Intelligent Transportation System

Basweshwar Bansode[1], Ahmed Mujtaba Shaikh[2], Uzair Khan[3], Suleman Ansari[4]
[1] *Assistant Professor, Department of Civil, Shree L.rTiwari College of Engineering*
[2,3,4] *UG Student, Department of Civil, Shree L.r Tiwari College of Engineering*

***Abstract*—In recent years, transportation systems have been changing rapidly due to advancements in technology. One of the most promising areas of development is the Intelligent Transportation System (ITS), which is designed to make travel safer, faster, cleaner, and more efficient. ITS uses modern technologies like sensors, cameras, artificial intelligence (AI), and wireless communication to improve the way vehicles and roads interact. When combined with smart roads and electric roads, ITS can transform the future of transportation. Smart roads are roads that are built or upgraded with technology. These roads can monitor traffic, weather, road conditions, and even the behavior of drivers. They have sensors embedded in the surface or installed alongside the road. These sensors collect data in real-time and send it to a central system, which analyzes the information and provides updates to traffic lights, road signs, and drivers. This helps reduce traffic jams, lower accident rates, and improve overall road safety. Electric roads are a special kind of smart road that can charge electric vehicles (EVs) while they are driving. This is done using technologies like wireless charging coils or rails embedded in the road. These systems send power to the vehicle's battery without needing to stop and plug in. This makes long-distance travel easier and helps reduce the need for large charging stations. Electric roads can help encourage more people to switch to electric vehicles, which is better for the environment because EVs produce less pollution compared to regular cars that run on fuel. The Intelligent Transportation System connects all of these elements. For example, it can manage traffic by using AI to predict and control traffic flow. It can also help emergency vehicles reach their destinations faster by giving them priority at traffic signals. ITS can also assist self-driving cars by providing them with real-time information about road conditions, traffic, and other vehicles around them. This leads to safer and smoother driving experiences.**

I. INTRODUCTION

In an age where urbanization and technological advancement go hand in hand, transportation systems must evolve to meet the demands of growing populations, increasing vehicle usage, and the need for sustainable, efficient travel. Intelligent Transportation Systems (ITS) represent a
convergence of information technology, communication systems, electronics, and advanced traffic management techniques aimed at improving transportation safety, mobility, efficiency, and environmental sustainability.

ITS isn't just about technology—it's a strategic framework to enhance how people and goods move across urban and rural landscapes. Whether it's reducing traffic congestion, preventing road accidents, or minimizing fuel consumption, ITS plays a vital role in modernizing our transportation infrastructure.

An Intelligent Transportation System (ITS) is a modern way of managing transportation by using advanced technology. It helps improve how people and goods move from one place to another. ITS combines tools like sensors, cameras, GPS, traffic signals, and communication networks to monitor and control traffic in real time. The goal is to make transportation safer, faster, more efficient, and environmentally friendly.

Traditional transportation systems often face problems like traffic jams, accidents, and pollution. ITS solves these problems by collecting data from roads and vehicles, analyzing it, and then making smart decisions. For example, it can adjust traffic lights based on traffic flow, warn drivers about accidents ahead, or help emergency vehicles reach their destination quickly.

ITS is also an important part of smart cities, where everything is connected and technology is used to improve daily life. When combined with smart roads and electric vehicles, ITS can help reduce fuel use, improve road safety, and make travel more comfortable. As cities grow and the number of vehicles increases, Intelligent Transportation Systems will play a key role in creating a cleaner, smarter, and more organized future for transportation.

II. NEED OF ITS

The need for ITS arises from numerous challenges faced by transportation systems worldwide:

1. Traffic Congestion – Rapid urbanization and the increasing number of vehicles on roads result in frequent traffic jams, wasting time and fuel.
2. Accidents and Road Safety – Human error accounts for the majority of road accidents. ITS offers solutions like collision avoidance systems and real-time traffic alerts.
3. Pollution – Idle vehicles in traffic congestion contribute to air pollution. ITS helps reduce emissions through better traffic management.
4. Public Transport Inefficiency – ITS can enhance the performance of public transport systems by providing real-time data and improving schedule adherence.
5. Fuel Wastage – Uncoordinated traffic leads to increased fuel consumption; ITS minimizes this through intelligent route planning and traffic signal control.

