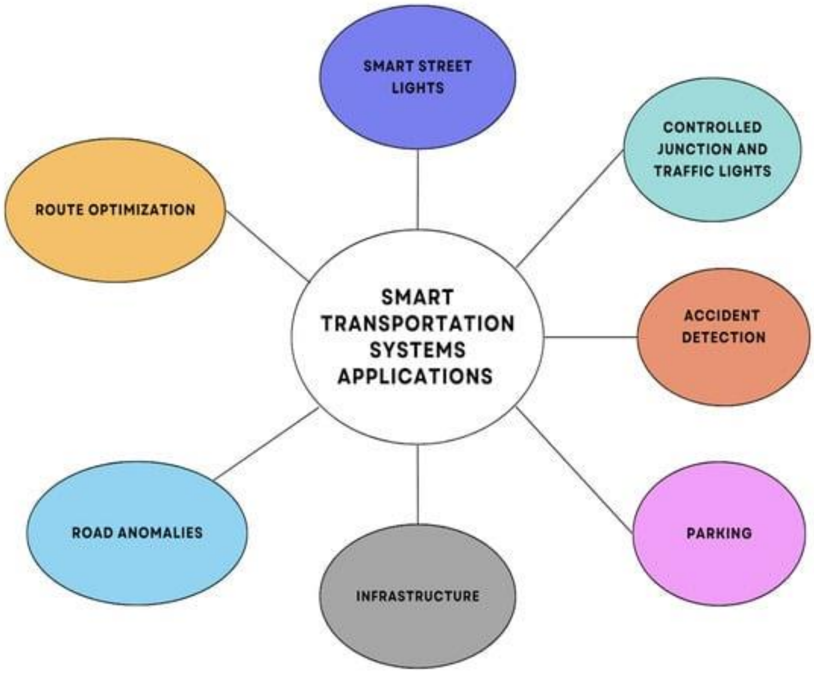
5.2.1 Smart mobility and transport

we examine the main current smart transportation systems. These systems are divided into seven classes based and their functionality as depicted in Figure We divided these systems to provide a structured understanding of the different types of systems and compared their functionalities pertaining to smart transportation systems.



Route Optimization

Urban regions frequently have traffic congestion, which is only worsening as more vehicles are added to the road. In order to reduce traffic congestion, route optimization proposes the optimum path for a given destination. Both the amount of time it takes to travel and vehicle emissions are decreased by reducing traffic congestion. The route optimization problem has been widely challenged and researched in the literature by applying various technical approaches to the IoT infrastructure.
Google was one of the first companies to harness the potential of crowdsourcing for developing new services. All modern mobile devices are compatible with the free Google Maps app. Integrated GPS, accelerometer, and gyroscope sensors are found in mobile devices. In 2009, Google unveiled a brand-new service that would provide users access to traffic data within Google Maps. Fixed location sensors or other monitoring systems did not gather the traffic data. Using the maps application, the end user's mobile device can submit anonymous information about their location and speed. To reduce congestion, Google Maps can now recommend other routes based on traffic data.

Parking

By eliminating the need to hunt parking lots in search of an open spot, making it easier to find available places in advance helps lessen traffic and pollution [29]. Many parking applications are created to monitor parking lot availability efficiently, provide users with reservation options, and even incorporate parking detection and alerting systems. Many IoT devices have been employed to detect the presence of a car in a parking spot and convey the information to a centralized system. Additionally, other studies apply ML algorithms that use image data to detect free parking slots massively. Saarika et al. [57] proposes a smart parking strategy with the concept of an IoT-supported parking lot and a smart signboard to display pertinent information.

Ultrasonic sensors in the parking lot will determine whether parking spaces are available, and a WiFi module will gather and transfer the data to a cloud server. A user can now utilize a smartphone application or a smart signboard to check parking availability. The signboard is an LCD or LED display powered by a Raspberry Pi that will gather and show data on parking accessibility, weather conditions, travel times to specific locations, etc.

To determine availability, the authors in [108] also place ultrasonic sensors at each parking space. The sensor is linked to an Arduino Uno, which uses an ESP8266-01 WiFi module to transmit data to a cloud server. The MQTT protocol is used for communication. The cloud server runs Thing Speak, an IoT platform that provides customers with various management and monitoring options. Last but not least, customers can download an Android app that enables them to reserve parking spaces and automate parking payments.

Lights

Smart Street Lights (SSL) are a crucial component of a smart city and are included in the category of smart transportation services. Smart lighting can save energy while providing dynamic functionality and manageability. We implements an SSL implementation based on IoT technology. By including a light sensor, an IR sensor, GPS, and a wireless connection module, streetlights acquire smart features. By being aware of congested locations and dynamically adjusting their light intensity, lamps can make densely populated areas safer while simultaneously using less energy.

When the street light breaks, the GPS can let a centralized system tracks its location and condition and expedite maintenance procedures. The NB-IoT network serves as the foundation for the communication between the management system and SSL. The management system is built on fog nodes, which gather information from a number of bulbs and periodically assess their condition.

