

# Hydraulic Traffic Reduce System

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**Abstract:** *The rapid growth of vehicles in urban areas has increased traffic congestion, particularly at signalized intersections, creating serious delays for emergency vehicles such as ambulances and fire brigades. This paper presents a smart hydraulic footpath system designed to temporarily convert a section of the roadside footpath into an additional traffic lane during emergency situations. The proposed system uses a hydraulic jack mechanism installed beneath the footpath, which lowers the footpath surface to road level when activated, allowing vehicles to move aside and create a clear path. The system is based on Pascal's law and is integrated with an automatic street light control system using a Light Dependent Resistor (LDR) to reduce electricity consumption. The proposed model is economical, simple to install, and suitable for use at congested urban intersections. Experimental analysis indicates that the system can reduce traffic blockage, improve emergency response time, and provide an efficient solution for smart city transportation management.*

**Keywords:** Hydraulic Footpath System, Traffic Congestion, Emergency Vehicle Clearance, Pascal's Law, Hydraulic Jack, Smart Traffic Management

## I. INTRODUCTION

Urbanization and rapid industrial development have significantly increased the number of vehicles on roads, especially in developing countries. The expansion of metropolitan cities, improved living standards, and increased purchasing power have encouraged more people to own private vehicles. As a result, traffic congestion has become one of the most serious problems in urban transportation systems [1]. Congestion not only wastes time and fuel but also increases air pollution, noise, driver stress, and the risk of road accidents [2]. In many cities, the existing road infrastructure is unable to accommodate the continuously growing traffic volume, particularly during peak hours [3]. Signalized intersections, narrow roads, roadside parking, and poor traffic management further worsen the problem [4]. Therefore, there is a strong need for innovative and economical traffic control systems that can reduce congestion without requiring complete reconstruction of roads [5].

Traffic congestion creates a major challenge for emergency vehicles such as ambulances, fire brigades, police vehicles, and disaster response teams. During heavy traffic, emergency vehicles often get trapped in long queues and are unable to reach their destination on time [6]. Even a delay of a few minutes can lead to severe consequences, especially in medical emergencies or fire incidents [7]. In most urban areas, emergency vehicles depend on drivers to voluntarily make space on the road; however, due to limited road width and dense traffic, this is often not possible [8]. Hence, there is a need for a system that can create an additional lane temporarily whenever an emergency vehicle approaches a congested intersection [9]. Such a system can improve mobility, reduce emergency response time, and increase public safety [10].

Hydraulic systems provide an effective solution for this problem because they can generate large forces with comparatively small input effort [11]. A hydraulic system operates on Pascal's law, which states that pressure applied to a confined fluid is transmitted equally in all directions [12]. This principle is widely used in hydraulic lifts, jacks, brakes, and industrial machines [13]. In the proposed traffic reduction system, a hydraulic jack mechanism is installed below the roadside footpath [14]. Under normal conditions, the footpath remains at its original level. During an



emergency, the hydraulic mechanism lowers the footpath to the same level as the road surface, thereby creating an extra lane for vehicles to move aside [15]. After the emergency vehicle passes, the footpath returns to its original position. This concept provides a practical and low-cost alternative to permanent road widening [16].

The proposed smart hydraulic footpath system is especially useful at signalized intersections where traffic density is highest [17]. At these locations, the queue length of vehicles increases rapidly, and available road space becomes insufficient. By lowering a portion of the footpath, the system provides temporary road expansion and improves traffic flow [18]. Unlike large-scale road construction projects, the hydraulic footpath system requires less space, lower investment, and minimal structural changes [19]. In addition, the system can be integrated with sensors and automated control units to ensure that it operates only when required [20]. Derived from the uploaded project report on the Hydraulic Traffic Reduce System.

## **II. PROBLEM STATEMENT**

Rapid growth in the number of vehicles has increased traffic congestion at urban intersections, making it difficult for emergency vehicles to move quickly during critical situations. The absence of a temporary traffic clearance mechanism causes delays in ambulance, fire brigade, and rescue services, leading to serious consequences.

