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IMPLEMENTATION OF TRAFFIC VIOLATION DETECTION AND TRAFFIC CONTROL

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Abstract

The researchers show much interest in the identifying the control system for street lights using electrical energy. The conceptual idea involved in this project is monitoring the street light faults and control of the street lights in the control room and identify the person who is not obeying the traffic rule. The ultimate goal of the system is to warn the drivers through loudspeakers for their violation of rules they do during driving and sufficient time is provided to them to respond towards the incoming traffic position. Anyhow, whenever they violate the traffic rules the off-line checking is carried out by saving the datas of vehicle such as vehicle speed, GPS location, and other driving parameters are considered.

Introduction

The glowing of light in the world for the past, over many countries in the streets is provided by large numbers of lamp units. Clearly, street lighting is a huge electricity consumer. Clearly, some strategies in order to increase the efficiency must be applied. It is not sufficient to turn off lights, since several researches showed that this approach leads to an increase in night-time accidents, with More people injured, and also in crime. For all these reasons an intelligent control and Management systems based on dimmable luminaries, advanced control and communication systems and administrative aids must be provided.

Most of commercial available solutions exploit power line communications (PLCs) to implement a local network among streetlights. Such a solution does not require installing additional transmission line, preserving the already available infrastructure. The supervisory software of the remote controller systems usually can graph power consumption, can switch the lamp status and can locate devices on a map by means of a Geographic Information System (GIS) database. The latter is a very useful capability, since it allows the maintainer to be informed where is located the faulty lamp. However, the streetlight position can be retrieved only by means of a preliminary on-site survey or installing a GPS unit for each lamp. Both the approaches are quite expensive, even if automatic position extraction from ortho photos has been also.

The great majority of traffic accidents are caused by driver inattention, distraction due to in-vehicle activities, and fatigue. Drivers are not fully aware of their inattention or the distracting effects of in-vehicle tasks on their driving performance. Along these same lines, the majority of traffic violations such as speeding and ignoring stop signs are unintentional, and they occur due to a lack of concentration, rather than because drivers deliberately break the law. These unintentional mistakes could also occur as a consequence of variations in performance level, rather than through a lack of respect for traffic laws. Thus, driving assistance systems for alerting drivers about their negligent behavior on the road and warning them to be more careful is considered a primary solution for preventing crashes. Unlike passive safety systems, such as seat belts and airbags which provide protection.

In the case of collision, active safety systems assist drivers by delivering visual and/or voice warnings. These warnings should be issued with sufficient notice so that driver has enough time to react to the on-coming traffic situation. It is important to stress that a device that can warn drivers about the speed limit at sites where driving at the wrong speed may result in an accident, and therefore prevent them from doing so, is a crucial safety solution. In this aspect, the use of computer vision techniques is a valuable instrument to implement in driver assistance systems.

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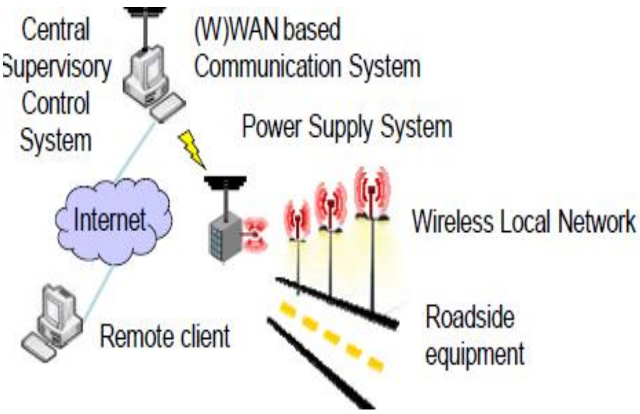
Another approach to enhancing the driving experience, and thereby safety, is improving driver behavior. This may be achieved by a data recorder device that could monitor and provide feedback on drivers' behavior. In fact, research carried out in shows that drivers involved in serious accidents where they are at fault, have a traffic violation record with a number of offences that is clearly above the average. There are also a great number of drivers involved in accidents who have no prior traffic violation record. But it seems obvious that drivers with a record containing several traffic violations have a much likelihood of becoming involved in a traffic accident. In this respect, systems that perform as driving surveillance could prevent drivers from committing traffic violations and infringements by instilling improved behavior. Thus, systems for alerting and recording driver violations should be considered as an alternative for deterring drivers from aggressive driving, rather than conventional punishments. This paper describes SACAT, an experimental system for traffic violation alert and management, which consists in combining the two approaches aforementioned: a computer vision system for traffic sign detection, and the automatic switching of street lights and fault identification.

