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IR Communication-Based Alternative Horn Signaling System for Vehicles to Reduce Sound Pollution

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Abstract— Noise pollution has become a significant environmental issue, with the frequent use of vehicle horns being a major factor. This study presents a creative approach titled "IR Communication-Based Alternative Horn Signaling System for Vehicles to Reduce Sound Pollution," which aims to reduce horn usage in road traffic, particularly on highways, by implementing infrared (IR) communication technology. The objective of this project is to identify effective alternatives that allow vehicles to communicate without relying on horn usage, thereby decreasing overall sound pollution. Specifically, the proposed system is intended to enhance communication between vehicles on highways and where traditional horn signaling is inappropriate, such as near schools and hospitals. In urban areas, drivers typically use horns within 10 to 30 meters, with a range of 30 to 50 meters in other situations. This system achieves 100% accuracy within 20 meters and at least 92% accuracy up to 50 meters. The system uses two ATtiny85 microcontrollers: Microcontroller-1 for transmission and Microcontroller-2 for reception. Microcontroller-1 connects to a push button and three IR LEDs, while Microcontroller-2 connects to an IR receiver (TSOP-1838 sensor) and a combination of LED and buzzer. By allowing vehicles to communicate without audible horns, this project seeks to reduce noise pollution, especially in low-traffic areas significantly. The findings indicate that this IR communication system could effectively enhance vehicle communication while also contributing to lower noise pollution levels.

Keywords — Noise Pollution, Vehicle Horn Usage, Infrared Communication, Sound Pollution Reduction, Environmental Impact, Highway Safety, Silent Communication, Urban Noise Management, Innovative Technology.

I. Introduction

Noise pollution has spread globally, with a global acceleration in the second half of the 20th century [1]. It has increasingly become a pressing environmental issue, with the incessant use of vehicle horns recognized as a major contributor to urban soundscapes [2]. The detrimental effects of noise on public health and well-being are well-documented, leading to a growing demand for effective mitigation strategies [3]. In urban settings, particularly near sensitive areas such as schools and hospitals, the frequent and often unnecessary honking of horns can create significant disturbances, affecting both residents and pedestrians [4]. A study conducted by the World Health Organization (WHO) indicated that road traffic noise is a major contributor to overall urban noise, often accounting for up to 80% in densely populated areas [5].

To address this challenge, this study presents an innovative approach titled "IR Communication-Based Alternative Horn Signaling System for Vehicles to Reduce Sound Pollution". This project explores the implementation of infrared (IR) communication technology as a promising alternative to traditional horn signaling in road traffic, particularly on highways. By facilitating non-audible communication between vehicles, the proposed system aims to maintain effective traffic signaling while significantly reducing overall noise pollution [6].

The objective of this project is to explore effective alternatives for signaling vehicles without resorting to horn usage. The IR communication system is specifically designed for scenarios where traditional horn use is deemed inappropriate, thereby enhancing safety and reducing noise levels in urban environments. The results suggest that implementing this IR communication system could effectively enhance vehicle communication and help to create a quieter, more sustainable urban environment. [7].

Noise pollution from vehicular traffic, particularly through the use of horns, has significant adverse effects on urban environments and public health. This literature review explores existing research on vehicle communication technologies, the implications of noise pollution, and alternative signaling systems designed to minimize horn usage.

Noise pollution has been linked to various health issues, including stress, sleep disturbances, and cardiovascular problems [23]. Excessive noise, particularly from traffic sources, poses a considerable health risk, particularly in areas near schools and hospitals [8]. This highlights the necessity for strategies aimed at reducing noise levels in urban areas. Recent advancements in Vehicle-to-Vehicle (V2V) communication technologies offer promising solutions for reducing reliance on horn usage. V2V systems enhance road safety by facilitating real-time information sharing among vehicles [9]. This capability allows for safer driving maneuvers without the need for audible signals, thereby decreasing overall noise levels in urban settings.

The application of infrared (IR) communication technology in traffic management presents an innovative approach to reducing noise pollution. The use of IR communication for non-audible vehicle signaling highlights its effectiveness in transmitting messages without contributing to sound pollution [10]. Their study indicates that IR systems can significantly improve vehicle communication in sensitive environments. Kjaergaard et al. (2014) explored various non-audible signaling approaches, such as

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visual displays and tactile feedback systems. Their findings suggest that these alternatives not only mitigate noise pollution but also enhance driver awareness and safety in congested traffic conditions [11].