III. COMPONENTS OF ITS

1. Advanced Traffic Management Systems (ATMS)

o Use sensors, cameras, and traffic signals to monitor and control the flow of traffic.

o Real-time traffic information is used to adjust signal timings and manage incidents.

2. Advanced Traveler Information Systems (ATIS):

o Provide travelers with real-time information about road conditions, traffic congestion, weather, and alternative routes via GPS, mobile apps, and digital signboards.

3. Advanced Vehicle Control Systems (AVCS):

o Include systems like adaptive cruise control, lane-keeping assist, and automatic braking, mainly in autonomous and semi-autonomous vehicles.

4. Advanced Public Transportation Systems (APTS):

o Improve public transit with real-time vehicle tracking, electronic fare systems, and predictive scheduling.

5. Smart Over Speeding Speed Breaker (SOSSB):

o Is an intelligent traffic control system that automatically activates or raises a speed breaker when a vehicle exceeds the speed limit. It helps reduce accidents by controlling vehicle speed dynamically without affecting compliant drivers.

6. Electric Vehicle Charging Lane (EVCL):

o Is a specially designed road lane that wirelessly charges electric vehicles as they move over it. It uses embedded electromagnetic induction or conductive technology to enable continuous charging without stopping.

Technologies Used in ITS

- Global Positioning System (GPS): For vehicle location tracking and route optimization.
- Geographic Information System (GIS): For mapping, spatial analysis, and traffic modelling.
- Wireless Communication (V2V, V2I): Vehicle-to-Vehicle (V2V) and Vehicle-to Infrastructure (V2I) communication for data exchange and automated driving support.
- CCTV and Surveillance Cameras: Used for traffic monitoring, law enforcement, and accident analysis.
- Sensors and Detectors: Embedded in roads to monitor vehicle count, speed, and weight.
- Artificial Intelligence (AI): For predictive analytics, smart signal control, and autonomous vehicle navigation.
- Internet of Things (IoT): Connects vehicles, infrastructure, and devices to enable seamless data flow.

Benefits of ITS

1. Reduced Traffic Congestion: o Intelligent traffic signal systems and dynamic route planning help reduce bottlenecks.
2. Enhanced Road Safety: o Collision warning systems and adaptive cruise control reduce the chances of accidents.
3. Environmental Sustainability: o ITS reduces fuel consumption and emissions by optimizing traffic flow and promoting eco-driving.
4. Improved Public Transport Services: o Real-time tracking improves reliability and convenience for passengers.
5. Cost Efficiency: o Less fuel wastage, fewer accidents, and improved logistics reduce overall transportation costs.
6. Data-Driven Decision Making: o Real-time and historical data can be used for planning

infrastructure, improving policies, and optimizing traffic systems.

Applications of ITS in Real Life

• Smart Traffic Lights: Adjust signal timings based on traffic density.

• Electronic Toll Collection (ETC): Enables automatic toll payment without stopping.

• Real-Time Bus Arrival Apps: Used in cities to inform passengers about bus locations.

• Red-Light Violation Detection: Cameras detect and fine vehicles breaking traffic rules.

• Automatic Number Plate Recognition (ANPR): Used for law enforcement and toll collection.

• Smart Parking Systems: Guide drivers to available parking spots via mobile apps or digital boards.

• Autonomous Vehicles: Use a combination of ITS technologies to navigate and operate with minimal human input.