SACAT: The experimental platform.



A Two-tire wireless adaptive street light controller

Architecture of the remote street light control system

The project defines a monitoring system for adaptive street lighting made up of five subsystems; roadside equipment; power system; local control system; central supervisory control system and communication system/network. In addition, it must be highlighted that typical deployment of adjacent streetlights mimics a line-of-sight (LOS) environment. In fact, streetlights are mounted above high poles, and their spacing guarantees that many lights are in range of each other. Hence, path redundancy is easily accomplished even with a reduced power link budget.

Moreover, the streetlights must be powered, so this energy is also available for the wireless streetlight controller during normal operation. The controller can be also powered by a battery pack, recharged by means of a solar

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harvester, in order to counteract power line faults. The number of streetlights within a municipality may be very large; it is therefore crucial to have an asset management and optimization system. Such a system should help service providers to properly manage the maintenance of streetlights. Thanks to the availability of a communication system that allows collecting data coming from an instrumented streetlight, pro-active maintenance is possible.

The asset database should have a web interface, in order to be accessed easily not only by the operators, but also by the public. In this way, final users could immediately notify a lamp fault. For this reason, most of the commercial systems implement the human-machine interface as an intuitive GIS system.

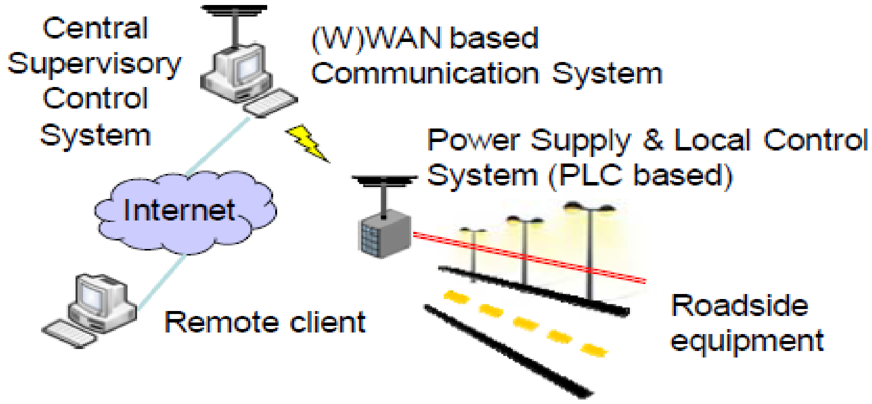
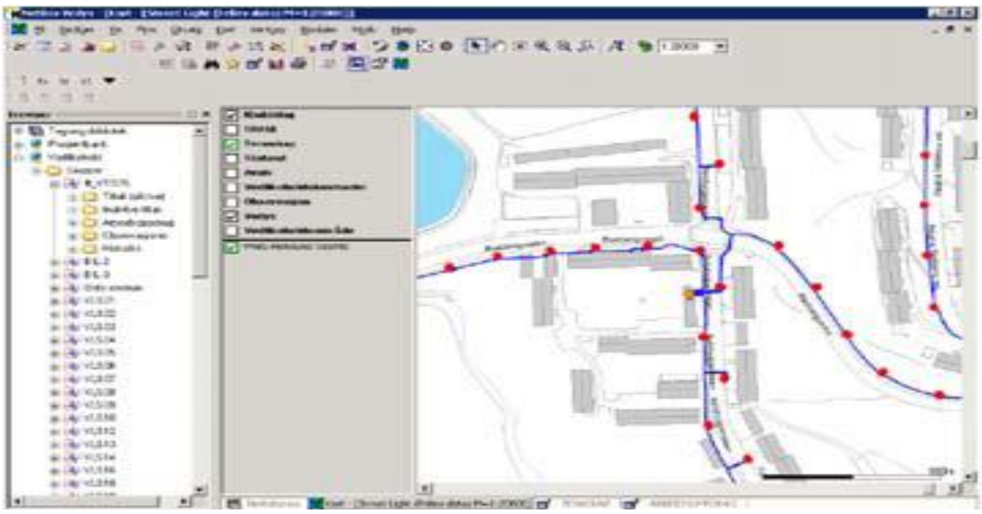


