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Improving Driver Assistance with Automatic Traffic Sign Detection and Real-Time Alerts

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ABSTRACT

Traffic sign recognition is essential for efficient transportation systems on highways and urban roads. This paper presents an overview of traffic sign detection and recognition methodologies, focusing on designing a system that can automatically detect road signs and display relevant information on the vehicle's dashboard. The system utilizes a signal transmitter for each roadside unit, facilitating real-time communication between vehicles and the roadside infrastructure via Vehicular Ad-Hoc Networks (VANETs). The proposed method addresses common challenges such as low visibility during adverse weather conditions and dense traffic. The results indicate improved road safety through timely alerts and enhanced driver awareness.

Keywords:- In-Car System, Microcontroller, RF, VANET, Transmitter, Receiver, Traffic Sign Recognition

1. INTRODUCTION

In today's rapidly evolving world, advancements in the automotive industry are essential for enhancing road safety. However, drivers often face difficulties in recognizing traffic signs due to distractions, weather conditions, or obstructed views. The primary goal of this research is to develop an intelligent system that automatically detects road signs and provides real-time alerts to drivers via dashboard displays. The system uses wireless communication to transmit sign information from roadside units to vehicles, leveraging Vehicular Ad-Hoc Networks (VANETs) to facilitate this exchange. This approach aims to minimize traffic rule violations and improve road safety, particularly under challenging circumstances.

Furthermore, with the increase in vehicle density and complex traffic conditions, existing systems struggle to ensure comprehensive detection accuracy. By integrating radio frequency (RF) communication and microcontroller-based processing, this system offers a reliable solution that operates effectively across diverse environments, including urban areas and highways. The development of such a system is crucial for addressing gaps in current intelligent transportation technologies and promoting safer driving practices.

2. LITERATURE REVIEWS

Conference Design and Implementation of Traffic Information Sharing Through Road Side Unit [1] by N-Patne, M Madankar IRF Int. In this study shows that RSUs can greatly improve traffic information exchange and management when used properly, leading to better traffic flow, increased safety, and environmental advantages. The authors recommend expanding the system's coverage

and integrating it with upcoming smart city infrastructure.

A Tight Integration Approach In this study order to improve localization accuracy in VANETs and enable the development of dependable intelligent transportation and autonomous vehicle systems, the study emphasizes that tight integration of GNSS and V2V-based relative positioning is an efficient option [2].

Interpretation A Real-Time Histographic Approach to Road Sign Recognition[3] The study highlights that histogram-based feature extraction offers a practical and efficient alternative to computationally intensive methods for real-time road sign recognition, supporting advanced driver assistance systems (ADAS) and smart vehicle applications.

Vehicular applications such as location-based services (LBSs), intelligent transportation systems (ITSs), and navigation heavily rely on real-time position information, often facilitated by Global Navigation Satellite Systems (GNSSs) like the Global Positioning System (GPS) . Early sign detection methods mainly focused on tracking, detection, and classification tasks, utilizing techniques like color and shape detection. The Hough Transform was one of the common approaches employed [4]. However, the limitations of these techniques, such as high computational costs and memory demands, made them unsuitable for real-time implementation in dynamic environments. Techniques like those presented by Loy and Barnes introduced the fast radial transform to detect road signs of various shapes, such as triangular and octagonal signs, more efficiently.

Color information has been a key factor in road sign detection, although approaches based on RGB color space have limitations due to sensitivity to illumination changes. To address this, researchers have explored alternative color spaces like CIELab, YCbCr, and HSI [5][6]. Despite these improvements, challenges remain, especially in scenarios involving varying outdoor lighting and complex urban environments.

Kalman filters and particle filters have been used in tracking processes to reduce recognition errors. However, these methods are limited by factors such as ego-motion, which can affect the tracking performance [7][8][9]. The Lucas-Kanade algorithm, an intensity-based differential technique, is another common approach for aligning image sets in tracking applications. Despite recent advancements, there are still significant limitations in existing road sign detection systems that need to be addressed.

In this paper, we propose using a wireless setup for communication to detect symbols on roadside boards, leveraging Radio Frequency Identification (RFID) technology to enable real-time detection and information sharing with in-car systems. This approach not only enhances road safety but also addresses limitations in existing sign detection methodologies [10][11].

3. METHODOLOGY

Under the current system, it is impractical for drivers to consistently monitor the messages displayed on roadside boards. Additionally, incorporating every symbol and message board into a Google map and keeping it updated is not feasible. The proposed system consists of a microcontroller, an LCD display, a transmitter,

and a receiver, as illustrated in the diagram below. For instance, a driver may struggle to see various roadside symbols, such as U-turns, railroad crossings, and nearby restaurants, especially during inclement weather, nighttime, or rainy conditions. To address these limitations, we propose a system designed to enhance driving safety by improving driver awareness of their surroundings.