Future of ITS:

• The future of Intelligent Transportation Systems is deeply connected with the advancement of smart cities and sustainable mobility. With the rise of 5G, AI, and autonomous driving, ITS will become more intelligent, interconnected, and predictive. The development of Mobility as a Service (MaaS) platform, where various modes of transportation are integrated into a single accessible service, is also a growing trend.

• Self-driving vehicles, drone-based delivery systems, and smart infrastructure will redefine urban mobility. As governments and industries invest more in digital infrastructure, ITS will play a central role in ensuring transportation systems are prepared for future demands.

IV. SMART SPEED BREAKER

• Road accidents due to over speeding are a major concern worldwide, especially in urban areas, school zones, and highways. Traditional speed breakers are a common solution, but they can be uncomfortable, cause damage to vehicles if not designed properly, and do not discriminate between speeding and non-speeding vehicles. To address these limitations, Smart Over Speeding Speed Breakers have emerged as an intelligent and adaptive solution.

• Smart speed breakers are designed to penalize only those vehicles that exceed the speed limit while allowing compliant vehicles to pass smoothly. These innovative systems combine mechanical engineering with sensors, control systems, and real-time data processing to create a safer and more efficient road environment.

Need for Smart Speed Breakers

1. Rising Road Accidents – Over speeding is one of the primary causes of road accidents, particularly in accident-prone zones.
2. Driver Comfort – Traditional speed breakers cause discomfort even for law-abiding drivers.
3. Emergency Vehicle Delays – Traditional speed breakers hinder the speed of ambulances and fire trucks unnecessarily.
4. Fuel Inefficiency – Sudden braking and acceleration due to traditional bumps lead to unnecessary fuel consumption.
5. Lack of Dynamic Control – Fixed speed breakers operate regardless of time, traffic, or urgency, unlike smart systems.

Working Principle of Smart Speed Breakers

The smart speed breaker system generally works in the following way:

1. Speed Detection – Sensors like radar, IR (infrared), or ultrasonic are used to measure the speed of an approaching vehicle.
2. Data Processing – The sensor data is sent to a microcontroller or processor which compares the detected speed with a predefined threshold.
3. Actuation – If the vehicle is over speeding, the system activates the speed breaker (usually by raising a mechanical plate or bar). If not, the road remains flat.
4. Signaling – LED indicators or digital boards inform drivers of their speed and warn them if they're about to face a raised breaker.

Types of Speed Breakers

Traditional Speed Breakers These are permanent structures made of concrete, rubber, or asphalt. They're fixed and do not change based on vehicle speed.

1. Rumble Strips: Small bumps or grooves that produce noise and vibration to alert drivers.
2. Humps and Bumps: Raised portions on the road meant to slow vehicles.

3. Speed Cushions: Wider structures that slow cars but allow emergency vehicles to pass between them.

Smart Speed Breakers (Dynamic or Intelligent): These respond to real-time data and vehicle behaviour.

1. Mechanical Actuated Speed Breakers: Hydraulic or pneumatic systems that lift the speed breaker plate only when over speeding is detected.
2. Electromechanical Speed Breakers: Controlled by motors and relays, lifting or lowering the breaker depending on speed data.
3. Embedded Road Plates: Plates that lower when vehicles drive at legal speed and stay raised for fast-moving vehicles.
4. Sensor-Based Speed Breakers: Use LIDAR, radar, or IR sensors to detect speed and control the road surface accordingly.

V. EV CHARGING LANE

• As the world shifts toward sustainable transportation, Electric Vehicles (EVs) are playing a vital role in reducing greenhouse gas emissions and dependence on fossil fuels. However, one of the major limitations of EV adoption is "range anxiety"—the fear that the vehicle will run out of power before reaching a charging station.

• To address this challenge, a groundbreaking solution has emerged: the Electric Vehicle Charging Lane (EVCL). These are specialized road lanes equipped with technology that can wirelessly or conductively charge EVs while they are in motion or temporarily stationary, eliminating the need to stop for charging and enabling continuous mobility.