Figure 1. A sketch of the adaptive street light controller.

The geo referencing process is normally performed by hand; therefore it is a very time consuming step in the development of the streetlight control system. In principle, the process could be automated installing an additional GPS module for every lamp pole; however, this approach is economical unfeasible in most of applications and cannot be applied for indoor lighting systems.



In many cases absolute geo localization is not needed; often it is sufficient to locate the lamp position in a coordinate system relative to the supply cabinet, which is a natural anchor point. Such a consideration suggests providing each lamp with a local wireless ranging device and in case to equip only the cabinet with a GPS receiver. Simple and cheap “Local Positioning Systems” based on the received signal strength could be suitable, but are strongly affected by the environment and require the estimation of the path loss. For this reason, the use of an alternative wireless ranging system is suggested and implemented in this work.

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Traffic violation alert and management

Traffic violation alert and management software architecture is organized into two modules: namely, the traffic sign detection and recognition (TSDR) and the traffic violation management (TVM). The TSDR module is used to detect vertical signs present along the road and is aimed at alerting drivers in certain dangerous situations, such as “Speeding”, “No Passing Zone”, “Intersections”, “Stop Signs”, “Yield Signs”, “Dangerous Turns”, “Steep Slopes”, or “Road Works”.

While considering the other portion, the TVM module is intended to manage traffic violations when they take place. At present, this module is focused only on three signs: namely, “Speed Limit”, “Stop Sign”, and “Forbidden Turning”. The TSDR is performed in several steps. First, when a traffic sign is detected and its image isolated, color segmentation is performed in HLS space. The result of this step is a series of objects that are subject to shape analysis, which is performed by filtering according to geometric restrictions followed by a probabilistic adjustment of straight and curved lines into the shape.

Afterwards, all the objects obtained from the previous steps are potential traffic signs, and their recognition is performed by a simple matching operation with a set of legal traffic signs, which are discarded if no match is produced. In the cases of positive matches, the result is normally an interpreted sign, which is then used for driver alerting policies. In some situations, warnings in the form of acoustical messages are emitted through the vehicle loudspeakers, and they are issued in advance in order to provide the driver with enough time to react to the on-coming traffic situation. As far as the traffic violation management module is concerned, at present it only focuses on three signs: namely “Speed Limit”, “Stop Sign”, and “Forbidden Turning”. Each sign has its own specific policy. For example, the speeding alert is handled by comparing the actual vehicle speed and the detected speed limit. The issued alert is maintained during a defined time-out period before registering the traffic sign violation. The flow diagram used to manage “Speed Limit”. In the same way, “Stop Sign” is managed by checking whether the vehicle speed has fallen to zero or not, and “Forbidden Turning” is handled by comparing the driver's intended direction, computed on the basis of the steering wheel angle, and the vehicle’s speed.

In the view of traffic violation management, when a violation is committed, its corresponding scenario is recorded, where its data record consists of indicating the type of traffic sign, its GPS location and a photograph of the surroundings. Some other data such as vehicle speed, acquired from the CAN bus interface, and its GPS location are continuously collected throughout the commute with a rate of approximately two records per second. Database information is organized by drivers, identified by their own smart cards, and by commutes linked .

It is worth mentioning that database unit can be used in ways beyond just traffic violation recording, and can be extended, for example, to analyzing movement patterns,

journey times, and for acquiring drivers’ parameters for researching drivers’ behavior. This tool is essentially graphical and gives users a precise idea of the vehicle path, its speed, and marks the GPS locations of the detected traffic signs as well as the registered traffic violations.

