle these challenges head-on, we have designed a robust system that leverages cutting-edge technologies, including ultrasonic sensors, the ESP8266 microcontroller, cloud-based data analysis, and customizable alert mechanisms.

This project is rooted in a methodology that encompasses meticulous sensor installation, precise ESP8266 programming, secure data transmission to the cloud, real-time data analysis through cloud-based platforms, and instant alarm triggering when wobbling is detected. Rigorous testing, calibration, and a well-structured maintenance plan ensure the reliability and long-term effectiveness of the system.

Our innovative solution extends beyond immediate safety enhancements. It also contributes to vehicle efficiency, cost savings, and real-time monitoring. By providing vehicle operators with real-time data insights, including the angle of wobbling, we empower them to take prompt action when necessary, thereby reducing the risk of accidents, enhancing vehicle maintenance, and improving fuel consumption. Additionally, the IoT aspect of the system allows for remote monitoring and data logging, making proactive maintenance a reality.

This project seeks to usher in a new era of vehicle safety and efficiency, where advanced technology meets the road to protect lives and investments. While the system's installation on new vehicles may be straightforward, retrofitting older vehicles presents a unique challenge that requires skilled installation. It is important to acknowledge that environmental factors, such as road quality and vibrations, may trigger false alarms, necessitating careful calibration. Moreover, the system relies on a power source, which implies the need for vigilant monitoring to prevent vehicle batteries from draining excessively. Inevitably, the system itself requires periodic maintenance to ensure its continued functionality.

The "IoT-Based Wobbling Motion Detector for Vehicle Safety" project not only aims to enhance the safety and efficiency of vehicles but also emphasizes the importance of user education. By educating vehicle operators on the significance of real-time data and the need for prompt action when wobbling is detected, we empower them to be active participants in the quest for safer roads.

In alignment with our broader objectives, we also consider the analysis of collected data to identify patterns and trends in wobbling motion, which can further refine vehicle maintenance and safety practices. We believe in the importance of thorough documentation, which includes installation instructions, maintenance procedures, and the Python analysis script, to ensure that our project can serve as a comprehensive reference for future users and maintainers.

The "IoT-Based Wobbling Motion Detector for Vehicle Safety" project embodies a commitment to safety, efficiency, and innovation. It introduces a multifaceted solution that capitalizes on state-of-the-art technology to address a critical challenge. By combining ultrasonic sensors, the ESP8266, and cloud-based data analysis, we offer a dynamic system that can revolutionize vehicle safety and maintenance practices. In the pages that follow, we delve into the project's intricacies, presenting a detailed overview of the methodology, expected outcomes, relevance, and present theories and practices in the field. Our commitment to excellence and innovation shines through as we share the blueprint for a safer and more efficient journey ahead.

2. Relevance of the project

In an era marked by continuous advancements in transportation, our project, the "IoT-Based Wobbling Motion Detector for Vehicle Safety," emerges as a compelling and highly relevant solution to enhance safety and efficiency across the spectrum of vehicular operations. This project directly addresses the following key areas of relevance:

2.1. Road Safety Enhancement:

- The project is fundamentally relevant in its commitment to mitigating a pervasive road safety concern: wheel wobbling. By offering real-time detection and alert mechanisms, our system empowers vehicle operators to proactively address this issue, thereby reducing the risk of road accidents.

2.2. Preventive Maintenance for Vehicle Efficiency:

- Beyond safety, the project significantly contributes to improving the efficiency and longevity of vehicles. Wheel wobbling, if left unaddressed, can lead to inefficient operation and increased fuel consumption. By detecting and addressing wobbling, our system supports cost-effective and environmentally responsible vehicle maintenance.

2.3. Cost Savings and Economic Impact:

- The project's relevance extends to economic factors, as it can yield substantial cost savings. By preventing damage caused by prolonged wobbling motion, vehicle owners and fleet operators can reduce maintenance and repair expenses, thereby enhancing their financial sustainability and competitiveness.

2.4. Real-Time Monitoring and Data Analysis:

- The project is highly relevant in the context of modern vehicle operation, which increasingly relies on real-time data monitoring and analysis. By providing continuous data on wheel conditions, our system aligns with the industry's growing demand for actionable insights and data-driven decision-making.

