**SSN COLLEGE OF ENGINEERING**

**KALAVAKKAM-603110**

**INTERNALLY FUNDED STUDENT PROJECT (IFSP-2024)**

**Development of Speed Control System for On-road Vehicles using STM32 Microcontroller.**

Name, Year and Department of the Project Students

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**Budget: Twenty thousand (₹ 20000)**

**Project Duration: 12 months**

Signature of the Project Students Signature of the Project Guide(s)

Signature of the HOD

**1. Project Title:** Development ofSpeed Control System for On-road Vehicles using STM32 Microcontroller.

**2. Broad Subject:** Embedded Systems

**3. Project Duration**: 12 months

**4. Budget**: Twenty thousand (₹20000)

**5. Project Summary:**

This project is centered around the development of a robust speed control system that harnesses the power of embedded systems. The primary goal is to create a system that can actively and continuously monitor various parameters and ensures the well-being and efficiency of the vehicle as well as the safety of the driver by controlling vehicle speed in real-time.

As the demand for transportation increases, it is vital that safety systems are put into place in vehicles to ensure the well-being of the driver as well as the people in the surroundings. In this case, a mechanism that would control the speed of the vehicle and send the required alert becomes essential. This project aims to integrate various already-existing safety systems into one, and make an effective speed control and alert system that utilises sensors to collect data and adjusts the speed in accordance with the appropriate algorithm provide to it.

Various studies have investigated the effectiveness of these systems and have proposed different methodologies for developing the same. Though a host of issues have been addressed, still there needs to be enough literature around how the firmware side of speed controller can be developed and tested at test benches before integration into a real vehicle for manufacturability.

**6. Keywords:** Embedded systems, electric vehicles, speed control

**7. Objectives:**

* **Proximity detection:** Detects proximity of vehicle/obstacle ahead using IR sensor and determine course of action on a case-by-case basis.

* **Driver fatigue detection:** Detects driver’s fatigue using IR glasses and provides warning through buzzer for the 1st time and reduces speed on 2nd time.

* **Motor temperature and current:** Senses motor current and prevents overheating/high current flow by suitable speed adjustment.
* **Tire pressure:** Simulate Tire pressure by supplying linearly proportional voltage through potentiometer. If tire pressure exceeds the acceptable threshold, speed is reduced by a certain percentage.

**8. Introduction:**

With the advancements in automative technology and the significant increase in the number of vehicles on the road, the use to of new technologies in the prevention of accidents and collision has becomes an important concern in the automative industry. Speed control is one such safety measure that play a vital role in mitigating these risks. This project aims to develop an embedded system that senses and adapts to external conditions, thereby controlling the speed. This would lead to a substantial decrease in human error, providing an additional layer of safety independent of the driver’s actions.

By monitoring parameters such as proximity, motor speed and temperature, and tire pressure, the system alerts the driver as well as adapts the speed accordingly to prevent collisions. This system also detects driver fatigue by monitoring the eye movements of the driver. This could go a long way in preventing accidents on highways that occur due to exhaustion and sleep deprivation of commercial drivers at high speeds. The model that this project presents can be further extended to Electric Vehicles (EVs) as well, allowing it to develop in accordance with the advancements in the automotive industry while also being sensitive to environmental concerns.

**9. Definition of the Problem:**

The primary focus of this project is to design a system that would enable control of speed at different level for an on-road vehicle. The parameters taken into consideration while designing this model are proximity of the vehicle from obstacles as well as other moving vehicles, motor temperature and current, tire pressure and driver fatigue which detected by tracking the eye movements of the driver. Based on these conditions, the system suitably adjusts the speed according to the algorithm provided to it when programming the STM32 microcontroller. In necessary cases, it will also send an alert to the driver. Though safety systems are already used in manufacture of automobiles, this project attempts to bring together multiple separate systems into a single one, while also introducing some new features. The model presented by this project can be extended to new-age EVs as well.