• An Electric Vehicle Charging Lane is a dedicated lane embedded with charging infrastructure that allows EVs to charge their batteries while driving or stopping on the lane. It uses wireless (inductive) or wired (conductive) power transfer technologies integrated into the road surface to deliver energy to the vehicle's battery without manual connection.

Need for EV Charging Lanes

1. Range Anxiety Reduction: EVs often have limited driving range and long charging times. Charging lanes offer uninterrupted energy supply.
2. Charging Infrastructure Gap: EV charging stations are not yet widespread in many regions; charging lanes bridge this gap.
3. Time Efficiency: Drivers don't have to stop and wait to charge, which saves time and improves productivity.
4. Sustainable Urban Mobility: Promotes the adoption of EVs, especially in commercial fleets and public transportation.
5. Support for Autonomous Vehicles: Enables driverless EVs to operate for longer periods without human intervention.

Working Principle: The fundamental operation of an EV charging lane involves energy transfer from the road to the vehicle through:

1. Wireless (Inductive) Charging
   - Uses electromagnetic induction. • Power is transferred from charging coils embedded in the road to a receiving coil under the vehicle.
   - This method does not require physical contact.
2. Conductive Charging
   - Involves direct contact between charging conductors in the road and a pickup unit under the vehicle.
   - More efficient but requires alignment and moving contact mechanisms.
3. Hybrid Systems
   - Some systems use a combination of inductive and conductive technologies for optimized performance and compatibility with various EVs.

Types of Electric Vehicle Charging Lanes

1. Dynamic Charging Lanes
   - Active while the vehicle is moving. • Best for highways and high-speed roads.
   - Reduces the need for large onboard batteries.
   - Uses wireless charging mostly.
2. Static Charging Lanes
   - Used when vehicles are stationary, like at stoplights, bus stops, or parking areas.
   - Easier to implement and test.
   - Can use either inductive or conductive methods.
3. Semi-Dynamic Charging Lanes
   - Vehicles charge while moving slowly or during brief stops (e.g., in traffic or toll booths).
   - Often used in city traffic scenarios.
4. Bus Rapid Transit (BRT) Charging Lanes
   - Special lanes designed for public buses.
   - Charging occurs at designated stops or during

transit between stops.

Advantages of Electric Vehicle Charging Lanes

1. Continuous Charging • Allows EVs to charge while moving, significantly extending their range without downtime.
2. Reduction of Charging Stations • Less reliance on stationary chargers and long queues at charging points.
3. Time-Saving • No need to stop for charging, which is particularly beneficial for commercial and delivery fleets.
4. Smaller Batteries • Vehicles don't require large, heavy batteries if they can be charged on the move.
5. Urban Planning Benefits • Integrates seamlessly into road infrastructure without occupying extra space for charging stations.
6. Support for Public Transportation • Buses and taxis can operate without disruption, leading to more reliable services.

VI. LITERATURE REVIEW

EV CHARGING LANE

Yuvaraja S^1, Narayana Moorthi R^1*, JagabarSathik Mohamed Ali^2 and Dhafer Almakhles2*1 Electric Vehicle Charging Research Centre, Department of Electrical and Electronics Engineering, SRM Institute of Science and Technology, Chennai, India,2 Renewable Energy Lab, College of Engineering, Prince Sultan University, Riyadh, Saudi Arab

