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TRACKING OF VEHICLE TAILLIGHT AND SIGNAL DETECTION BY EMBEDDED SMART CAMERAS

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Abstract—An important aspect of collision avoidance and driver assistance systems, as well as autonomous vehicles, is the tracking of vehicle taillights and the detection of alert signals (turns and brakes). In this paper, we present the design and implementation of a lightweight algorithm for a real-time vision system, capable of detecting and tracking vehicle taillights, recognizing common alert signals using a vehicle-mounted embedded smart camera, and counting the cars passing on both sides of the vehicle. In contrast to most existing work that addresses either daytime or nighttime detection, the Presented system provides the ability to track vehicle taillights and detect alert signals regardless of lighting conditions. The mobile vision system has been tested in actual traffic scenes and the results obtained demonstrate the performance and the lightweight nature of the algorithm.

***Index Terms*—Embedded cameras, vehicle signal detection,transportation, autonomous vehicles, collision avoidance systems, tracking, image processing, lightweight algorithms.**

I. INTRODUCTION

As reported by the National Safety Council in 2009, about a third of all automobile accidents that occur in the U.S .constitute rear-end collisions, with 30% of them resulting in severe injuries. Due to this fact, various detection systems have become popular for use with advanced driver assistance systems (ADAS) and potential autonomous vehicle applications (i.e. lead vehicle following, collision avoidance).The ability of computer vision-based systems to provide visual data for other advanced applications (e.g. brake and turn-signal detection) make them preferable over current systems being researched and marketed (radar-based and laser-based). Vision-based mobile tracking systems with decision capabilities have become a viable application with the development of embedded smart cameras capable of performing onboard processing and wireless communication.

Most of the research on vision-based algorithms can be classified into the following two categories (features from each category may be shared to increase reliability):

1. *Local feature*-based: individual frame information is used, extracted via morphology and color/intensity thresholds. Different color spaces may be employed
2. *Temporal information*-based: tracking one or many vehicles across many frames, with interference from other objects (typically encountered during daytime a more challenging scenario). Computationally more intensive methods, such as mean-shift tracking and particle filters, are required for more complex applications.

In this paper, we propose an efficient and robust algorithm for tracking vehicle taillights in all lighting conditions, detecting and classifying vehicle alert signals, and counting the number of passing vehicles in neighboring lanes. The algorithm is implemented entirely on a vehicle-mounted embedded smart camera and employs sophisticated correction mechanisms to increase the level of robustness. The main advantage of this algorithm over existing work is the ability to track taillights and detect vehicle signals at night, as well as during the day—a challenging and computationally expensive task

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The main advantage of this algorithm over existing work is the ability to track taillights and detect vehicle signals at night, as well as during the day—a challenging and computationally expensive task Due to the nature of these algorithms, a method designed for detecting vehicles during the daytime does not work during night-time and vice-versa (visual data available from a monocular camera at night are not sufficient for state-of-the-art object detection or template matching algorithms). Similarly, static-exposure night-time detection approaches fail in the daytime.

1.1 V2LC with LED Taillight and Rolling Shutter Camera

Visible light communication (VLC) has recently emerged to become a promising wireless communication technology. Vehicle lights and traffic lights have started to utilize LEDs and due to their shorter response time, they can be easily modified to become VLC transmitters. In addition, cameras embedded in smartphones can be used as VLC receivers. As a result, Vehicular VLC (V2LC) between vehicle lighting and smartphone cameras has the potential to enable a great number of applications with low cost. In this paper, a prototype V2LC system that utilizes under sampled frequency shift ON-OFF keying (UFSOOK) modulation is proposed.

The system utilizes rolling shutter cameras as the receiver and takes advantages of its characteristics to improve the receiving performance. An off- the-shelf vehicle LED taillight is used as the transmitter. Information is transmitted in the continuous state (ON-OFF) changes of LEDs which are invisible to human eyes. The performance evaluation results demonstrate that the communication prototype is robust and can resist common optical interferences and noises within the image.