2.5. IoT Integration for Remote Monitoring:

- The integration of IoT capabilities extends the project's relevance by enabling remote monitoring and data logging. This aspect is particularly valuable for fleet management and remote diagnostics, further enhancing the efficiency and safety of vehicles.

2.6. Alignment with Vehicle Engineering and Autonomous Vehicles:

- As a project within the domain of vehicle engineering, our work encapsulates the technical and engineering facets of vehicle safety and performance enhancement. Moreover, our implementation in autonomous vehicles underlines its relevance to the cutting-edge field of autonomous transportation and the enhancement of decision-making and safety in autonomous vehicles.

In summary, the "IoT-Based Wobbling Motion Detector for Vehicle Safety" project offers a comprehensive and relevant solution to critical challenges within the automotive industry. Its impact spans safety, efficiency, cost savings, and data-driven decision-making, positioning it as a highly pertinent endeavor with far-reaching implications for the modern transportation landscape.

3.Literature Survey:

Grynal D'Mello et al (Dec 2021): The author presents a novel approach to wheel alignment monitoring systems that typically rely on complex computer vision technologies, expensive high-end cameras, precise objects, and significant computational resources, often requiring experienced operators. In an effort to improve accessibility, the study introduces an easy-to-use, cost-effective solution using an MPU6050 sensor and an ESP32 microcontroller, complemented by a customized graphical user interface (GUI). Testing this IoT-based wheel alignment system on a vehicle yielded results comparable to traditional methods, indicating its practicality and potential as a viable alternative in the field of wheel alignment inspection.

Huibo Wu, China et al (Sep 2020): The author presents an early loosening warning system comprising two modules: the tire monitoring module and the working control module. The tire monitoring module, installed on the tire and designed without its power supply, communicates wirelessly with the control module, located in the vehicle body, via radio frequency. During driving, if a tire becomes loose, the monitoring device sends an automatic wireless alarm signal. Upon receiving the alarm, the driver can promptly initiate emergency measures such as parking and inspection, thereby averting potential traffic accidents resulting from loose tires.

Shiva Paudel et al (July 2020): This paper introduces a straightforward approach for identifying camber and toe in/out errors using a disturbance observer (DOB) without the need for extra sensors or mechanisms. The proposed method is validated through practical application on a differential drive mobile robot, where the robot is commanded to follow a predefined path, and the torque profile is analyzed to determine wheel misalignment. This innovative approach offers potential benefits for electric vehicle alignment assessment without the need for additional hardware.

Riton Kumer Das (Dec 2018): This study focuses on the experimental investigation of wheel alignment systems for light vehicles. Various wheel alignment adjustment techniques are applied in real-time to enhance vehicle performance. The paper introduces a computerized and computer vision-based system for measuring automobile wheel alignment. The experimental analysis indicates that vehicle wheel alignment tends to become misaligned in the range of 4000 km to 5000 km of running. The findings underscore the importance of regular wheel alignment checks using advanced technologies, which substantially extend tire life, enhance tire safety, and improve vehicle handling satisfaction.

Nira Dynamics AB et al (Aug 2016): Their invention utilizes a wheel speed signal for the detection of wheel anomalies, including loose wheels or wheels with zero pressure. It achieves this by generating a first and second detection signal based on the wheel speed signal, in conjunction with a first and second reference signal, respectively. The detection of anomalies such as loose wheels is triggered when at least one of the detection signals surpasses a predefined threshold. This disclosure encompasses methods, systems, and computer program products designed to achieve this objective, providing an innovative approach to wheel anomaly detection.

Brian David Hayes et al (March 2006): The author introduces a loose wheel detection assembly featuring a sensor securely mounted to the hub, which identifies movement between the wheel and hub. A controller processes the data and triggers an in-cabin warning system, bolstering vehicle safety by promptly alerting the operator to potential loose wheel issues.

4.Present Theory and Practices:

In the domain of vehicle safety and maintenance, current theories and practices predominantly focus on conventional methods for monitoring and ensuring optimal vehicle performance. Existing approaches include routine inspections, manual diagnostics, and scheduled maintenance procedures, which play a pivotal role in vehicle upkeep. However, these methods encounter limitations when addressing critical concerns such as wheel wobbling, a phenomenon that, if not detected and addressed promptly, can compromise vehicle safety and efficiency.

