Wireless Cameras Network for Intelligent Traffic Surveillance System

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Abstract- **Wireless Networks (WNs) have attracted wide interests in both academic and industrial communities due to their diversity of applications. In this paper a Wireless Camera Network (WCN) which utilizes advanced embedded system & wireless network (WNs) protocol for networks used to improve motorways safety from abnormal situations. The system consist of numbers of embedded smart cameras connected via wi-fi and are deployed along a motorway and connected via wireless network (wi-fi) to be an eye for operators. The system will capture and interpret images (which may cause danger to motorway users) and an alarm system will be triggered to inform motorway operators for immediate actions. Various algorithms for image processing and object recognition will be implemented for image interpretations. At the same time, images from network smart cameras will be sent for storage to a server for record purposes.**

Keywords **- wireless camera network (WCN), wireless networks (WNs), embedded system, GNU/Linux, smart camera, Image Processing, Object recognition.**

I. INTRODUCTION

All Wireless communication has benefited our lives in computer network which leads to significant changes in our working environment and habits due to usage of mobile systems. Wireless and Wireless Networks are now replacing the use of cables between computers and electronic devices [1]. Wireless network was first used for military missions. Now it is being deployed in wide range of civil applications due to its size and affordable cost [2]. Now that the wi-fi or other wireless technology has become mature, it is also possible to design a Wireless Camera Network (a combination of image processing embedded system and wireless network) for monitoring purposes. There are various embedded system platforms that can be implemented for this project such as FPGA, DSP chips other micro controller chips. However Single Board Computer based on GNU/Linux operating system is chosen due to its flexibility, sustainability, and open source.

II. LITRETURE REVIEW

There are works that try to make use of Wireless Network (WN) for various kinds of applications such as those reported in [3] and [4]. In [3] it focused on hardware design while [4] was on high level algorithms for controlling traffic lights. Also in [5] Zang and Forshaw proposed a parallel system for extracting information about the speed and direction of traffic movement, generating descriptions of movement with specified regions ('cells') on the road. This system did not generate information about vehicle size or shape, or about the number of vehicles. Harlow and Peng described methods for processing range imagery and performing vehicle detection and classification. Kastrinaki et. al. presented an overview of image processing and analysis tools used for traffic applications on traffic monitoring and automatic vehicle guidance[5]. In [6] Georgiana, Kien and Rui explored the advantages of employing Internet-connected to enhance e-transportation with the ability to respond to terrorist threats and other human-caused disasters. The surface transportation system is of critical importance in responding rapidly and effectively to various human-caused disasters. The significance of their work consists of enhancing the surface transportation aspects of homeland security by leveraging e-technologies in the street network to develop a Smart Traffic Evacuation Management System (STEMS). As part of intelligent transportation systems, Internet-connected sensors and cameras have become ubiquitous along roads and motorways, enabling many novel e-transportation applications. Recent advancement in sensor technologies has facilitated the development of new e-transportation applications, by providing traffic data with better spatial and temporal resolution, accuracy, precision, repeatability and consistency [6].

Sam Tran Phu Manh and M.S.and T.A.Yang have devised a method, Optimized Communication and Organization (OCO), for efficient target tracking in wireless sensor networks and also they developed Optimized Computation and energy dissipation to maximize the lifetime of the sensor

network [7]. Unfortunately, none of the work has been discussed on how to design and implement practical protocols and systems based on WN and it cameras (nodes) in order to improve existing traffic systems. The problem of collision detection has been discussed in [8] and [9]; however, their works are based on the above-mentioned technologies such as automatic machine vision so they also have the problems in terms of deployment as described earlier [10].

Interest on image processing and its applications started in 1921 where the focus was on developing devices which could capture high resolution images. Since then various digital images processing and techniques were researched for various applications. This led to the appearance of the new computer systems and the space orbit programs to show the capability of processing images. The use of the technique of the image processing started in California 1964 by Pasadena State to improve the images they got from the Jet Propulsion space labs when they tried to process moon images that they received from the space ship Ranger7, and then from that time field of image processing underwent a wide improvement and development [11].