**10. Review of status of Research and Development in the subject:**

At both a national and international level, several research papers have been published on the topics of cruise control, proximity detection and assistance, and speed control. Many of these models use sensors and GPS tracking systems to collect real-time data. Some of the papers regarding the same are listed below.

**10.1 National Status:**

* **“**Design and Implementation of an Embedded System for Intelligent Vehicle Control"

Authors: M. Vijayalakshmi, A. S. Harish, and P. Santhakumar

Publication: *International Journal of Advanced Research in Computer and Communication Engineering*, 2013

Summary: This paper presents the design and implementation of an embedded system aimed at intelligent vehicle control. It includes speed control mechanisms that utilize various sensors and microcontrollers to monitor and adjust vehicle speed, contributing to accident prevention.

* "Development of an Embedded System for Vehicular Speed Control Using GPS and GSM"

Authors: R. Chavan, N. Wankhade, and S. Chavan

Publication: *International Journal of Computer Applications*, 2015

Summary: This research paper discusses the development of an embedded system that uses GPS and GSM technologies to control vehicle speed based on location-specific speed limits. The system aims to prevent accidents by enforcing speed limits in designated areas.

**10.2 International Status:**

"Model Predictive Control for Adaptive Cruise Control with Guaranteed System Stability"

Authors: J. Zheng, S. Liu, and L. Wang.

Publication: *IEEE Transactions on Control Systems Technology*, 25(4), 1403-1410.

Summary: This paper presents a model predictive control (MPC) approach to adaptive cruise control (ACC), focusing on maintaining safe distances between vehicles while ensuring system stability under varying driving conditions. The research highlights the use of predictive models to optimize speed control.

**11. Novelty importance of the proposed project in the context of current status**

**Current Status:**

1. **Traditional Speed Control Systems:** Most vehicles today rely on conventional speed control systems, such as cruise control, which maintain a constant speed set by the driver. These systems typically use basic inputs like throttle position and vehicle speed.
2. **Basic Speed Limiting Systems:** Some vehicles are equipped with basic speed limiting systems that prevent the vehicle from exceeding a pre-set maximum speed. These systems are often manually controlled by the driver and do not adjust dynamically to changing conditions or inputs beyond the set limit.
3. **Eco-Driving Systems:** Some modern vehicles incorporate eco-driving features that provide feedback to the driver on how to drive more efficiently. These systems may suggest optimal speeds and driving behaviours to minimize fuel consumption and emissions, but they generally do not directly control the vehicle’s speed.
4. **Regulatory Environment:** The regulatory landscape is also evolving, with new safety standards and guidelines being introduced for speed control and autonomous driving systems. This creates both opportunities and constraints for innovation in vehicle speed management technologies.

**Novelty of the Proposed Project:**

1. **Integration of Multiple Parameters:** The proposed project aims to develop a speed control system that goes beyond the traditional methods by integrating a wider array of parameters. This could include proximity detection, driver fatigue detection, tire pressure and motor temperature and current. The combination of these factors can provide a more responsive and adaptive speed control system.
2. **Real-Time Decision Making:** Unlike existing systems that rely heavily on predefined algorithms or limited input data, this project may introduce a system capable of real-time, dynamic decision-making using sensors that can continuously adapt to changing conditions, ensuring optimal speed control.

**Importance of the Proposed Project:**

1. **Safety Enhancements:** As road safety remains a critical issue globally, any advancement in speed control technology that can reduce accidents and improve driver response times is of significant value. This project could contribute to lowering accident rates by providing more nuanced and responsive speed control.
2. **Contribution to Autonomous Vehicle Development:** The project could also play a role in the broader field of autonomous vehicle development. By pushing the boundaries of how vehicles interpret and respond to various driving parameters, it may offer insights or technologies that can be applied in self-driving cars.
3. **Commercial and Consumer Benefits:** Finally, the project has the potential to offer both commercial benefits (e.g., more advanced vehicle features) and consumer benefits (e.g., increased driving comfort and safety), making it a valuable addition to the automotive industry.