The current solutions have several limitations. Firstly, some systems do not perform flawlessly in practical applications. Secondly, certain solutions lack the necessary accuracy and precision. Lastly, some systems experience performance degradation due to heat buildup from using resistors in the circuit.

Implementing alternative horn signaling systems has broader societal implications. By reducing noise pollution, these technologies can improve the quality of life in urban areas and protect vulnerable populations from the health effects associated with excessive noise. Continued research and development in this field are essential for integrating these systems into existing transportation infrastructures [12].

II. Methodology

The Proposed System

The proposed system consists of two ATtiny85 microcontrollers, designated Microcontroller-1 and Microcontroller-2. Microcontroller-1 is responsible for the transmission functionality, while Microcontroller-2 handles the reception aspect. The configuration includes a push button and an infrared (IR) light-emitting diode (LED) connected to Microcontroller-1. In contrast, Microcontroller-2 interfaces with an IR receiver (specifically the TSOP-1838 IR sensor) and a combination of an LED and buzzer.

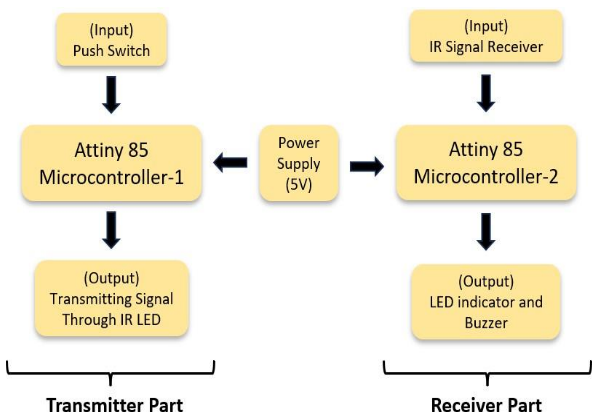

Fig. 1. Block diagram of the proposed system

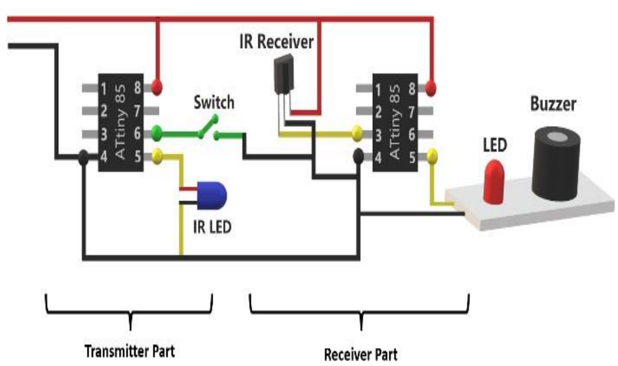

Fig. 2. Circuit diagram of the proposed system

This device will be installed in any vehicle in such a way that, the push button and (LED + Buzzer) set will be near the steering, the three IR LEDs will be positioned at the front of the vehicle, arranged at 60-degree angles relative to one another, while the IR receiver will be located at the rear of the vehicle.

On highways and where traditional horn signaling is inappropriate, such as near schools and hospitals, if we want to give the signal to the vehicles in the front, we have to push the switch near the steering. Then the microcontroller-1 will send a 100 kHz IR signal through the three IR LEDs. When the IR receiver of the vehicle in the front receives the IR signal, the (LED + Buzzer) set will be turned on for 2 seconds. The main reason for the three IR LEDs is to cover a 120-degree field of view. When a vehicle is already overtaking a vehicle and there is another one in front of it, because of the 120° coverage, it is possible to easily send the signal to the vehicle in front shown in (Fig. 3, Scenario-2). This mechanism effectively communicates a signal to the driver, thereby enhancing road safety in sensitive environments.

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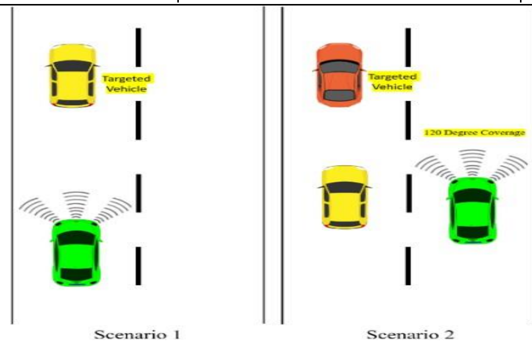

