

Intelligent Transport Systems for Vulnerable Transport Users: Use of Assistive Technology for Sustainable Development Goal Target 11.2

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Abstract—Intelligent transport system (ITS) has got acceptance and applicability in real life with emergence of various disruptive technologies as these technologies are helpful in managing the dynamic real time situation leading to effective utilization of resources. However, there is need to enhance the scope of ITS so that it shall address the issues of the section of the vulnerable transport users for their ease. These vulnerable users include children, women, old, cyclists, pedestrians, or persons with different abilities. Target Sustainable Development Goals (SDGs) 11.2 has focused on the said issue and advocates inclusive transport system that may be helpful to vulnerable users. Assistive technology may play a key role in developing such transport system. The present work is an effort to identify such assistive technologies that shall be incorporated with the existing ITS for Vulnerable Transport User (ITS4VTU). A separate layer for such purpose vehicle-to-vulnerable is also advocated by the present study.

Index Terms— Artificial Intelligence, Intelligent Transportation System, Assistive Technology, Sustainable Development Goal, Vulnerable Transport User.

I. INTRODUCTION

Sustainability is the key for our survival and our co-existence in this world. It is the collective duties of all to protect the planet earth once it has been set into order. That is why United Nations (UN) has defined a multi-dimensional shared blueprints in the form of 17 Sustainable Development Goals (SDGs) so that everyone in this planet may prosper and live in peace [1]. The SDGs have defined targets to be achieved by year 2030. SDG 11 is focused on achieving safe, resilient, inclusive, and sustainable human settlements and cities. Various targets has been set by SDG 11 and one of them is related sustainable transport systems for vulnerable (Target 11.2) [2]. With the emergence of Artificial Intelligence (AI) [3] and other disruptive technologies, Intelligent Transport System (ITS) [4] has received considerable attention as these technologies are helpful in management of highly interconnected multi-model transport networks leading to safety, efficiency, and sustainability. By deploying traffic monitoring networked devices and by utilizing the services of wireless communication, the real time real time traffic data may be collected. The acquired data is then transferred to the traffic control centers for taking decisions and to do optimization accurately. The offered services may real time response, the traffic flow management, congestion control, resource optimization, and various other targeted & effective transport services. With the conceptualization and development of smart cities [5], the technologies may be utilized in

multiple dimensions that is an opportunity and will pose challenges in the context of ITS. One such challenge is to address the issues of vulnerable persons and technologies may play a prominent role in it. These vulnerable persons may be children, women, old, Cyclists, pedestrians, or persons with different abilities. The SDG target 11.2 specifically focused on the said issue and AI is the candidate technology for assisting the implementation.

A. Artificial Intelligence and its Applicability

AI came in existence with various approaches and methods to solve the complex problems in a defined manner which human beings are more comfortable with. The evolution of AI and the use of it have been improved and increased with the growth of many sectors [6]. AI refers to the intelligence and set of instructions that are generally given to the robots to operate as per the provided instructions. In today's world, AI has become the most popular with all the advancements and technologies. The simulation of human intelligence by the programmed machines guided by the set of instructions and trained data. These machines help in solving the human tasks and improve the complicated tasks in a pre-defined manner. The AI help in analyzing and present patterns of the datasets and are able predict the future trends. It has a capability of dealing big datasets to solve the problems accurately.

The AI helps many real-time products to improve their capabilities. It also helps in adapting the data by upgrading the real-time datasets with many benefits. The working of AI depends on machine learning, neural networks, and deep learning techniques. All these techniques help to enable the AI approaches and methods to improve the characteristics and features of the technologies which are widely used to growing and enhancing the transportation sector to an extent. Apart from transport system, there exists various applications that uses AI. Few of these are mobile industries, navigation & travel, video gaming, banking sector, and smart home systems.

B. Role of AI in Transport System

AI has been implemented in road transport, aviation, shipping and railways, navigation ports, and numerous transport fields [7]. It helped to increase the functionality and performance of the transportation field and also helps in making accurate decisions on implementing strategies. The main objective of AI in transportation systems is to provide easier, cleaner, and safer modes of transport and to address the problems such as heavy traffic flow, route optimization, road safety and others. It also helps in infrastructural facilities projection [8]. There are various advantages with the implementation of AI in the transportation field such as reducing accidents, decreasing the number of deaths during accidents and helping in detecting and predicting the traffic flow, and examining the activities through the cameras [9]. It plays an important role towards autonomous trucks that reduce the severe impacts and improved the safety measures of the modes of transportation. The real-time example of transportation is the self-driving vehicle which helped in decreasing accidents and injuries.