1.2 Design and simulation of car taillight control circuit based on multisim

Simulation on the control circuits of the vehicle taillight is carried out in terms of the Multisim software. The design principle and constructive method of the circuits are explained in detail. Virtual instrument and element are used to fulfill the design and simulation of the cell and whole circuits. The innovation of the present method is the complementation between the hardware and the Multisim simulation software, which can lead to the diversity of the electric circuits' hardware design. It can be used to the training of the knowledge's integration, utilization, and transformation and increase the efficiency of the circuits' design.

1.3 Vehicle Security System Using Zigbee

The first car been stolen was reported in 1896. Since then, car safety tools and after that car security system faced a fast rapid development. The security system has become one of the key factors in car manufacturing as the demand from the buyer. The main objective of this project is to secure and monitor the car based on combination of Zigbee system, Peripheral Interface Controller (PIC) 16F877A microcontroller, vibration sensor, temperature sensor and micro switch. In order to develop a user friendly security system, it is used as a tool to send data or information to the Liquid Crystal Display (LCD) at the receiver for displaying the car situation. There are two programs used in this system which for the transmitter and the receiver. Proteus 7 Professional will be used in designing process of the circuit and to conduct simulation works. Meanwhile, PIC C Compiler software will be used to compile the C language code to Hexadecimal (HEX) code so that it is compatible to the PIC. The hardware and software issues of wireless monitoring system have been successfully developed by using Zigbee technology. This system is expected to enhance the capability of existing system and reduce cost of the system. With significant improved in range and reliable data accuracy in real time, this project promise a bright future with a high commercial value. In addition, with its compact and robust feature it attract future user in buying the product and the same time have good application value in future as well as reducing the statistic of stolen cars.

1.4 Vehicle distance sensor using a segmented IR laser beam

The determination of relative distances and relative speeds between vehicles is a prerequisite for the implementation of features like collision avoidance or automatic guidance in car control systems for the future. An experimental optoelectronic system for this purpose is described below which is based upon a multisegment infrared laser emitter and receiver system using no moving parts (i.e., a "staring" sensor, in contrast to

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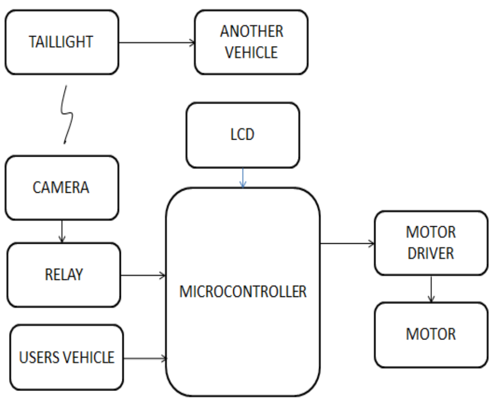
scanning Lidars). Infrared distance measurement systems will become known as one type of safety equipment for future vehicles. As described in the PROMETHEUS Topics of Research such systems could be used e. g. as sensor systems for smart cruise control, collision avoidance, or driver information systems. The basic research on future traffic systems requires different distance sensors in the range of 0.5 m up to 200 m. First experiments done by the European automotive industry with existing laser rangefinders have shown that this technique cannot be used for distance sensors for vehicles. Vehicles like cars are not reflectors inthe sense of a wall or a board. Vehicles appear, from the optics point of view, more like a facet mirror. It depends on the area of the car struck by the beam whether a narrow beam reflection signal can be measured or the light is reflected away and no signal can be found

III. PROPOSED SYSTEM

The important aspect of the paper is to avoid the collision that are caused by the vehicles mislead by the indicator. The input given is the taillights that are placed in the other cars. Initially the taillights are detected in camera. It uses Y'UV colour space in which the luminance(Y) and colour data (UV) are separated. In next step, it identifies the different intensity levels to plot out the day and night. It also identifies the soft threshold area. Upon identifying the soft threshold levels, it leave out the empty space and detects potential taillights to be tracked. Now it detects the colour combination such as red or white/yellow used in most of the cars by its intensity level. The lights are identified as symmetrical y axis so that it is not confused with neighbour cars. When the taillights are ON, it tracks the light leaving out the luminance and based on the light, the user's vehicle is automatically controlled. It is also shown in LCD display. Accidents are avoided

