Role Of Artificial Intelligence In Automatic Traffic Light Detection System

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Abstract: In the era of high-end cutting edge technology, Artificial Intelligence (AI) serves as the backbone of intelligent & self-adaptive devices. AI has spread its root in almost every field by providing ease in the development of powerful, robust, and expeditious devices. These AI-based systems serve as a helping tool for Driver Assistance system (DAS) and Traffic Light Detection Systems (TLDS). These systems can be of great help to a visually deficient or a Colorblind person by generating alert messages and helping collision avoidance and saving the driver from any mishap. TLDS may also strengthen the mobility of visually challenged and old-aged. The TLDS stages can be categorized into four steps, preprocessing for noise removal, segmentation for region of interests (ROI) generation, feature extraction actual color, and shape detection. The Application areas for AI in computer vision and image processing are lane detection, trajectory planning, motion detection, geo-location localization, traffic lights, and signs detection, etc. This study concentrates on AI-based TLDS tools/apps and videos. As a result of AI-based TLDS, the roads will be more mobile, energy-efficient, less collided thus saving human lives.

Index Terms: Artificial intelligence, Driver assistance system, Traffic Light detection system, visually color deficient, Computer vision, Image processing, Segmentation & classification.

1 INTRODUCTION

Artificial intelligence has flooded the automobile market by its innovative support in numerous sub-systems of a system as complex as a DAS [1-2], thus improving its overall efficiency and making them more road-safer. In manual detection driver's un-attentiveness, fatigue, mental stress, color-blindness can be fatal. Using a TLDS can make driving easier without worrying about the traffic light orientation, illuminations, and varying weather conditions. The AI-based tools have various applications such as object detection, object recognition, and classification, pattern matching, sentiment analysis, etc. [6]. The most crucial task for an intelligent vehicle is to percept its surrounding environment and make a quick decision at intersection crossings, crosswalks, and minimizing a collision. For this computer vision comes into the picture. With the help of image processing, real-time traffic images are generated and various complex tasks like route planning, traffic light, and sign detection, Lidar & camera-based localization, online and offline occupancy grid mapping for varying environmental conditions, metric & topological road mappings, moving object tracking using grid-based models, sensors and stereo, lane detection, pavement markings, trajectory planning, collision avoidance are performed [4][7]. The AI-based tools can help to make quicker and better decisions by providing accurate road information and generating alert messages accordingly. The role of AI in TLDS is discussed in this paper. The paper is further divided into many subsequent sections, part II suggests the various approaches to image processing, part III elaborated Color vision deficiency and its effect on human visualization, part IV describes the various AI-based tools used to implement DAS.

2 STAGES OF IMAGE PROCESSING BASED TRAFFIC LIGHT DETECTION SYSTEM

Computer vision-based traffic light detection system is broken into five stages. a) preprocessing for noise removal b) segmentation for candidate's extraction c) feature extraction for shape and color information extraction d) classification for categorizing traffic light as Red, Yellow or Green and Finally the last stage e) tracking for matching previously captured image with the new frames to detect if something has changed since the last capture or not? 2.2 Final Stage

Fig 1: *Five major stages of image-based traffic light detection system*

The pre-processing stage is provided with raw images as input data and then preprocessed to remove noises such as illumination, saturation, contrast, rain strokes, the shade of tree/leaves, etc. [5] [8-9]. The preprocessed image is then further processed to extract look-alike regions explicitly known as candidate regions. The extracted candidate regions are worked upon to extract regions that have high relevancy of color and shape of a traffic light, to classify them as either red, yellow, green lamps or human, cyclic or hand-shaped lamps. Finally, the tracking stage matches the lamp information with previously captured to verify if something has changed since the last capture or not? And generate an alert message accordingly. These stages provide as the backbone for the critical stage of tracking to help the driver make quick and correct decisions.

3 IMAGE PROCESSING BASED TOOLS/APPS FOR TLDS FOR VISUALLY IMPAIRED:

Image processing can provide robust results while being used for traffic light detection systems. There are cases where the driver is visually color deficient and needs an extra pair of eyes for keeping track of surrounding traffic to understand the traffic signs and orientations better [3]. With the help of AI-based detection applications such as Driver Assistance system app, Ringo, AutoGuard, DashCam, AutoBoy DashCam, CarDashCam, Speedometer DashCam, etc. All of these AI-based commercial applications can be used to detect Traffic Light signals with the help of your very own smartphone.These