C. Intelligent Transportation System

The ITS plays an important role in enhancing all modes of the transportation system. It aims to provide all the advanced methods and helps all the citizens to travel more easily and safely. The concept of an ITS is to save the time of all the citizens and to reduce the impacts of traffic problems. The objectives are to make the city smarter and increase the effective implementation methods to solve all the encountering issues that are related to traffic congestion. Automated techniques and technologies usage is to be incorporated for the said purpose. The operational process of an ITS helps in managing all the complicated tasks and accurately solves them. ITS other objectives are to help in improving the safety of the traffic and reduces the pollution of the city. The technology helped in collecting, storing, and analyzing the real-time systems to improve the parameters based on speed, performance, and accuracy.

The intelligent transport system implementation is all about exchanging and handling the instructions to control the systems and appropriately operate the real-world interface. All the applications which are used in architecture are traffic, travelers, and emergency. These applications help to provide all the interfaces and help to provide essentials to the services.

II. REVIEW OF LITERATURE

Several methods and research are carried out on this transportation system to analyze the working of AI systems. Table 1 shows the research and the existing methods that are used for building the model.

TABLE I. LITERATURE REVIEW OF ITS WITH FOCUS AND METHODOLOGY

Research	Country	Main Focus	Methodology/Results
[10]	USA	The author's contributed, mainly on the frameworks that are suitable for smart cities using intelligent traffic management systems. This work mainly focused on enhancing efficiency by using closed-loop management systems.	This framework is based on the multi-agent systems that manage the potential traffic congestions to reduce the overall traffic time in most of the metropolitan cities.
[11]	China	In this paper propose high-speed control systems, especially in trains. They are several operations of the train like GPS, sensor data, train control, GSM signal, etc. The main focus is to provide safety, operations, maintenance, and passengers services, etc.	Fuzzy RDF model is used to improve uncertain reasoning in the context of train control system.
[12]	China	Authors demonstrated new concept, driving the scenario Internet. This is an intelligent vehicular network and referred by author as Cognitive Internet of Vehicles. This project aims to address the person which is previously mentioned while driving.	The research used AI, edge computing alongwith cloud computing, and 5G network slicing. By extracting useful data from both physical and information data space, Cognitive Internet of Vehicles improves transportation safety and network security.
[13]	China	The objective of this research is to improve road safety using the Internet of things. The emphasis has been given on various vehicular communication modes.	To have efficient transmission scheduling, deep Q learning is used. It is an attempt to develop an efficient data communication scheduling technique to overcome the cost of cognitive vehicular networks.
[14]	Hong Kong	This paper providing information about the future transport system. It addresses the facilities provided to the people, such as a smarter vehicleinfrastructure and a good pedestrian environment.	A connected environment is used to overcome the challenges in the transportation system.
[15]	Australia	Authors present the idea that providing an overview of applications in artificial intelligence, especially in the transport system. The main focus is on addressing the challenges of AI in the transport problems such as traffic management, safety, etc.	Research emphasized the role of Artificial Neural networks, fuzzy logic, and genetic algorithms to overcome the challenges in the transportation system.
[16]	UK	The aim of this paper provides information about the novel concept of AI where the transport system affects the urban. The author also states the dimension of the new transport mobility era.	ANN technique is used to analyze the smart city transport system.
[17]	Canada	The study is carried out on sustainability challenges and changes that are happening in the intelligent transport system. This review states the AI usage in different future studies on approaches for system dynamics, design thinking, and so on.	This paper provides the challenges that are faced in the transportation system where ANN is used to analyze.
[18]	China	The technology is updating every day where AI-based efficient protocol is built/developed for intelligent transportation systems. This proposed work implements Distributed Artificial Intelligence (DAI) by combining it with a neural network. This network produces an efficient routing system while compared with the other several existing methods.	This proposed method uses DAI neural network with Self Organizing Map (SOM) which provides the best solution for energy consumption by the network.

III. SDG 11.2 AND VULNERABLE TRANSPORT USERS

Globally, the number of persons that need assistive instruments are more than 1 billion but only 10% of those require have possession due to various factors [19]. To encouraging social inclusion a well-functioning transportation infrastructure is essential at various levels of society. For the said purpose SDG 11.2 is focused. The aim is to provide the transport services with special attention to vulnerable transport users. This study focuses on a ITS for vulnerable transport users. Vulnerable users (as depicted in fig. 1.) include children, women, old, Cyclists, pedestrians, or persons with different abilities. They are all disproportionately represented in road accidents, especially as pedestrians. In addition, because disabled people have reduced mobility and/or sensory perception, a conventional ITS may not fully meet their needs. ITS shall have a special focus to make their travel easier and safer.