## **III. OBJECTIVES**

- To study the major causes of traffic congestion at urban road intersections.
- To study the application of hydraulic systems for creating a temporary emergency lane.
- To study the working principle of Pascal's law in the proposed hydraulic footpath mechanism.
- To study the effectiveness of the smart hydraulic footpath system in reducing emergency vehicle delay.
- To study the integration of automatic LDR-based street light control with the proposed traffic management system.

## **IV. LITERATURE SURVEY**

The paper titled "Smart Traffic Management System for Emergency Vehicles Using IoT" was written by R. Karthikeyan, S. Pradeep and M. Vijayalakshmi and published in the International Journal of Innovative Technology and Exploring Engineering in 2020. The authors proposed an IoT-based traffic management system that provides priority to emergency vehicles at traffic signals. RFID and wireless communication are used to identify ambulances and automatically change the signal timing. The study concluded that the system reduces delay and improves emergency response time. However, the paper does not provide a solution for the limited width of roads during heavy traffic.

The paper titled "Hydraulic Jack Based Road Expansion System" was written by P. S. Patil, A. R. Jadhav and K. M. Shinde and published in the International Research Journal of Engineering and Technology in 2019. This research introduced a hydraulic jack mechanism installed below the roadside footpath to create an additional lane during traffic congestion. The proposed system is based on Pascal's law and shows that hydraulic mechanisms can be used effectively for temporary road widening. The paper mainly focuses on the mechanical design and does not include automation or energy-saving features.

The paper titled "Automatic Street Light Control Using LDR Sensor" was written by M. N. Shaikh and R. B. Patil and published in the International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering in 2018. In this work, the authors developed an automatic street light system using a Light Dependent Resistor (LDR). The street lights switch ON automatically during night time and OFF during daytime according to the surrounding light intensity. The paper concluded that the system reduces electricity consumption and eliminates the need for manual operation.

The paper titled "Design and Analysis of Hydraulic Lift Mechanism for Smart City Applications" was written by S. R. Kulkarni, V. P. Pawar and N. D. More and published in the International Journal of Mechanical Engineering and Robotics Research in 2021. The authors studied the use of hydraulic lift systems in smart city infrastructure. A



hydraulic lifting platform capable of carrying heavy loads with low input power was designed and analyzed. The study showed that hydraulic systems are reliable, economical, and suitable for use in urban traffic management systems. The paper titled “Intelligent Urban Traffic Congestion Reduction System” was written by A. K. Sharma, P. Verma and D. Singh and published in the International Journal of Scientific Research in Computer Science, Engineering and Information Technology in 2022. This paper proposed an intelligent system for reducing traffic congestion using sensors, automation, and adaptive road management techniques. The system continuously monitors traffic density and temporarily increases road capacity whenever required. The authors concluded that temporary lane expansion combined with smart control methods can significantly improve traffic flow in congested urban areas.

## V. WORKING OF SYSTEM

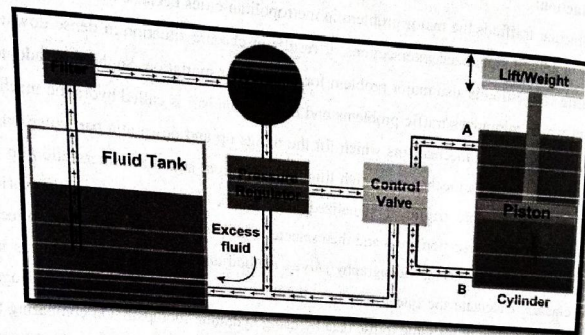


Fig 1: Hydraulic System

The working of the proposed smart hydraulic footpath system is divided into different modules so that the entire process can operate in a systematic and automatic manner.

### Emergency Vehicle Detection Module

This module is used to detect the arrival of an emergency vehicle such as an ambulance, fire brigade, or police vehicle near the traffic junction. The detection can be done manually by the traffic controller or automatically using RF transmitters, sensors, or a wireless signal provided in the emergency vehicle. Once the system receives the signal, it sends an activation command to the control unit.

### Control Unit Module

The control unit acts as the brain of the system. It receives the signal from the emergency vehicle detection module and decides whether the hydraulic system should be activated. The control unit may contain a microcontroller, relay circuit, or switch arrangement. After receiving the emergency signal, it turns ON the hydraulic pump and also activates warning indicators for pedestrians and drivers.