The recent progress in the dynamic wireless power transfer (DWPT) system brings feasibility to increase the driving range of an electric vehicle (EV). The on-road wireless charging system reduces the volume of the EV's battery and charging the vehicle while driving. So, the powered roadways can potentially decrease the dependency on heavy-sized batteries for EV applications. The capability of transferring maximum power from the ground surface to the vehicle requires the critical design of the entire DWPT system. The various factors such as wireless charging pads, power electronic converters, compensators, and controllers influence the power transfer rate of the system. An appropriate impedance matching network assists the system during power transfer. Moreover, the design of coils in DWPT needs to consider the sensitive misalignment tolerance, safety issues, complex design, and cost factors. In this article, the basic topologies, history, and fundamentals of the DWPT charging system are discussed. In addition, the impact on the power grid due to the DWPT system and factors involved in microgrid integration are discussed. However, the current scenario of different compensators, converters, and design topologies proposed in the dynamic charging system is included. This article presents a comprehensive overview and challenges involved in a DWPT system such as the design of a power converter, charging couplers, compensation network, foreign object detection system, economic factors, and microgrid-integrated DWPT system. An economic analysis, electromagnetic compatibility, and interference of the charging system are also analyzed vastly. The human exposure level with its allowable limits developed for the wireless power transfer system is discussed.

SMART SPEED BREAKERS

1.Ms. Janhavi Joshi Assistant Professor ,2. Sandeep Kumar, 3. Surya G, 4.R. P. Bharadwaj Rao, 5. Sunderesan V

The paper proposes a smart speed breaker system using image processing to control the speed of vehicles. The system consists of a camera and an image processing unit that detect the speed of the approaching vehicle and adjust the height of the speed breaker accordingly. The system effectively reduces the chances of accidents caused by speeding vehicles and outperforms the conventional speed breaker system. The authors have provided a detailed explanation of the system's design and implementation, which can be useful for researchers and practitioners interested in developing similar systems. The paper proposes an automatic intelligent speed breaker system that uses image processing techniques to detect the speed of approaching vehicles and adjust the height of the speed breaker accordingly. The proposed system aims to reduce the chances of accidents caused by speeding vehicles. The authors present the design and implementation of the system, which includes the selection of hardware components, image processing algorithms, and control logic. The experiments conducted to evaluate the performance of the proposed system show that it effectively controls the speed of vehicles and has the potential to improve road safety. The paper proposes an intelligent speed breaker system for road safety that uses image processing. The system comprises a camera and an image processing unit that detect the speed of approaching vehicles and adjust the height of the speed breaker accordingly. The authors have presented the design and implementation of the proposed system and conducted experiments to evaluate its performance. The results show that the proposed system effectively controls the speed of vehicles and can improve road safety. The paper can be useful for researchers and practitioners interested in developing similar systems. The paper presents a real-time automatic number plate recognition system for vehicle tracking using image processing. The system can recognize number plates of moving vehicles in real-time and track their movement. The proposed system uses image processing algorithms and machine learning techniques to recognize the number plates. The authors have conducted experiments to evaluate the performance of the system under different lighting and weather conditions. The proposed system has the potential to improve traffic management and can be useful for law enforcement agencies.

VII. METHODOLOGY

1. PROBLEM IDENTIFICATION
2. PLANNING
3. LITRETURE REVIEW
4. CASE STUDY
5. EV CHARGING LANE
6. SMART SPEED BREAKER

ELECTRIC VEHICLE CHARGING LANE CASE STUDY

1. In an effort to achieve a sustainable transportation system, Electric Vehicles (EVs) have been promoted by governments worldwide. However, the adoption of this environmentally friendly and economically efficient means of transportation is still limited compared to Internal Combustion Vehicles (ICVs). The relatively short driving range, limited charging availability and long charging time are significant hurdles for accelerating transport electrification. In order to overcome these shortcomings, wireless charging technology has been developed and already tested on many platforms, including Tesla, BMW, Nissan, Honda and Renault (Mubarak et al., 2021).

2. Wireless charging includes stationary wireless charging in which EVs are charged while parking at charging facilities and charging-while-driving with the charging mechanism installed under the road surface (Jang, 2018). Charging-while-driving can also be classified as (i) quasi-dynamic charging when an EV accelerates or decelerates from a resting position and (ii) dynamic charging when an EV is in motion. Although stationary wireless charging is safer and less burdensome, it is not significantly different from conventional plug-in conductive charging in terms of charging time, frequency, vehicle operation, and charging station allocation (Cirimele et al., 2018). However, charging-while-driving, especially dynamic charging, enables EVs to be charged while in operation and offers more opportunities for widespread availability.