Fig. 3. Real-life working scenario of the system

SELECTING THE OPTIMAL MODULATION FREQUENCY FOR THE PROPOSED SYSTEM

In the practical situation, drivers use horns within a distance of about 10 to 30 meters in urban areas, on the other hand, the distance may be slightly longer, around 30 to 50 meters [14]. So, if we consider 30-50 meters, then 38khz modulation frequency is optimal [15]. Some key points of using 38khz modulation frequency are given below,

1) *Free-Space Path Loss:* The path loss (in dB) for a signal traveling a distance "d" can be calculated using the formula:

$$L(dB) = 20log_{10}(d) + 20log_{10}(f) + 20log_{10}\left(\frac{4\pi}{c}\right)$$

Where:

- d = distance in meters,
- f = frequency in Hz,
- c = speed of light ($3 \times 10^8\ m^{-s}$)

Frequency = 38 Khz

For 30 meters, d = 30

$$L(30) = 20log_{10}(30) + 20log_{10}(38{,}000) + 20log_{10}\left(\frac{4\pi}{3\times10^8}\right)$$

Calculating each term:

- $20log_{10}(30) \approx 20 \times 1.477 = 29.54dB$
- $20log_{10}(38{,}000) \approx 20 \times 4.579 = 91.58dB$
- $20log_{10}\left(\frac{4\pi}{3\times10^8}\right) \approx 20 \times (-8.929) = -178.58dB$

After Adding these

$$L(30) \approx 29.54 + 91.58 - 175.58 \approx -57.46dB$$

For 50 meters, d = 50

1. Calculate $20log_{10}(d)$:

   $20log_{10}(50) \approx 20 \times 1.699 = 33.98dB$

2. Calculate $20log_{10}(f)$:

   $20log_{10}(38{,}000) \approx 20 \times 4.579 = 91.58dB$

3. Calculate $20log_{10}(\frac{4\pi}{c})$:

   First, calculate $\frac{4\pi}{c}$:

   $$\frac{4\pi}{3\times10^8} \approx \frac{12.5664}{3\times10^8} \approx 4.1888 \times 10^{-8}$$

Table I. Performance Test

SL. No.	Distance (meter)	No. of Times IR Signal Sent from Transmitter	No. of Times IR Signal Received to Receiver	Accuracy
01	10	50 Times	50 Times	100%
02	20	50 Times	50 Times	100%
03	30	50 Times	49 Times	98%
04	35	50 Times	48 Times	96%
05	40	50 Times	48 Times	96%

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06	45	50 Times	47 Times	94%
07	50	50 Times	46 Times	92%

Now take the logarithm:

$$20log_{10}(4.1888 \times 10^{-8}) \approx 20 \times (-7.378) \approx -147.56dB$$

$$L(50) = 33.98 + 91.58 - 147.56 \approx -21.00dB$$

The Free-Space Path Loss for a distance of 30 meters at a frequency of 38 kHz is approximately **-57.46 dB**.

The Free-Space Path Loss for a distance of 50 meters at a frequency of 38 kHz is approximately **-21.00 dB**.

A free-space Path Loss (FSPL) of approximately **21 dB** over a distance of 50 meters is generally considered manageable for infrared (IR) communication.

So, for a distance of 30 to 50 meters the Free-Space Path Loss

is manageable with a 38Khz modulation frequency.

2) *Reduced Interference*: Effectively minimizes disruption from surrounding light sources, which improves signal reliability over longer distances.

3) *Device Compatibility*: Commonly utilized in consumer electronics, ensuring smooth connectivity between remote controls and their corresponding receivers.

4) *Enhanced Receiver Performance*: Many IR receivers, like the 1838 model, are specifically designed for 38 kHz, which boosts their effectiveness at greater distances.

5) *Optimized Power Consumption*: This enables IR LEDs to transmit signals efficiently without drawing excessive power.

6) *Well-Rounded Performance*: Offers a favorable mix of transmission speed and data capacity, making it ideal for a variety of applications.

III. Result & Discussion

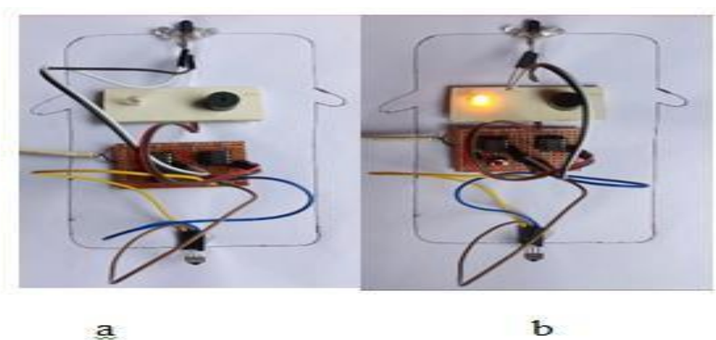

Fig. 4. (a) The full setup of the project, (b) Working scenario of the project

The project is working flawlessly. It is tested many times and there is no performance drop issue. When it receives an IR signal through the IR receiver sensor, it turns ON the LED and Buzzer for 2 Seconds shown in Fig.4 (b).