4.1. Current Practices in Vehicle Safety:

- Present theories and practices are centered around the physical inspection of vehicles, encompassing visual inspections, periodic servicing, and routine maintenance checklists.
- Vehicle operators and mechanics traditionally rely on visual and manual assessments to identify potential issues or signs of wear and tear, including wheel-related problems.

4.2. Limitations in Detecting Wheel Wobbling:

- One significant limitation of current practices lies in their inability to provide real-time insights into wheel wobbling. Routine inspections often miss subtle or intermittent wobbling issues that can develop during vehicle operation.
- In many cases, wheel wobbling may only become apparent once it reaches a critical stage, potentially leading to accidents, damages, and increased maintenance costs.

4.3. Emerging Trend in Data-Driven Solutions:

- An emerging trend in the automotive industry is the adoption of data-driven solutions to enhance vehicle safety and performance. The integration of sensors and real-time data analysis has shown promise in revolutionizing maintenance and monitoring practices.
- Data-driven solutions offer the potential for early detection of issues, predictive maintenance, and remote monitoring, aligning with the growing demand for efficiency, cost savings, and enhanced safety.

4.4. Present Relevance and Innovation:

- The project, "IoT-Based Wobbling Motion Detector for Vehicle Safety," is situated at the intersection of these trends and limitations, introducing a groundbreaking approach to wheel wobbling detection and prevention.
- By leveraging IoT technology, ultrasonic sensors, and real-time data analysis, the project represents a significant advancement in the realm of vehicle safety and maintenance practices, offering a solution that can provide real-time detection and alerts, ultimately improving safety and efficiency.

4.5. Expected Contributions:

- This project aims to address the limitations of current practices by introducing a pioneering solution that bridges the gap between traditional inspections and real-time data-driven analysis. The project is expected to contribute significantly to vehicle safety and efficiency.
- Its innovations, including the utilization of IoT technology and data analysis, offer the potential to redefine standard practices in the automotive industry, enhancing safety and optimizing maintenance routines for both manual and autonomous vehicles.

In summary, the project capitalizes on the current state of theories and practices in the automotive industry, embracing data-driven trends and addressing existing limitations to introduce an innovative and relevant solution that holds the promise of revolutionizing vehicle safety and maintenance practices.

5.Proposed work:

The proposed work for the "IoT-Based Wobbling Motion Detector for Vehicle Safety" project encompasses a structured plan to accomplish the project's key objectives and deliverables. It is organized into a series of well-defined tasks and milestones:

5.1. Sensor Installation and Data Collection:

- Objective: Securely install an ultrasonic sensor on the vehicle's swingarm to measure the perpendicular distance between the wheel rim and the swingarm. Initiate data collection.
- Method: Employ precise engineering techniques for sensor placement to ensure accurate data collection.

5.2. ESP8266 Programming for Real-time Analysis:

- Objective: Program the ESP8266 microcontroller to read sensor data, calculate the wobble angle, and trigger alarms in real-time when necessary. Ensure seamless data flow from the sensor to the ESP8266 for further processing.
- Method: Develop custom firmware for the ESP8266, enabling data processing and real-time wobble angle calculations. Implement an alert mechanism for immediate feedback to vehicle operators.

5.3. Cloud Integration for Data Transmission:

- Objective: Establish a secure connection between the ESP8266 and a cloud-based platform to enable real-time data transmission. Implement communication protocols to ensure the reliable delivery of data to the cloud.
- Method: Implement IoT data transmission protocols, such as MQTT or HTTP, to securely and efficiently connect the ESP8266 with cloud-based storage and analysis services.

5.4. Cloud-Based Data Analysis and Alerts:

- Objective: Develop cloud-based data analysis scripts and algorithms to receive, process, and analyze real-time data, including wobble angle calculations. Configure the cloud platform to trigger alarms and notifications when wobbling exceeds predefined thresholds.

- Method: Utilize cloud services and platforms for data analysis, leveraging Python, Node.js, or cloud-specific tools to perform real-time data processing and alert generation.

5.5. Rigorous Testing and Calibration:

- Objective: Conduct extensive field tests under varied road conditions to validate the system's performance. Fine-tune system parameters within the ESP8266 and cloud-based data analysis to minimize false alarms and optimize detection accuracy.
- Method: Carry out controlled tests, adjusting the system's thresholds and parameters to ensure accurate wobble detection while minimizing false alarms.