**12. Patent details** *(domestic and international),* if applicable

**13. Work plan and Detailed technical information**

**13.1 Methodology:**

This project utilizes embedded systems to control various parameters. The STM32 Microcontroller is used here due to its versatile capabilities and high configurability. It is configured to read the input of the sensors which monitor the required parameters. The parameters that entail to be monitored are proximity of obstacles and other moving vehicles, motor temperature and current, tire pressure and driver fatigue.

The tire pressure has a high impact on the tire-road contact as it influences the characteristics of the tire forces, thereby regulating the speed and hence is a vital one to be monitored. Driver fatigue detection system alerts the driver depending on the severity of the drowsiness symptoms and sends the required alert while controlling the speed. Proximity is checked using IR sensors to prevent collisions due to obstacles and other vehicles with a gradual lowering of speed, while the motor current is monitored as well to adjust the speed accordingly.

The input of these sensors is fed to the STM32 which, by means of Embedded C firmware and appropriate speed control logic, generates a suitable adjustment in the speed of the BLDC motor used to simulate the motor of the car. The speed control logic which depends on the PWM value, varies depending on the severity and chances of impact. Hence, the output of the STM32 is given to the motor to observe these changes in speed.

Each of the individual parameters are read using appropriate sensors like IR sensors for proximity and eye-tracking whereas tire pressure is simulated by proportional changes in voltage by an apt software. These conditions are only simulated since testing any on-road prototypes may be perilous. Hence, this method of parameterization and simulation by employing a subsystem is the approach that will be followed through the course of this project.

**A diagram of a computer system

Description automatically generated**

**14. Time schedule of activities giving milestones**

**14.1 Time Schedule of Activities through BAR Diagram**

**15. Deliverables:**

* Real-time monitoring and control of vehicle parameters.
* Semi-automatic speed adjustment.
* Additional security using alert system.
* Extended applications to EVs

**16. Target beneficiaries of the proposed work:**

1. **Automobile Companies:** Car manufacturers can integrate this advanced speed control system into their vehicles, offering a competitive edge by improving safety, efficiency, and driving comfort.
2. **Individual Consumers:** Everyday drivers will benefit from increased safety, reduced risk of accidents, and potentially lower fuel costs through more efficient driving patterns.
3. **Commercial Drivers:** Truck and bus drivers can experience reduced stress and fatigue with systems that adapt to driving conditions, leading to safer and more comfortable driving experiences.
4. **Suppliers**: Companies that provide components or systems to vehicle manufacturers (e.g., Bosch, Continental, Denso) can benefit by developing and supplying the hardware and software for this speed control system.
5. **Universities and Research Labs:** These institutions can use the outcomes of this project to further research in automotive technologies, AI, and environmental studies. It can also serve as a case study or a foundation for developing more advanced systems.

**17. Suggested plan of action for utilization of research outcome expected from the project**

**17.1 As journal publication**

**17.2 Patent filing**

**17.3 Project preparation for submission to external funding**

**18. References:**

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**19. List of facilities and Equipments available with Department for the project**

**20. Budget Estimates:**

* STM32 microcontroller: ₹4000
* BLDC motor 500 W, 24 V: ₹6000
* Inverter with driver: ₹5000
* Sensors: ₹2000
* Miscellaneous: ₹3000
* **Total:   ₹20,000**

**21. Budget Justification:**

The budget has been allocated to cover expenses related to research materials, equipment, personnel, and other necessary expenses. The justification for major equipment and specific budget items is as follows:

* Hardware expenses, including the purchase of the microcontroller and all required sensors amount to around ₹6000 (STM and sensors).
* Cost of the motor used to simulate the car motor is around ₹11000
* There are no software expenses applicable as of now for this project. Hence, it is omitted.
* Miscellaneous expenses such as the purchase of basic circuit material vital to testing the project are allocated ₹3000.