### Hydraulic Pump and Reservoir Module

The hydraulic pump and oil reservoir are the main parts of the hydraulic system. When the control unit activates the system, the hydraulic pump starts drawing oil from the reservoir. The pressurized oil is then sent towards the hydraulic cylinder through connecting pipes. The reservoir stores sufficient hydraulic fluid for repeated operation of the system.

### Hydraulic Cylinder and Footpath Movement Module

This module is responsible for converting the hydraulic pressure into mechanical movement. The hydraulic cylinder is installed below the roadside footpath. As hydraulic oil enters the cylinder, the piston inside the cylinder moves and causes the footpath platform to lower gradually. The footpath is lowered until it becomes level with the road surface. In this condition, the footpath acts as an additional temporary lane.

### Temporary Traffic Clearance Module

After the footpath reaches road level, vehicles standing near the roadside are able to move onto the lowered footpath area. This creates extra space on the road and allows the emergency vehicle to pass without delay. The system remains active only for a short time until the emergency vehicle crosses the junction.



### Footpath Restoration Module

After the emergency vehicle passes, the control unit sends a return signal to the hydraulic system. The hydraulic oil is sent back to the reservoir, causing the cylinder piston to return to its original position. As a result, the footpath rises again and becomes a normal pedestrian walkway. This module ensures that the road and footpath return to their original condition immediately after use.

### Safety and Warning Module

For safety purposes, the system includes warning lights, buzzer alarms, and indicator boards near the footpath. When the hydraulic system is activated, these warning devices inform pedestrians not to walk on the footpath and alert drivers that an emergency lane is being created. This prevents accidents and ensures safe operation.

### Automatic Street Light Control Module

The system also includes an LDR-based automatic street light module. During daytime, the street lights remain OFF because sufficient sunlight is available. During night time, the LDR senses darkness and automatically switches ON the street lights. This module improves visibility near the traffic junction and reduces electricity wastage.

Thus, the complete system works through the coordination of all these modules. The emergency detection module identifies the need for traffic clearance, the hydraulic module creates an additional lane, the restoration module returns the system to normal condition, and the street light module provides safe and energy-efficient operation. Derived from the uploaded project report.

## SYSTEM DESIGN

### 5.1 Overview of System

The proposed system is a smart hydraulic footpath mechanism developed to reduce traffic congestion and provide a clear path for emergency vehicles at crowded road intersections. The system is designed in such a way that a portion of the roadside footpath can be temporarily converted into an extra traffic lane whenever an ambulance, fire brigade, or police vehicle approaches. This is achieved by installing a hydraulic lift arrangement beneath the footpath.

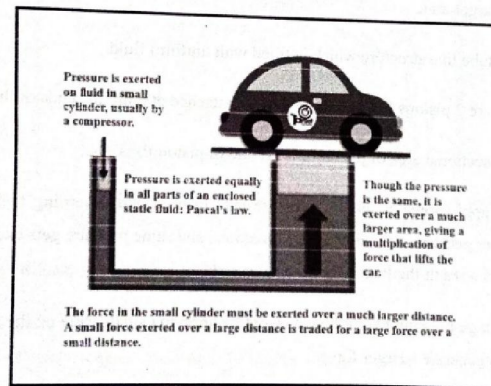


Fig 2: Principle Hydraulic jack

Under normal conditions, the footpath remains at its original height and is used by pedestrians. When the system receives an emergency signal, the hydraulic mechanism is activated and the footpath is lowered to the same level as the road. Vehicles standing near the side of the road move onto this lowered platform, thereby creating enough space for the emergency vehicle to pass quickly through the traffic. After the emergency vehicle crosses the area, the footpath is restored to its original position automatically.

The system also includes an automatic street light control mechanism using an LDR sensor. The street lights turn ON automatically during night and OFF during daytime, which helps in reducing electricity consumption. Thus, the proposed system provides a combined solution for traffic management, emergency vehicle movement, and energy saving. Derived from the uploaded project report.