Computer Graphics (CG) is a vast, important, and popular discipline. From its beginning around 1970, CG is now a mature discipline built on a strong mathematical basis and with applications in an ever increasing number of areas. CG is interesting because its results are visual and often impressive. It is thus a discipline that attracts many scientists, but it is also useful for researchers as it provides them with suitable knowledge of the algorithms they will use to create graphical applications and representations of all sorts of data [12].

III. OBJECTIVES AND RESULTS

The main objective of this research is to design an applied image processing techniques using single board computer platform for motorway surveillance system. The system will be a replacement of human for triggering alarms which if something dangerous has happened or potential horrific

scenario (potential accidents) is about to happen. In general this project consists of a smart camera system interconnected with wireless technology for traffic surveillance which shall call Wireless Camera Network (WCN). Images might also be stored in a server for future usage and at the same time, the smart camera will perform image processing for potential dangers.

IV. METHODOLOGY

The proposed Wireless Camera Network (WCN) system consists of a collection of nodes and a base station. A node is a microprocessor which handles and processes data from the camera sensors, local memory, radio and battery, and a base station which is responsible for receiving and processing data collected from various nodes and cameras; and sending controlling signals of the situation [13].The main drawback is the energy constraint as it seems impractical to change or recharge a battery [2]. But a solar cell can be used to offset this drawback.

So the Wireless cameras Network (WCN) are embedded computers which are formed in a large system that operate functionally as in ad hoc mode or in instruction mode(i.e. to say they are interconnected with each other to form a large computerized system network) they may be part of , or installed in , power generation system or in industrial production factories or various construction equipment schemes or robotic or mechanical equipments or communication system or in remotely controlled irrigation schemes or airport terminals to monitor, control and command the functionality of the system they may be fed by power supply operated by solar energy in the isolated or remotely placed equipments. It combines the function of LLC, MAC, RTS/CTS and other function for the data transfer according the OSI standard layer and to implement the interconnection that included sensor to provide reliable data transfer through specified communication channel which may spread spectrum orthognal frequency division multiplexing or other types of communication.

The brain of a smart camera is a special processing module that performs application specific information processing. The design of a smart camera as an embedded system is challenging because video processing has insatiable demand for performance and power, but at the same time embedded systems place considerable constraints on the design. Today, GestureCam, and FPGA-based smart camera can recognize simple hand gestures. The first completed version of GestureCam has shown promising real-time performance and is being tested in several desktop HCI (Human Computer Interface) applications. Y. Shi and T. Tsui developed a smart camera that can recognize simple hand gestures. The camera was built using a single chip of FPGA as processing device. The first version prototype of GestureCam has shown very promising real-time performance and recognition rate [14].

V. COMPARISIONS

• Wire and Wireless:

The use of wireless instead of wires is recommended when possible. The wireless network uses different technologies from the wired network and therefore has considerably lower bandwidth capabilities. Because of this, any high volume traffic applications, such as streaming video will not only be slow for the clients who use that application, but all other clients connecting to the same AP will be similarly affected. Servers are not permitted on the WLAN [15].The main difference is the type of technology and the type of installation used. However there is no difference when it comes to the system's capabilities and effectiveness [16].

The wireless model includes both 802.11g (wireless) and 10/100 Ethernet (wired) connections. The wired-only model has only the Ethernet interface. Aside from that, they are the same [17].A wired network and a wireless network function similarly. Table (1) shows the main differences in the two networks [18].

From all above recommend the use of Wireless Camera Network, because the use of wires will cause mess in installation.