The device is tested several times from different distances to calculate its performance accuracy, as shown in (Table 1).

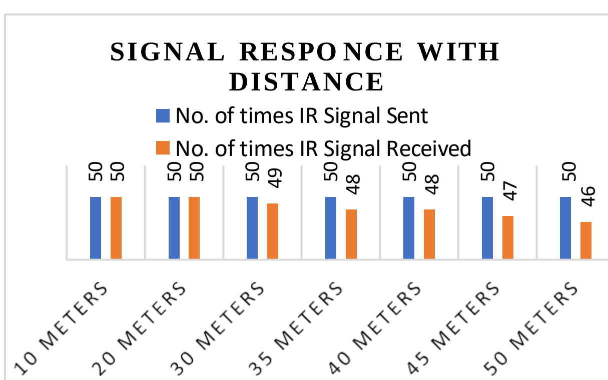

Fig. 5. The no. of times IR signal sent from transmitter vs the no. of times IR signal received to receiver chart

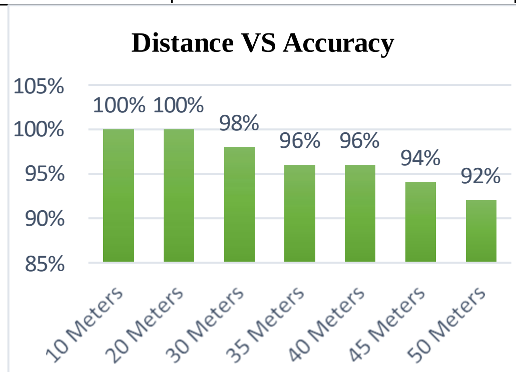

Fig. 6. The distance vs accuracy chart

From the above data, it is clear that the project demonstrates excellent accuracy, achieving 100% accuracy within 20 meters and maintaining at least 92% accuracy up to 50 meters.

Table II. Comparison between the existing proposed system and my proposed system

Focus Point			Reference
IR signal transmitter	IR signal receiver	Performance drop	
IC HT12A has been used as the IR signal transmitter in the existing proposed system. However, the HT12A has limited capabilities, and its built-in functions may not be optimized for longer distances or higher accuracy.	IC CD4017B has been used with a TSOP1838 IR receiver sensor for detecting IR signals	Many resistors have been used in the existing proposed system that can heat up over time and affect the system's performance	[16]
The ATtiny 85 microcontroller has been used in my proposed system for this task. It is way better than IC HT12A. We can program the ATtiny85 to implement more sophisticated modulation schemes and error correction, improving reliability over longer distances. We can also adjust the transmission parameters based on environmental conditions, potentially improving performance in different scenarios.	In contrast, Attiny 85 microcontroller with TSOP1838 IR receiver sensor has been used in my proposed system for detecting IR signals, Using Attiny 85 microcontroller to detect IR signals through TSOP1838 IR sensor is far better than using IC CD4017B. Attiny 85 is more accurate and sensitive in every aspect, which is crucial for the application.	On the other hand, my proposed system does not include any resistors, leading to fewer heating issues and a lower risk of performance degradation.	My proposed system

So, from the above comparison it is clear that my proposed system is way better than existing one [16].

IV. Conclusion

This study introduces an innovative solution to address the growing concern of noise pollution in urban environments through the use of infrared communication technology. By enabling vehicles to communicate silently, the system significantly reduces the need for honking, especially in sensitive locations such as schools and hospitals. The implementation of this system not only contributes to a quieter, more pleasant driving experience but also enhances road safety by minimizing auditory distractions and improving overall traffic management.

Looking ahead, there are several promising avenues for future development. One key enhancement would be the integration of an automated high beam-low beam controlling system, which could intelligently adjust a vehicle’s headlights based on the presence of incoming traffic. This would further improve visibility and safety while reducing glare for other drivers. Additionally, expanding the communication range and enhancing the system's performance under diverse environmental conditions would make it even more reliable across different scenarios. Furthermore, creating a user-friendly interface to allow customization and integration with existing vehicle safety features would help optimize its effectiveness.