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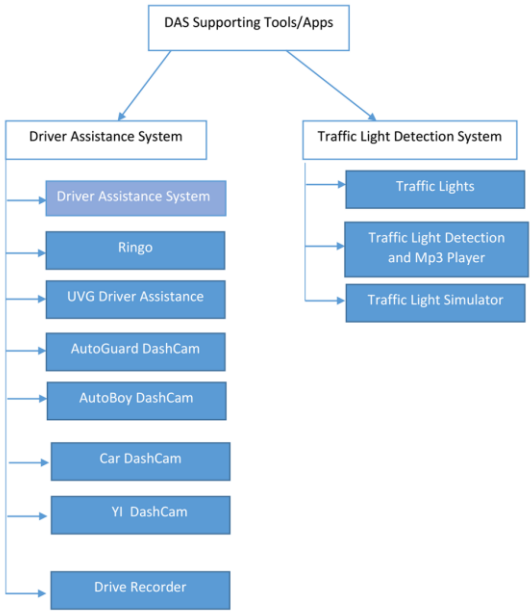
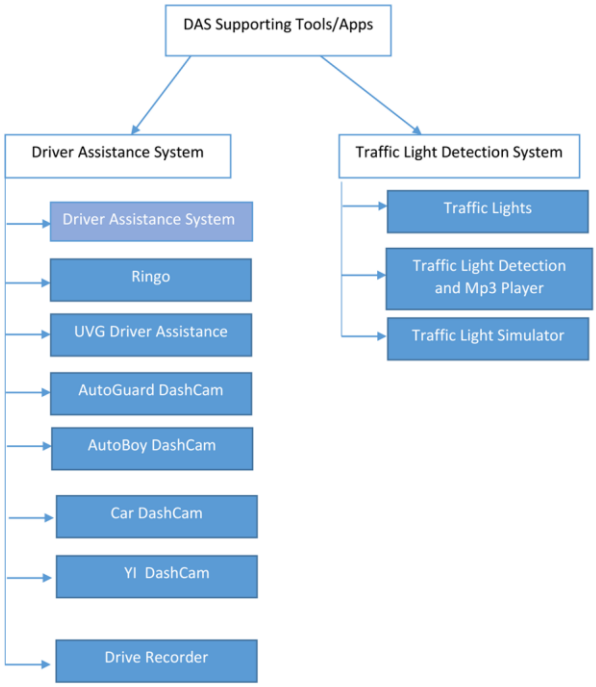
applications are not only capable of detecting Traffic Lights but also can be useful in localization, trajectory planning, collision avoidance, and many more tasks. Traffic lights are the most common tool for managing traffic around the globe and thus correctly identifying a traffic light and making quick and right decisions is the most crucial task for a DAS. Numerous tools/apps are available for providing mobile-based DAS support and can be categorized into two categories.



4 ROLE OF EXISTING TOOLS/APPS FOR DRIVER ASSISTANCE SYSTEMS AND TRAFFIC LIGHT DETECTION SYSTEM

Various tools & apps are available on the internet to help to provide a practical demonstration and a better understanding of how a DAS system works. Few of them are discussed in the subsequent sections

4.1 Driver Assistance System: This video records videos on your very own smartphone without requiring any external sensor or device. According to [14] this app performs three major functions, 1) DashCam 2) Lane Tracking 3) Anti-collision. Each of these functions performs their specified task to improve DAS performance.



4.2 AI-TLDnR: This app can be treated as a subpart of the complex DAS system. This app detects the Red light and locks it and play music from your phone's internal library to help you fight boredom while waiting. As soon as the light signal changes it generates an alert message by generating a beep sound and judges car moment along with traffic signal height. It supports collision avoidance by monitoring the speed of the vehicle and turns on the camera as soon as speed drops below 10km/h [10].

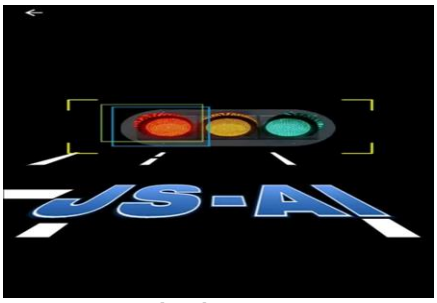


Fig 2) *AI-TLDnR*

Fig 3) *Music player*

4.3 Ringo:
An AI-based app that not only performs function but also asks about your opinions for improvements. Ringo can change the camera angle to get a better view of roads, supports distance estimation, and transforms the camera setting to landscape to portrait and vice versa accordingly [12]. This app also supports Lane detection, window mode, voice alert, and collision avoidance.

4.4 AutoBoy Dash Cam: AutoBoy provides the features of a black box on your smartphone. AutoBoy supports background recording in Three-full foreground and background recordings, camera zoom, focus, exposure, sound, flash, etc. are automatically controlled [13]. This app supports some advanced DAS features such as auto start of (car dock, gps, Bluetooth, power connection) when the door is opened and turn off otherwise. The recorded videos can be backed up on YouTube for future purposes.

5 EDUCATIONAL APPS ON FUNCTIONING OF TLDS:

Various traffic light simulators are available for demonstrating the functionality of traffic lights and how they switch between colors and shapes to make traffic flow easier. Some of the apps are listed in the subsequent sections that help to understand the traffic signals and how they toggle between light colors.

5.1 Traffic light simulator: Traffic light simulator app helps you simulate traffic signals and lamps like a real-time scenario. The traffic signals and toggle between light colors, with speed and phase length.

5.2 My Traffic Light free: This app provides a real-world scenario, with sounds of the roads, and demonstrates how the time (in seconds) are calculated and how you can simulate your traffic signals [11].

			
Fig a) Red Light	Fig a) Green Light	Fig a) Red Light with right green arrow	Fig a) Red Light with right yellow arrow.

6 EDUCATIONAL VIDEOS:

Educational videos are there to help you understand how a DAS with TLDS works by capturing real-time road data via a moving car and then pass that data to the TLDS. The TLDS further identifies the traffic light and highlights it in a box similar to that of traffic light color. A red, green or yellow circle is highlighted in the mentioned video to notify the driver with traffic signal color. This video also demonstrates the timer in seconds and calculates the distance between traffic light and the vehicle.

YouTube video Link: https://youtu.be/DP62ogEZgkI

7 CONCLUSION:

Driver Assistance systems are the must-haves for future cars. From making mobility easier to collision avoidance on roads, they play an important role in saving precious human lives. Different apps are available to detect Traffic lights from your smartphone without needing any additional sensor or hardware device. These apps are freely available and thus are commercially viable. Such type of applications is building pathways to futuristic cars. Artificial intelligence and image processing based Driver Assistance Systems having Traffic Light Detection Systems can be combined to improve mobility for older and visually deficient people, alerting a fatigued driver and making roads safer.

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