3.1 BLOCK DIAGRAM



3.2 MICROCONTROLLER

The AVR is a modified Harvard architecture machine, where program and data are stored in separate physical memory systems that appear in different address spaces, but having the ability to read data items from program memory using special instructionsA microcontroller has all or most of these features built-in to a single chip, so it doesn't need a motherboard and many components, LEDs for example, can be connected directly to the AVR. If you tried this with a microprocessor, bang.PC microprocessors are always at least 32-bit and commonly now 64-bit. This means that they can process data in 32-bit or 64-bit chunks as they are connected to data buses this wide. The AVR is much simpler and deals with data in 8-bit chunks as its data bus is 8-bit wide, although there is now an AVR32 with 32-bit bus.

3.3 LCD

A liquid-crystal display (LCD) is a display, electronic, or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements.The LCD screen is more energy efficient and can be disposed of more safely than a CRT. Its low electrical power consumption enables it to be used in battery-powered electronic equipment.

3.4 Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

3.5 Motor Driver

A motor controller is a device or group of devices that serves to govern in some predetermined manner the performance of an electric motor.A motor controller might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, regulating or limiting the torque, and protecting against overloads and faults.Every electric motor has to have some sort of controller. The motor controller will have differing features and complexity depending on the task that the motor will be performing.

3.6 Camera

A smart camera or intelligent camera is a vision system which, in addition to image capture circuitry, is capable of extracting application-specific information from the captured images, along with generating event descriptions or making decisions that are used in an intelligent and automated system. A smart camera is a self-contained, standalone vision system with built-in image sensor in the housing of an industrial video camera. It contains all necessary communication interfaces, e.g. Ethernet, as well as industry-proof 24V I/O lines for connection to a PLC, actuators, relays or pneumatic valves. It is not necessarily larger than an industrial or surveillance camera. A capability in machine vision generally means a degree of development such that these capabilities are ready for use on individual applications. This architecture has the advantage of a more compact volume compared to PC-based vision systems and often achieves lower cost, at the expense of a somewhat simpler (or omitted) user interface

3.7 AVR STUDIO

Atmel® Studio 6 is the integrated development platform (IDP) for developing and debugging Atmel ARM® Cortex®-M and Atmel AVR® microcontroller (MCU) based applications. The Atmel Studio 6 IDP gives you a seamless and easy-to-use environment to write, build and debug your applications written in C/C++ or assembly code.

Atmel Studio 6 is free of charge and is integrated with the Atmel Software Framework (ASF)—a large library of free source code with 1,600 ARM and AVR project examples. ASF strengthens the IDP by providing, in the same environment, access to ready-to-use code that minimizes much of the low-level design required for projects. Use the IDP for our wide variety of AVR and ARM Cortex-M processor-based MCUs, including our broadened portfolio of Atmel SAM3 ARM Cortex-M3 and M4 Flash devices.

IV. CONCLUSION

In this paper, we have presented an algorithm capable of detecting and tracking vehicle taillights, detecting alert signals (turns and brakes), and counting passing vehicles in neighbouring lanes. The latter functionality in particular has potential use for traffic engineers to monitor traffic volume using connected vehicles. We presented 'live test' experimental results with a vehicle-mounted embedded smart camera in actual traffic. The described algorithm is fully implemented on an embedded smart camera with low power requirements, capable of operating as a standalone device, with a processing time of approximately 183.16 Ms per frame (5.46 fps). Soft colour thresholds are used to pre-process a frame of video, image clean-up is performed through a series of tests, and Kalmanfilter and codebook are used for tracking the lights. The use of a code book allows for greater robustness. The presented method can track the vehicle taillights and detect alert signals during daytime as well as night-time

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