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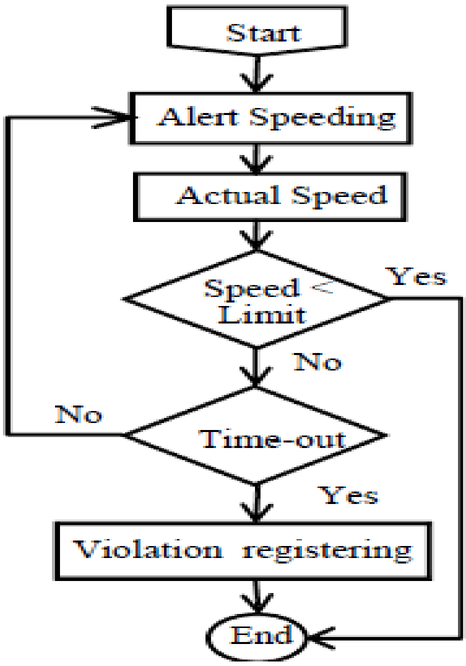
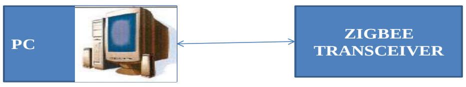


Flow diagram for speeding violation alert

BLOCK DIAGRAM

CONTROL ROOM



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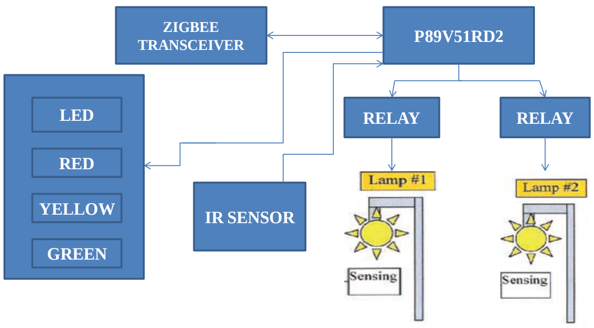
STREET LIGHT AUTOMATION



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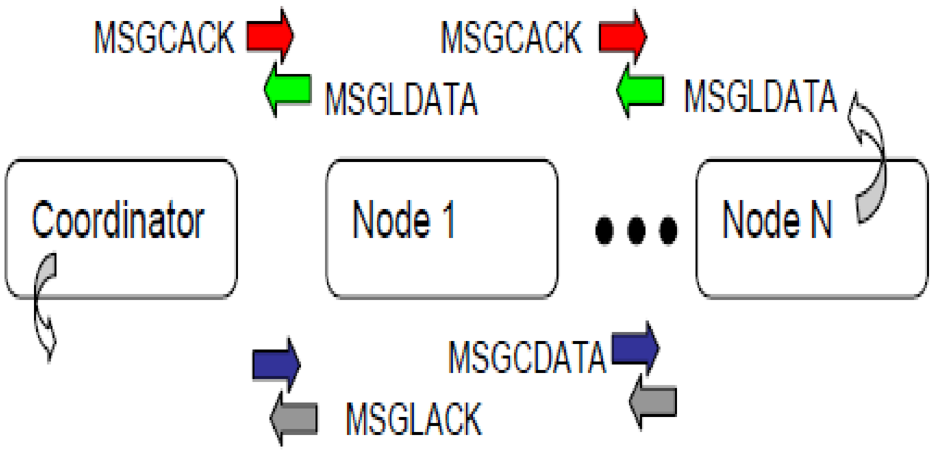
Experimentation for network nodes

The communication is bidirectional and occurs from the cabinet to the light pole (control mode) and vice versa (diagnostic mode). The node in the cabinet is also the network coordinator and acts as the gateway toward the WAN tier-two network. A simple proprietary protocol stack has been developed to experimentally test the performance of the system. The physical layer is clearly based on the CSS radio.