5.6. User Education and Training:

- Objective: Develop user-friendly educational materials to educate vehicle operators on the significance of real-time data, wobble angle calculations, and alarm indications. Conduct training sessions to ensure that users effectively utilize the system.
- Method: Create user manuals, training videos, and on-site training sessions to facilitate user understanding and system adoption.

5.7. Maintenance Plan Development:

- Objective: Create a comprehensive maintenance schedule that outlines routine tasks and schedules for maintaining the ESP8266, sensors, and cloud infrastructure. Ensure the long-term reliability and accuracy of the system.
- Method: Define maintenance tasks, intervals, and responsibilities to keep the system in optimal working condition.

5.8. Data Analysis and Insights:

- Objective: Analyze collected data in the cloud to identify patterns and trends in wobbling motion. Extract actionable insights for proactive maintenance and safety improvements.
- Method: Use cloud-based analytics tools and techniques to extract valuable insights from historical data, enhancing vehicle safety and maintenance practices.

5.9. Documentation:

- Objective: Produce detailed project documentation that includes installation instructions, maintenance procedures, and the cloud-based data analysis scripts.
- Method: Create comprehensive documentation to serve as a reference for future users and maintainers of the system, encompassing both hardware and cloud-based components.

The proposed work section delineates a systematic and integrated approach, harnessing the power of IoT, sensor data, cloud-based analysis, and real-time alerts to enhance vehicle safety and maintenance. This well-structured plan ensures that the project's core objectives are met effectively and efficiently.

6. Experimental Setup:

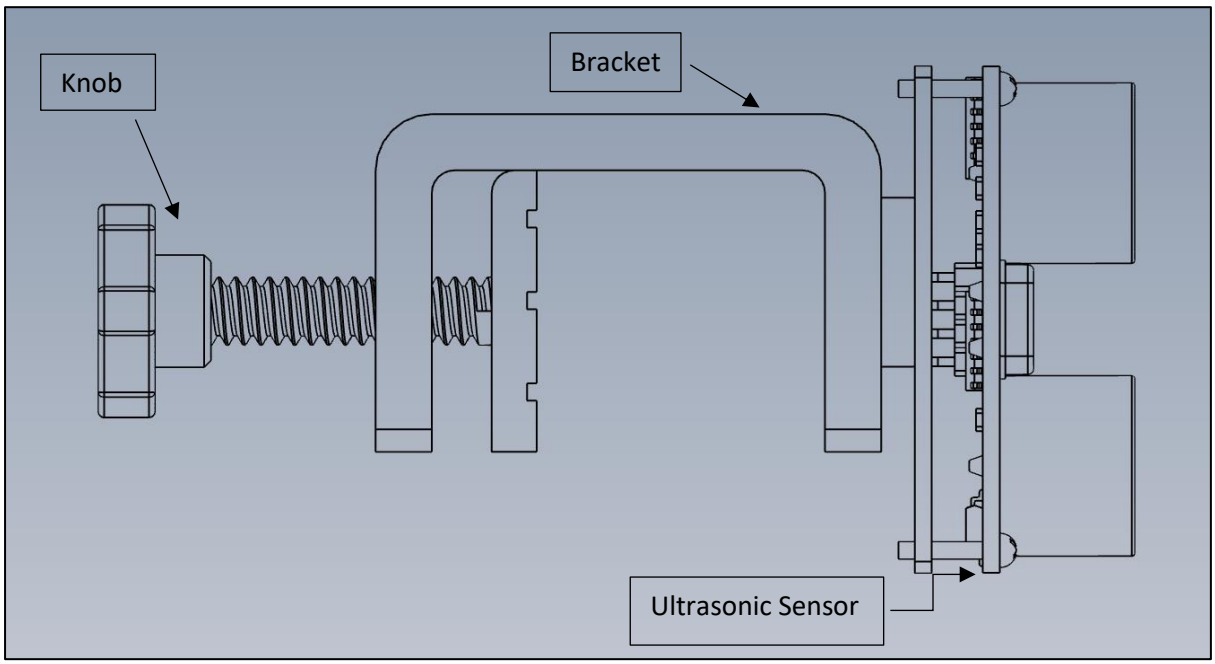

Fig : 2D diagram of model

7. References:

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