## **5.2 Main Components of System**

The proposed hydraulic traffic reduction system consists of the following main components:

### **Hydraulic Jack / Hydraulic Cylinder**

The hydraulic cylinder is installed below the footpath and is responsible for lifting or lowering the footpath platform. It converts hydraulic pressure into mechanical movement.

### **Hydraulic Pump**

The hydraulic pump supplies pressurized oil to the hydraulic cylinder. It helps in operating the footpath movement mechanism.

### **Oil Reservoir**

The oil reservoir stores the hydraulic fluid required for the operation of the system. The pump draws oil from this tank whenever the system is activated.

### **Control Valve**

The control valve controls the direction of hydraulic oil flow. It decides whether the footpath should move downward or return to its original position.

### **Footpath Platform**

The footpath platform is the movable portion of the roadside footpath. During emergency situations, this platform is lowered and used as an additional lane.

### **Electric Motor**

The electric motor is used to drive the hydraulic pump. When the control unit gives a signal, the motor starts and the hydraulic system begins working.

### **Emergency Vehicle Detection Sensor**

This sensor detects the arrival of an ambulance, fire brigade, or police vehicle. It can be a manual switch, RF receiver, or sensor-based detection unit.

### **Control Unit / Microcontroller**

The control unit receives signals from the sensor and controls the complete operation of the system. It activates the hydraulic pump, warning lights, and restoration process.

### **Warning Lights and Buzzer**

These components provide safety indications to pedestrians and drivers when the footpath is being lowered or raised.

### **LDR Sensor**

The Light Dependent Resistor is used in the automatic street light system. It senses light intensity and controls the switching of street lights.

### **Street Lights**

The street lights are automatically controlled by the LDR circuit to provide illumination during night time.

### **Connecting Pipes and Frame Structure**

Pipes carry hydraulic oil between the reservoir, pump, and cylinder. The frame structure supports the footpath and all other components of the system. Derived from the uploaded project report.

## **VI. RESULTS**

The developed smart hydraulic footpath system was tested under simulated traffic conditions to evaluate its effectiveness during emergency situations. The results showed that the system lowered the footpath successfully within a short duration and created an additional temporary lane along the roadside. This extra lane enabled vehicles to move aside easily, thereby creating a clear path for ambulances, fire brigades, and other emergency vehicles.

During testing, traffic congestion at the junction reduced noticeably after activation of the hydraulic system. The travel time required for the emergency vehicle to cross the congested area was significantly lower than in normal traffic conditions. The system also restored the footpath to its original position immediately after the emergency vehicle passed, without affecting regular road traffic or pedestrian movement.



The hydraulic mechanism operated smoothly throughout repeated trials. The hydraulic cylinder, pump, and control valve functioned properly and were able to support the required load without any major leakage or mechanical failure. The response of the system was reliable and suitable for practical use in urban traffic conditions.

The warning lights and buzzer system also worked effectively. These safety devices informed both drivers and pedestrians when the hydraulic footpath was being lowered or raised. As a result, the chances of accidents or unsafe movement near the footpath were minimized.

The LDR-based automatic street light module produced satisfactory performance under different lighting conditions. The street lights turned ON automatically during night and switched OFF during daytime, reducing unnecessary electricity consumption. This feature increased the overall efficiency of the system and made it suitable for smart city applications.

Overall, the obtained results indicate that the proposed smart hydraulic footpath system is an economical, efficient, and practical solution for reducing traffic congestion and improving emergency vehicle movement at urban intersections.

## VII. CONCLUSION

In conclusion, the proposed smart hydraulic footpath system provides an effective and innovative solution to the problem of traffic congestion at urban intersections, particularly during emergency situations. The system successfully creates an additional temporary lane by lowering a portion of the roadside footpath through a hydraulic mechanism, thereby allowing ambulances, fire brigades, and other emergency vehicles to move quickly without delay. The study proves that hydraulic technology can be used efficiently for temporary road expansion without requiring major modifications to the existing road structure. The integration of warning indicators and an automatic LDR-based street light control system further improves the safety and energy efficiency of the overall design. The experimental results demonstrate that the system is simple to operate, economical, reliable, and suitable for use in smart city transportation networks. Therefore, the proposed system can play an important role in reducing traffic congestion, improving emergency response time, and creating a safer and more efficient urban traffic management system.

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