• Smart and Normal digital camera:

The important differences between a smart camera and "normal" camera, such as consumer digital camera and camcorder, lie in two aspects. The first is in the camera system architecture. A smart camera usually has a special image processing unit containing one or more high performance microprocessors to run intelligent ASIP (application specific information processing) algorithms, in which the primary objective is not to improve image quality but to extract information and knowledge from images. The image processing hardware in a normal camera is usually simpler and less powerful with the main aim of achieving good visual image quality. The other main difference is in the primary camera output. A smart camera output is either the

feature extracted from the captured images or a high level description of the scene, which is fed in to an automated

	Wireless	Wired
Installation Time	Can be completed in days	May take several weeks or even months to complete
Installation Mess	Installation is non-intrusive. The installation can be completed with minimal mess and will not disturb your guests.	Installation is very intrusive. It may be necessary to cut into walls and floors.
Cost	A typical wireless network will save up to 80% over a wired network.	Expensive
Performance	Will perform the same as, or better than, a wired network.	Performance can be interrupted by cable cuts
Standards	Devices can be "software" upgraded to meet new standards	Cabling would need to be replaced to meet new standards
Upgrade possibility	A wireless network can be upgraded just by swapping out the networking equipment	An upgrade would involve the same amount of work that was required to perform the initial installation.
Upgrade Time	Can be completed in days	May take several weeks or even months to complete.
Ease of Use	Guests wirelessly "connect" to the network and type in their password. Their password is valid for the length of their stay.	Guests have to plug in a cable to gain Internet access.
Mobility	Guests can connect from any guest room or common area. Once connected, they can move around freely.	Guests can connect only where there is a network jack. Usually, they need to be at the desk in a guest room. Once connected, they must remain in the same general area
Marketing	You can market that you have "Wireless high-speed Internet access"	You can market that you have "High-speed Internet access"

TABLE I
COMPARING BETWEEN WIRE AND WIRELESS CONNECTIONS

control system, while for normal camera the primary output is the processed version of captured image for human consumption. For this reason, normal video camera have large output bandwidth requirements (indirect proportion to resolution of the image sensor used), while smart camera can have very low data bandwidth requirements at the output (it can be just one bit in the simplest case, with '1' meaning 'there is motion' and '0' meaning 'there is no motion').

Image 1. Network Camera and Smart Cameras

VI. THE MAIN STRUCTURE

Detection and recognition of the level of congestion and abnormal situations at highways are very important problem and they are valuable source of information in traffic management. Although it is just one of the aspects that make up a traffic management system, it seems to be a crucial point for gathering information which is obtained from video system [5].

Today the initial cost of video systems is decreasing and its use is increasing. As an example, video cameras were first used in traffic management for roadway surveillance based on their ability to transmit closed-circuit television (CCTV) imagery to a human operator for interpretation. However, present day technology uses video image processing techniques to automatically analyze the scene of interest and extract real-time information for traffic surveillance and control; this facilitates the development of Internet-based traffic information systems. Currently available traffic-sensing devices provide a wide range of information, from tracking vehicle presence, volume and speed, to detecting traffic density or travel time. The ubiquitous deployment of sensors in the transportation network, along expressways and at intersections of local streets, is complemented by the increased accessibility of the collected real-time and historical traffic data over the Web. Several approaches for sensor data dissemination over the Internet have been proposed in the literature, as an example, a browsing environment providing access to real-time and historical traffic data over the Web is the Freeway Performance Measurement System (PeMS), currently that is deployed in California. Therefore the environment for finding and sharing cameras data and applications over the Internet would encourages a more spread out deployment of cameras and would facilitates the development of more and more transportation applications adaptable to real-time traffic conditions. Advances in cameras data dissemination have been major factor that has motivated the researchers to explore new e-technologies for improving the surface transportation aspect of homeland security [6].

This part discusses the WCN application and the basic design of it. By consider that Camera and image wireless network could further develop real time large scale system of computerized city motorway system and highway road monitoring and control system. This could be achieved by installing camera sensors on the highway and at certain junctions to monitor highway users & pedestrians. It can also monitor road illumination and other environmental also security problems. The cameras processor units can monitor the highway, and the data from the cameras are sent to mobile police cars unit subordinated by area section police station where the main server which is responsible of monitoring the highways of different parts of the city is installed, this station is placed as base station where it receives the cameras display through necessary switching unit. These units can send an over ride control signal to the specified or respective node.

The energy source of a node (cameras) is generally considered non-rechargeable. Thus, the most researchers are concerned in tradeoffs between energy conserving and performance.