In addition to the automatic processes that SSLs offer, they can also be remotely administered via the established management platform. Kokilavani and Malathi presents a similar and simpler method for smart lights. This design connects the lamp with a light sensor, an IR sensor, and an IR led using a raspberry pi as the microcontroller.

The sun’s rise and set will be detected by the light sensors, which will then turn on and off the bulb. In order to save energy, the lighting can also recognize passing vehicles or pedestrians and switch the lamps on and off dynamically.

Controlled Junction and Traffic Lights

A controlled junction uses traffic lights to control when vehicles may enter the junction. This is done in an effort to smooth access to a traffic jam on the route. Sensors are frequently used to control traffic signal junctions. These sensors identify areas where traffic accumulates as it approaches the junction and then extend the green light to allow for more vehicles to pass through. Transponders installed in junctions can also be used to prioritize entry to the junction so that emergency vehicles and public transportation can move through the junction more quickly.

By carefully regulating the timing of traffic signals and the speed of approaching cars, intersection control tries to maximize junction throughput and reduce stopping time.
The authors in the research suggest a revolutionary decentralized traffic light control system that utilizes wireless sensor networks.
The wireless sensor network, the localized traffic flow model policy, and the higher-level coordination of the traffic light agents are the three levels of the system architecture. The nearest Intersection Control Agent (ICA) receives data from the wireless sensors, which track the number, speed, and other characteristics of passing cars, and uses it to estimate the intersection's flow model.
The real-time adaptive control of the traffic signals is the key contribution. This will also enhance the movement of cars. By regulating the traffic lights, an intersection control agent controls the intersection. To control a larger area, several intersection agents can communicate with one another.

5.2.2 Industrial IoT

The Industrial Internet of Things (IIoT) is the collection of sensors, instruments and autonomous devices connected through the internet to industrial applications. This network makes it possible to gather data, carry out analyses and optimise production, increasing the efficiency and reducing the costs of the manufacturing process and the provision of services. Industrial applications are complete technological ecosystems that connect devices and these with the people who manage the processes in assembly lines, logistics and large-scale distribution.

Current IIoT applications are primarily concentrated in manufacturing, transport and energy, with **an investment of over 300 billion dollars worldwide in 2019 which is expected to double by 2025.** In the immediate future it is expected that the adoption of the IIoT will result in the implementation of more industrial robots, such as cobots, warehouse and transport control systems, and predictive maintenance systems.
The difference between the Internet of Things (IoT) and its industrial version (IIoT) is that while IoT focuses on services for consumers, **IIoT focuses on increasing safety and efficiency at production sites.** For example, consumer solutions have focused on smart devices for the home, from virtual assistants to temperature sensors or security systems, or for people, such as wearables that monitor health.

CHARACTERISTICS OF THE INDUSTRIAL INTERNET OF THINGS (IIOT)

Not all systems can be classified as IIoT. In general, they need to be networked systems that generate data for analysis and produce concrete actions. The operation of IIoT systems is based on a layered structure:

Devices. The visible part of the system is the devices: sensors, GPS locators, machines, among others.

Network. Above this is the connectivity layer, i.e. the network that is established between these devices and the servers through cloud storage or edge computing.

Services. These are computer applications that analyse the data collected and process them to offer a specific service.

Content. This is the interface with the human operator, which can be a computer, a tablet or even devices such as virtual reality or augmented reality glasses.

APPLICATIONS AND SOLUTIONS OF THE INDUSTRIAL INTERNET OF THINGS (IIOT)

The applications of the Internet of Things in industry are varied, but below we review some of the most relevant:

- **Use of autonomous vehicles**
  The transport of components to the plant or products to the warehouse can be done by autonomous vehicles that are able to move from one side of the factory to the other by detecting obstacles.

- **Optimisation of machine performance**
  An inactive machine represents a loss of revenue. Thanks to sensors and data processing, it is possible to optimise machine utilisation time inside a manufacturing plant.

- **Reduction of human errors**
  Human operators will continue to be essential for many tasks, but the tools they use will be connected to the system to save time and avoid errors.

- **Improvement in logistics and distribution**
  Stored products incorporate sensors that provide real-time data on their location and even on their temperature and surrounding conditions which will be particularly useful during, for example, the distribution of the COVID-19 vaccine.

- **Decrease in the number of accidents**
  Wearables, such as goggles, bracelets and gloves, allow data to be collected from the operator wearing them. Examples of this data range from their location or proximity to machines, to their pulse, temperature and blood pressure, thereby reducing the possibility of accidents.

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The impact of the Internet of Things
on some industries

ELECTRICITY
- Plant automation
- Checking of the condition of equipment
- Maintenance of sustainable environments

TRANSPORT
- Real-time management of orders and shipments
- Automated vehicle tracking
- On-demand inventory management

GAS AND OIL
- Measurement of crude oil extraction ratios
- Connected oil and gas pipelines
- Remote asset monitoring and management

HOSPITALITY
- Room automation
- Improvements in room service
- Integration between resorts

WATER
- Water flow controllers
- Waste water treatment
- Smart consumption management

Source: DZone.