3. In the present paper, we focus on the dynamic wireless charging infrastructure or wireless charging lanes (WCL). In addition to making charging more convenient and increasing EV market penetration, WCL also offers advantages, including the ability to reduce the size of batteries and lighten vehicles and facilitate charging with renewable energy sources (Bi et al., 2019). However, the new technology has raised new issues for network design and operations due to the change of traveller's routing and charging behaviours. This study aims to support the system planner to optimally deploy WCL in the manner of maximising social welfare while considering traffic dynamics and route choice behaviours.

4. Based on the demand pattern and route choice behaviours, EV charging infrastructure location problems can be formulated and solved by different approaches, including node based, flow-based and equilibrium-based models (Shen et al., 2019). The node-based models were initially proposed by Church and Meadows (1979) based on the covering demand nodes concept. It is assumed that the demands are generated at individual nodes and can be used to locate on-site low-power charging facilities (level 1 and level 2 modes) where the users can park their vehicles for several hours or overnight to fully recharge (Nozick, 2001, He et al., 2016). On the other hand, the flow-based approach is preferable for fast charging facilities (level 3 charging model) due to its ability to consider the demands in the form of traffic flow and capture travellers' route choice (Hodgson, 1990, Kuby and Lim, 2005, Xu and Meng, 2020). In order to capture the mutual interaction of re-routing behaviours and the charging

locations decision and avoid the deterioration in network performance, the equilibrium-based approach can be adopted in a bi-level optimisation program (He et al., 2018, Miralinaghi et al., 2020, Tran et al., 2021b).

SMART SPEED BREAKER CASE STUDY

1. Modernization is a multilevel process with large number of technologies and progression behind every construction. The way the buildings are planned and the properties that the materials hold are the root cause of successful structures. So as to ensure the qualities and quantities of products used for civil engineering, various researches are taking place around the globe. The current issue of i-manager's Journal on Civil Engineering compiles the characteristics and properties of construction materials, the safety aspects of Road Engineering, Seismic Vulnerability of Heritage buildings and Soil index properties.
2. Bharath Kumar and his co-author Ramujee have investigated the performance of Wollastonite and fly-ash in cement concrete by determining mechanical characteristics and durability characteristics by conducting tests to determine compressive strength, tensile strength, bond strength, Acid attack, Alkali attack and Rapid Chloride Penetration Test (RCPT). The materials used in the experiment are Cement, Mineral

Admixtures, Aggregates and Super plasticizer. The results of the study on mortars and concretes would be presented in a relative manner quantifying the performance criterion in terms of strength and durability. The replacement with fly ash-wollastonite system is proved to reduce the strength in comparison to concrete in which cement was replaced with Wollastonite.

Prashanth Miryala et.al have predicted the Soaked CBR Value with Index Properties of Black Cotton Soils of Sangareddy Region. In this study, thirty (30) number of soil samples (having 44<LL<84) were collected from different parts of Sangareddy District (Telangana). Different laboratory tests, including Atterberg limits, Specific Gravity, Gradation

Analysis, soaked CBR and compaction were performed on these samples and various linear relationships were established between index properties and soaked CBR of the samples using a statistical software (SPSS). Simple and multiple linear regression analysis was performed and eight predictive equations were developed for estimating the soaked CBR value from the index properties of soil with a maximum value.

Sree Lakshmi Devi and his co-author Srinivasa Rao have investigated the effect of freezing and thawing on quaternary blended SCC for different water binder ratio and compared with control self-compacting concrete. In the present investigation three mineral admixtures are incorporated and it is called as Quaternary Blended Self Compacted Concrete (QBSCC). Based on the results it shows that Quaternary Blended Self – Compacting Concrete using Fly ash, GGBS and Micro Silica proved to be cost effective and eco-friendly without compromising strength and durability of concrete.

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