A wireless radio is the most energy consuming unit of a node. It can operate in three or four different states: transmitting, receiving, idle and sleeping [19]. The implementing and control these states are done by using some of important protocols such as the MAC s protocols and the best protocol should be chosen to solve the energy problem. There is the possibility of using laser technique to send data and video signal in optical fiber cable to avoid external electrical interference, and also to have a very large bandwidth to accommodate video signal and large amount of data from the large number of sensors cameras and other AP.

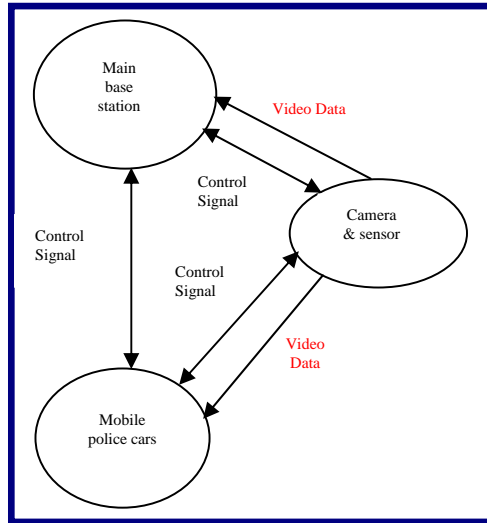Figure 1 shows the process of the system above

Figure.1. System Process

VII. THE INSTALLATION

Below are the steps that should followed to solve the problem found in the system process:

1. Distribute a group of camera sensors on highway and at traffic light and junctions of the main roads.
2. Check the power and energy of each nodes by sending signal to the server that is responsible of checking the nodes situation
3. Use some recognitions protocols and some transformation functions such as Fourier transformation and Gaussian transformation to recognise the edges of the objects. Filtering algorithms, wavelet Transform protocols could be used too. Then get way classify the objects in the road.
4. Install new programming method which is a large library of intelligent algorithms OpenCv (Computer Vision) work in GNU-Linux under Ubuntu to recognise the abnormal objects situation in the image.
5. Send the image data to the base station by sending signals to the nearest node which leads to the base station.
6. Analyse the signal and data received then send that particular signal (image of object and it information) from the base station to the patrol cars and police station.

Some basic theories of processing are needed to analyse the image:

- Processors Image
- The Digitizers
- Digital Computers
- Memory Devices

- Displays and Recording devices

Figure (2) shows the operation that takes place among the elements of the Digital Image System, note that the line between the digitizer and the digital computer refers to the perfect situation when one of the connecters has been connected [10].
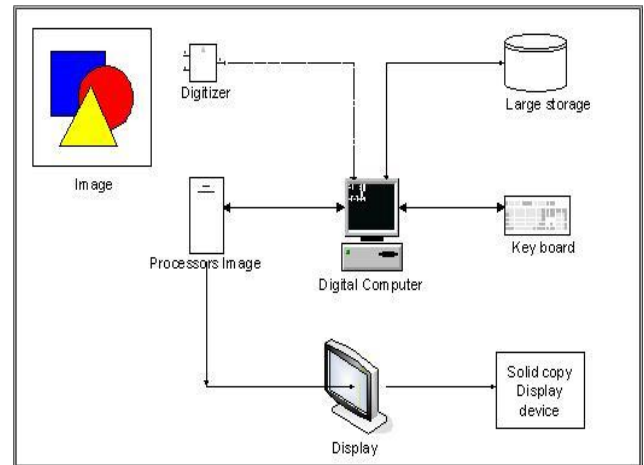

Figure.2. Processing Digital Images processing System Components

VIII. SIMULATION EVALUATION ALGORITHEM

The necessary Image Recognition Application that recognizes the objects captured by the camera will be used to check the abnormal of situation in the highway points, the applications would be done and implement by using gcc under GNU-Linux and Open CV libraries. The Open Computer Vision library is a collection of algorithms and sample codes for various computer vision problems. The library is compatible with IPL (Intel's Image processing library) and if available then using IPP (Intel Integrated performance primitives) for better performance. Open CV provides low level portable data types and operators, and a set of high level functionalities for video acquisitions, image processing functions and analysis, structural analysis, motion analysis and object tracking, object recognition, camera calibration and 3D reconstruction.