The ITS shall identify the pedestrian crossing and shall be able to locate pedestrians with disabilities, identify the precise sort of disability, and deliver adaptive responses based on the disability. Furthermore, by being aware of the location of the crippled pedestrian, the infrastructure can respond in a way that maximises help for the latter. Here are a few examples:

- People with mobility or cognitive disabilities will benefit from a green phase that is tailored to their needs.

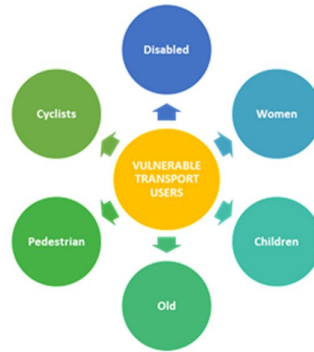


Fig. 1. Vulnerable Transport Users

- Additional audio information for pedestrians with visual or cognitive problems, beyond the standard beeps or ticks. The message content and loudness of the audible message can be adjusted based on how close the waiting area is to the impaired pedestrian's current location.
- For pedestrians with hearing or cognitive disabilities, a variety of visual signals are available. It is possible to provide visual assistance to the visually impaired pedestrian as close as possible because of the position of the pedestrian in relation to the system.
- Flashing light systems in the pavement can be used to assist walkers with cognitive or hearing problems in finding their way.

For such vulnerable users Assistive technology [20] may play a significant role. It is an umbrella term that is used to refer the set of technologies used by person with disabilities or old/children/women to the activities that they find it difficult or impossible. Some of the examples are technologies used in automated wheel chair, hearing aid, vision aid, etc.

IV. ASSISTIVE TECHNOLOGIES AND ITS4VTU

Assistive Technology is very much helpful in improving functioning of a person and hence enhancing their well-being and quality of life. One of the main challenge for ITS4VTU is to recognize vehicle-to-vulnerable as an explicit layer of the ITS as depicted in figure 2.

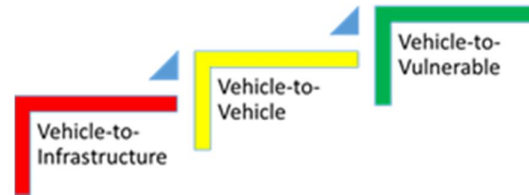


Fig. 2. ITS4VTU Layers

The layer vehicle-to-vulnerable must be able to recognize and utilize the assistive technologies. Some of the useful assistive devices [21] are (also refer fig. 3.):

- **Mobility Aids:** The various orthotic devices, and prosthetic devices such as walker, wheelchair etc. may be automated with assistive technology for ease of use.
- **Assistive Listening Systems:** FM systems, infrared systems, personal amplifiers may be used to help people assist in more clearly.
- **Cognitive Aids:** Memory aid, speech recognition, voice recorder, word prediction software, personal digital assistant and mnemonics are used to help people with attention, memory, or other thinking skills deficiency.
- **Physical Modifications:** Modification are required to the provide and environment for vulnerable users such as ramps, wider doorways, grab bars, adapted vehicle, automated kiosk, tactile guiding paver and tactile warning paver to enable access to buildings, and workplaces.

- **Wearable Technologies:** Smart watch, smart wrist band, smart jewelry, fitness tracker, smart clothing, various implantable in the body, and head-mounted display are used to allow the person with limited motor skills to accomplish various activities.

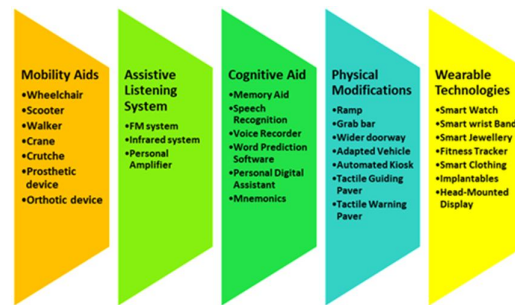


Fig. 3. Assistive Technologies for ITS4VTU

So, to develop an ITS4VTU the provisions must be made where vehicle-to-vulnerable layer shall be able to identify and utilize assistive technologies as depicted in fig. 4.



Fig. 4. Vehicle-to-Vulnerable layer Assistive Technologies in ITS4VTU

V. CONCLUSIONS

The present research work described the role of AI in ITS. It also presented the various works in this direction in different countries. Further, it attempted to identify the various vulnerable users in transport system such as elderly, women, children, differently abled and others. Since vulnerable users need special provisions, it has been emphasized that assistive technologies shall be used in ITS. The research then proposed a vehicle-to-vulnerable layer shall be included in layered architecture of ITS. The vehicle-to-vulnerable layer must be able to recognize and utilize the assistive technologies identified in this research. It has been referred to as ITS4VTU (Intelligent Transport System for Vulnerable Transport Users). This article will also help the new researchers who want to contribute on different dimensions of the transport system.

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