4. SYSTEM DESIGN

The system requires the design of transmitter and receiver (Tx/Rx) modules. A reprogrammable circuit creates the transmitter module, which sends out coded messages representing different road signs. Each transmitter will have dual power source options: solar power and battery power. This design allows for wireless frequency matching and device identification through channel and device ID settings. The receiver module is set to a predetermined channel to read the frequencies and retrieve the data broadcasted by the transmitter.

A microcontroller-based hardware module will be developed, along with specific software code to facilitate information reading. The software will include functionality to display defined text or graphical symbols on an LCD or graphics LCD display module.

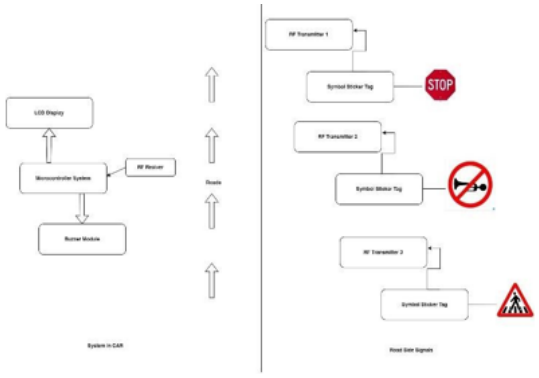

Fig 1: Research Idea

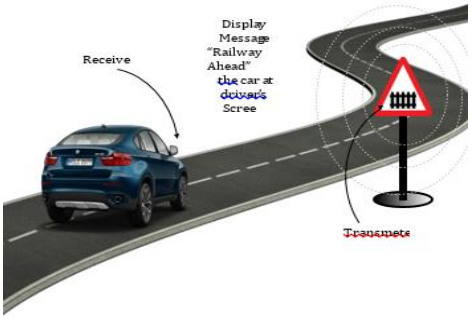

Fig2: block diagram of system

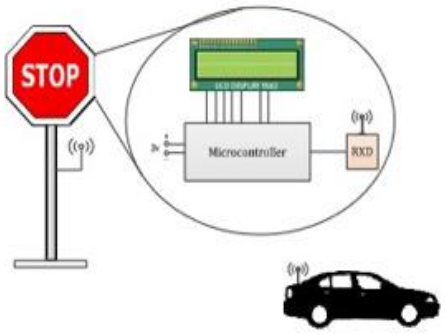

Fig 3. Block diagram of Module for radio frequency

Fig 4: Working Module of Road Side Symbol System

RF MODULE SPECIFICATIONS

The system operates within a frequency range of 30 kHz to 300 GHz. The carrier wave's amplitude changes to represent digital data in this RF system, utilizing Amplitude Shift Keying (ASK) modulation. RF communication is preferred over infrared (IR) for several reasons, including its longer range capabilities and ability to penetrate obstacles that would obstruct IR signals. The RF module consists of an RF transmitter and an RF receiver operating at 434 MHz. The RF transmitter receives serial data and wirelessly transmits it at a rate of 1 Kbps to 10 Kbps, using a pair of encoder/decoder modules.

DATA TRANSMISSION AND PROCESSING

In this system, the transmitter sends a signal that is received by the receiver, which forwards the information to the CPU through a communication port. The port value determines how the data is retrieved. The circuit then processes the signals, comparing the detected frequencies with those stored in the database. When a match is found, a corresponding audio alert is played, and relevant information is displayed on the car's LCD panel.

The RF module connects to a parallel port, and the processor's built-in software manages additional processing tasks. The results are displayed on the LCD screen, while a radio tuner is required to tune to the specified frequency.

CONCLUSION

The proposed roadside symbol detection system effectively addresses the challenges drivers encounter in recognizing roadside symbols, especially under adverse weather conditions such as heavy rain or low visibility. By integrating an RF module (receiver), Arduino UNO microcontroller, 16x2 LCD display, Arduino IDE programming software, and a buzzer module, the system significantly enhances driver awareness and safety. The LCD display provides real-time information about roadside symbols, ensuring that drivers are continuously informed about crucial road conditions. The in-car system captures signals transmitted by roadside boards, facilitating timely communication that promotes safer driving experiences.

Moreover, the incorporation of solar power ensures uninterrupted performance and minimizes maintenance requirements, making the system particularly advantageous in hilly or remote areas. This project not only improves decision-making related to speed and trajectory but also issues timely warnings for over speeding or potential traffic violations. The demonstrated efficiency of this system positions it as a valuable resource for researchers and practitioners in the fields of road safety and intelligent transportation systems, paving the way for future enhancements such as text recognition on roadside signs.

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