Notice that the system should be built according to time delay, priority, distance of cameras, grouping of cameras of a number of sections, communications between the cameras, data scheduling, and the necessary response of the system. Extracting information about the motion of road traffic can be done by using image analysis, then the Algorithm in [20] which done by Zhang and M. R. B. Forshaw in 1997 could be used.

The algorithm contains the following steps:

1. Cell map generation: Traffic movement on the road usually shows some regular patterns at certain locations.
2. Data acquisition: Seven successive digitized TV frames are acquired and input to the transputer array, which calculates a single estimation of speed and direction for each cell at a given instant of time.
3. Image Pre processing: A median filter is a commonly used, powerful noise reduction method in image processing. For every pixel in the image, the median grey value among itself and its immediate neighbors is chosen as the new pixel value.
4. Corner Detection: The comer detector implements a comer response calculation and spatiotemporal analysis.
5. Neural network for finding feature displacements: Matching of corners is performed by several Hopfield-type neural networks. Although neural networks are inherently parallel structures, each network is implemented sequentially on a single transputer.
6. Interpretation of road traffic scenes: After matching corners in the three successive images, a displacement vector can be generated for each cell with the same transputer as was used in matching. This gives an estimate of the speed and direction of motion of objects at the cell location.

This information, together with knowledge of the expected traffic behavior, forms a complementary description of road traffic within the scene [20].

There is different problems in traffic surveillance , in this paper we try solve two of them which is car parking illegally and cars turn from illegally places.

The programming is written in OpenCV under GNU Linux and it contains the following steps:

1. Capture Images frames from camera and save them to do real time operations.
2. Specify ROIs (Region Of Interest) and classify the ROI places when there is no problem on it (no vehicles on the road).
3. Do operations to the next frames by comparing it with the first ROI and check the histogram, then the problem will be discovered as vehicles stand in the road illegally or cars move on the opposite of the road .
4. Check the type of vehicles by use object recognitions methods also can do that by analyze the size of vehicles (height and width as x ,y) .
5. Send an image signal to the patrol car or the nearest police station.

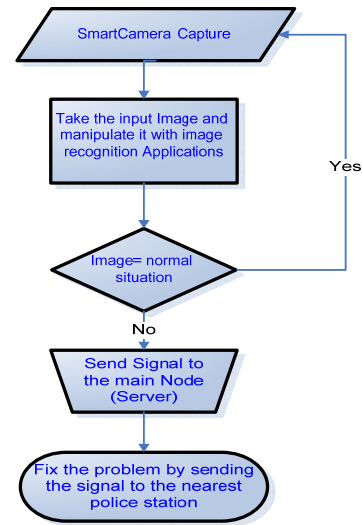Figure 3 shows how the basic processed in the system.

Figure.3. Flowchart of Data Processing in Wireless Smart Camera

IX. FUTURE PLAN

Another camera can be used in future to recognize the template number of the vehicles which will work by sending signal from the first camera to inform the second camera to start it job recognize the numbers for cars that break the traffic rules . Another suggestion could be proposed by allow voice communication in the wireless camera network. This can be done by placing microphones at the camera sites. When the patrol cars discover some abnormal scenes, he can speak to that location via the WCN to warn or make an announcement; in this situation SBC board provided with on board audio will be need.

X. CONCLUSION

This paper described the use of embedded smart camera as a part of WCN with SBC board system that is used to get safe and efficient secure system in highways and motorways. Here we depend on some theories, functions and protocols that work using OpenCV libraries and GNU under Linux Operating system.

The program could be run in real time by use both HP Centrino Duo laptop with built in camera and HP Desktop SCSI connected with usb Logitech camera also can run with recorded video file. The program tested during day time .But not during night time yet, because night situation require a type of camera that not affected by the lights of the cars and preferred to use infrared camera for ensure getting a good results in case of there is any problem of street lightning system and if the cars switch off their lights

In future the use of WCN can be a very promising technology.

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