The MediumAccess Control (MAC) is based on contention and implements Carrier Sensing Multiple Access with Collision Avoidance (CSMA/CA). It must be remembered that the overall throughput required by the application is quite low and does not pose sever constraints. In addition, in this peculiar application nodes are normally mains powered and consumption due to retransmissions is not critical. At this level, each node is univocal identified by its MAC address, which is also its serial number. The role of the network protocol is to translate MAC addresses into network addresses and to forward the messages from the source to the destination hop by hop. In the considered scenario, it is clear that a privileged dimension exists and it is natural to take advantage of it; benefits of a position centric routing approach for street lighting systems are already underlined in the literature. Basically, the idea is to use the distance knowledge in order to satisfy a minimum transmission energy cost function; where the MERR protocol is described. In addition, the availability of high directivity antennas has suggested the idea of Dis MAC, where a sort of "bucket brigade" between adjacent nodes is established. A localized relative coordinate system can be obtained mixing ranging information with angle of arrival and/or digital compass estimations, enabling some position centric applications as flooding, discovery or source-sink communication.



Data packets exchange across the network.

These capabilities can be easily added to the wireless node, but the development of the routing protocol is outside the scope of this work. For this reason a simplified routing strategy has been implemented. The ranging measurement normalized by the received signal strength is used to identify neighbours at the MAC Layer in the preliminary discovery phase. When this phase ends, all the nodes send their neighbour table to the coordinator, which reconstructs the actual nodes arrangement and assigns Network Layer addresses. In the operating phase, each node forwards packets coming from one- or two-hops nodes to increase reliability. At the top of the stack, the application layer defines two different messages according to the data forwarding direction; MSGCDATA, from the coordinator to the streetlights and MSGLDATA, from the streetlights to the coordinator. Both the data packets are acknowledged using a MSGCACK and MSGLACK packet; respectively.

The actual network nodes have been designed around the NanoLOC (NA5TR1) device from Nanotron. The core of the system is a monolithic fully digital implementation of a CSS transceiver. This transceiver adopts the BOK modulation and allows for a gross data rate in the range from 2 Mbps to 125kbps. The transceiver is controlled

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by an ATmega 128L microcontroller from Atmel. The nominal transfer rate of 1Mbps has been chosen; the baseband chirp has a 1 µs duration and nominally occupies 80 MHz, i.e. the whole ISM band @ 2.4 GHz. The coarse time resolution in the detection of the

RTT is determined by the sample rate of the ADC in the receiving path; it is about 4 ns, i.e. 1.2 m. Sub meter spatial resolution is obtained thanks to dithering & averaging technique. Random and evenly distributed time shifts are added to the chirp position (e.g. by the noise or intentionally); then several consecutive chirp pulses are averaged at the receiver side. In this way the overall resolution is improved; such an operation is performed in hardware and it is transparent for the final user.

Conclusion

In this paper, a system for traffic violation alert and management has been presented. The proposed hardware architecture combines an on-board computer vision system for traffic sign detection and a data recorder for managing traffic violations. The system is aimed at assisting drivers, and more particularly for reminding them of the presence of at least some specific traffic signs on the road. The warnings come in the form of acoustical messages emitted through the vehicle loudspeakers, and they are issued with sufficient time to provide the driver with enough notice to react to the on-coming traffic situation. Despite the alert and allowed reaction time, finally, if a traffic violation is committed, it is registered in a database. The violation record consists of indicating the type of traffic sign, its GPS location and a photograph of the surroundings, and the vehicle's speed. SACAT experimental platform focuses at present only on "Speed Limit", "Stop Sign", and"Forbidden Turning" violations, but more situations such as "Parking Violation", "No Passing Zone", or "Red Light", are under consideration

In this work a wireless network for streetlight remote control is discussed. In particular, the novelty of the proposal is in the location awareness of nodes, which can self localize themselves. Simple prototypes have been built using commercial hardware. The capability of the ranging measurements, the basis for localization, is deeply characterized, showing an overall accuracy on the order of one meter. In near future, location aware routing algorithms will developed that will improve the efficiency of the network.

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