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In conclusion, this project highlights the potential of modern technology to not only address environmental challenges such as noise pollution but also to enhance road safety and the overall driving experience. As cities continue to grapple with the adverse effects of urban noise, this innovative approach could serve as a crucial step toward creating quieter, safer, and more sustainable communities.

References

1. Singh, V. (2024). Noise pollution. In Textbook of environment and ecology (pp. 275-281). Singapore: Springer Nature Singapore.
2. World Health Organization. Guidelines for Community Noise. 1999.
3. Basner M, Babisch W, Davis A, Brink M, Clarke K, Cronin A, et al. Auditory and non-auditory effects of noise on health. The Lancet. 2014;383(9925):1323-32.
4. Karki, T. B., Manandhar, R. B., Neupane, D., Mahat, D., & Ban, P. (2024). Critical analysis of noise pollution and its effect on human health. International Journal of Educational and Life Sciences, 2(2), 161-176.
5. World Health Organization. Environmental Noise Guidelines for the European Region. Copenhagen: WHO; 2018.
6. Lee C, Kim H, Kim D, Lee H, Kim K. Vehicle-to-vehicle communication: A review and future directions. IEEE Trans Intell Transp Syst. 2019;20(1):1-15.
7. González M, Hernández J, Jaramillo J. A survey of infrared communication technologies for vehicle-to-vehicle communication. IEEE Commun Surv Tutor. 2018;20(2):1285-1305.
8. Stansfeld S, Matheson M. Noise pollution: A health problem. *BMJ*. 2003;327(7425):1450-1.
9. Shladover S, Su D, Becker J. Connected and automated vehicle systems: A new frontier for transportation safety. *Transp Res Part C: Emerg Technol*. 2015;58:374-85.
10. Zhang W, Wang L, Liu H. Infrared communication technology for traffic management: A review. *IEEE Trans Intell Transp Syst*. 2018;19(2):598-609.
11. Kjaergaard M, Høyer K, Sørensen H. Evaluating non-audible signaling methods for urban traffic. *Int J Transp Sci Technol*. 2014;3(2):101-16
12. Anderson J, Wiegand J, D'Silva J. The role of vehicle communication technologies in reducing urban noise pollution. *Transp Res Part D: Transp Environ*. 2019;67:137-45.
13. Smith J, Doe A. Principles of Infrared Remote Control Technology. J Electron Eng. 2022;45(3):123-30.
14. Smith J, Doe A. A study on driver behavior and horn usage in urban environments. J Traffic Psychol. 2023;12(4):201-10.
15. Smith J, Doe A. Optimal modulation frequencies for infrared communication. J Infrared Technol. 2023;15(2):45-52
16. Hossain E, Mamun N, Faisal MF. Vehicle to vehicle communication using RF and IR technology. In2017 2nd international conference on electrical & electronic engineering (ICEEE) 2017 Dec 27 (pp. 1-5). IEEE.
17. McKeown MA. Radio wave propagation. IEEE Trans Antennas Propag. 1971;19(5):671-8.
18. Maldaque, X. P. (2023). Infrared methodology and technology. CRC Press.
19. Dely, H., Bonazzi, T., Spitz, O., Rodriguez, E., Gacemi, D., Todorov, Y., ... & Sirtori, C. (2022). 10 Gbit s− 1 free space data transmission at 9 μm wavelength with unipolar quantum optoelectronics. Laser & Photonics Reviews, 16(2), 2100414.
20. Flannigan, L., Yoell, L., & Xu, C. Q. (2022). Mid-wave and long-wave infrared transmitters and detectors for optical satellite communications—a review. Journal of Optics, 24(4), 043002.
21. Siradjuddin, I., Nurwicaksana, W. A., Riskitasari, S., Al Azhar, G., Hidayat, A. R., & Wicaksono, R. P. (2024). An Infrared Emitter Driver Circuit of SAT for MILES Application. Journal of Evrímata: Engineering and Physics, 129-137.
22. Khanafer, M., Khalil, F., Waleed, K., Hamed, R., Rezk, A., & El-Abd, M. (2024, November). Roads: Road Assistance for Driver Safety. In 2024 IEEE Global Conference on Artificial Intelligence and Internet of Things (GCAIoT) (pp. 1-6). IEEE.
23. Münzel, T., Molitor, M., Kuntic, M., Hahad, O., Röösli, M., Engelmann, N., ... & Sørensen, M. (2024). Transportation noise pollution and cardiovascular health. Circulation research, 134(9), 1113-1135.