Smart Platforms Surveillance System to Enhance Communication in Disaster Environments

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***Abstract*— The modern communications technology is a positive case for disaster risk reduction, since they to it provides critical information to realize risk assessment. In this study, we present an innovative technique is characterized by an aerial platform as a robust method to monitor disaster area. Traffic Surveillance System (TSS), based on Detection and Early Warning (DEW) units, is used to monitor the roads in preventing accidents at the same time finding what causes the accidents. This is done by implementing some image vision protocols as that of Gaussian. This paper will discuss about the camera-video-surveillance capabilities of tracking across different and varied road environments including detection of moving vehicles. The programming method used will be the functional programming of OpenCV which could be operated under Linux OS. The bit error rate (BER) also was evaluated among multiple platform links in mobile environments. We adopted multi-level deployment besides low aggregate throughput delivered to all remote-sensing terminals in order to accommodate the reliability of data transmission from the last mile.**

Keywords: Low altitude platform; free space optic (FSO); remote sensing platform; Traffic Surveillance, OpenCV.

I. Introduction

Remote sensing and information exchange from the event location is one of th e priorities that must be addressed to risk assessment. The Asia- Pacific Disaster Report devoted an entire section to new technology and how it can be used to enhance disaster risk management [1].

According to [2] researcher they, have used low-altitude platform to strengthen the communication system in a state of emergency as a result of disasters. In this study, data process of transmitting between nodes network would be scrutinized. The node network was installed on the low altitude platform LAP as well as tho se installed on the ground unites (GNs).

In addition this paper focuses on obj ect recognition and detection which are important elements of computer vision fields. The main goal is to detect an object in streaming frames captured from camera installed in GNs. The traffic surv eillance System uses either background-foreground segmentation in co mbination with object tracking or analyze long-term background changes in a statistical background model [3]. This paper is organized as follows. Section 2 describes the architectural cycle's level of network deployment. Section 3 describes the platform system design and simulation performance in second part. Section 4 deals with TSS software design. Our conclusion appears in Section 5.

II. Network Architectures

Network architecture design that was used in this research includes two-levels of systems deployment. Each level contains multi- platforms, i.e., 1) the main platform (MP) which serves as the central station and is located within the first-level nodes (1^{L}Ns) of network deployment.

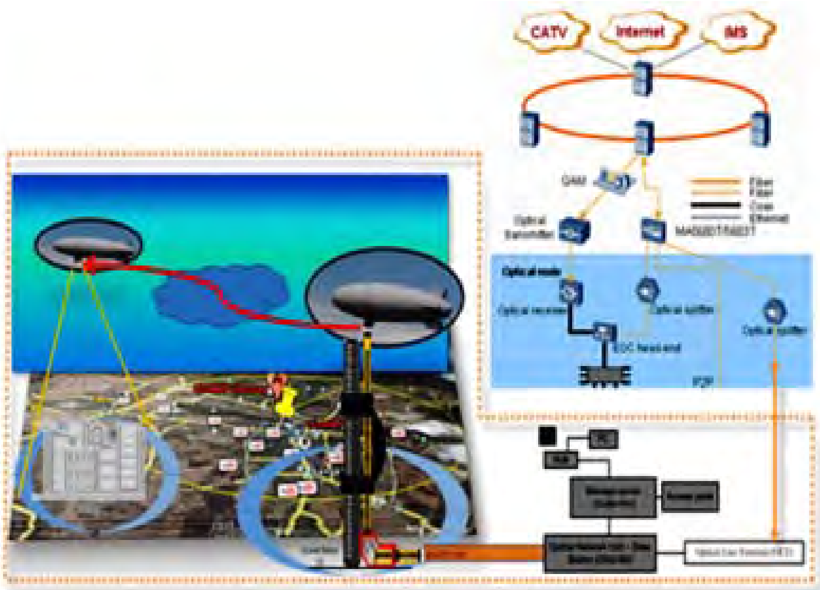


Fig1. Network Architecture

2) The second node (2^{nd}N) ground station one (GS1) is a main unit and the third node (3^{rd}N) ground station two (GS2) are located within the second-level nodes (2^{L}Ns) of network deployment. The 1^{L}Ns attitudes receives the signal transmitted from the 2^{L}Ns while; architectural multiple-level requires a line of sight between the nodes; so, the data packets can be reaching to desire destination. Figure1 illustrates network nodes deployments, GS are connected to the aerial platforms via free space optic (FSO). This is used to confront the demand for high data rate transmission. The physical nature of transition waves in space requires the availability of a LoS. The challenge in many applications is the lack of stability in the case of mobile FSO platforms this situation facing our current system. In short, the signal transmission between multi-level deployments needs to use systems control. Guidance system is responsible for directing FSO beam Laser between mobile platforms. This situation necessitates the creation of a system that can address the issue of guidance. For further details can be found in [4]. This paper will concentrate on the networks of deployment at 2^{L}Ns. The mechanism of main units GS1 is a correlation point between (2^{L}Ns) of deployment and main platform in (1^{L}Ns). Where they use the following transmission strategy:

- Radio frequency (RF) Cycle: the GS1 connects to MP via the IEEE 802.11a. In second step, the MP is linked to the 2^{L}Ns via RF and all nodes provide coverage area to the ground by utilizing the IEEE802.11.b/g/n standard.
- Optical cycle: the GS1 connects to GS2 via FSO channel to increase the quality of service.

A. *Ground Station (GS)*

This part includes the description of basic components in the terrestrial platforms, in addition to the methods which adopted the signal transmission between network nodes at Ground level.

Figure 2 describes the design of the GS that is used in the network architecture for the propagate nodes in level II. The design describes fundamental components of the system, and Table I refers to the location of each part in the design. GS is comprised of the following: 1) platform cover of the plastic container D2, which contains the control boards at the top level of the GS. 2) A global positioning system (GPS), identified as B1 which is a space-based system that provides reliable location and time information for the GS. 3) GPS sensors with the board shield B1 that is linked to micro controller A1.4) Embedded system hardware and a personal computer memory card international (PCMCIA) – WAN I1 and LAN I2. 5) Communication devices that provide [IEEE 802.11a in 5.8 GHz, IEEE 802.11 b/g/n in 2.4 GHz]. FSO Systems which have been installed on the lower part of the GS appeared in G. The charger batteries K1, K2, and K3 are fixed outside A on the board installation P.TSS is installed on the arm of the platform which will be discussed in detail later. Above ingredients are parts of the Transmission and surveillance system which is located in the upper part of the platform.

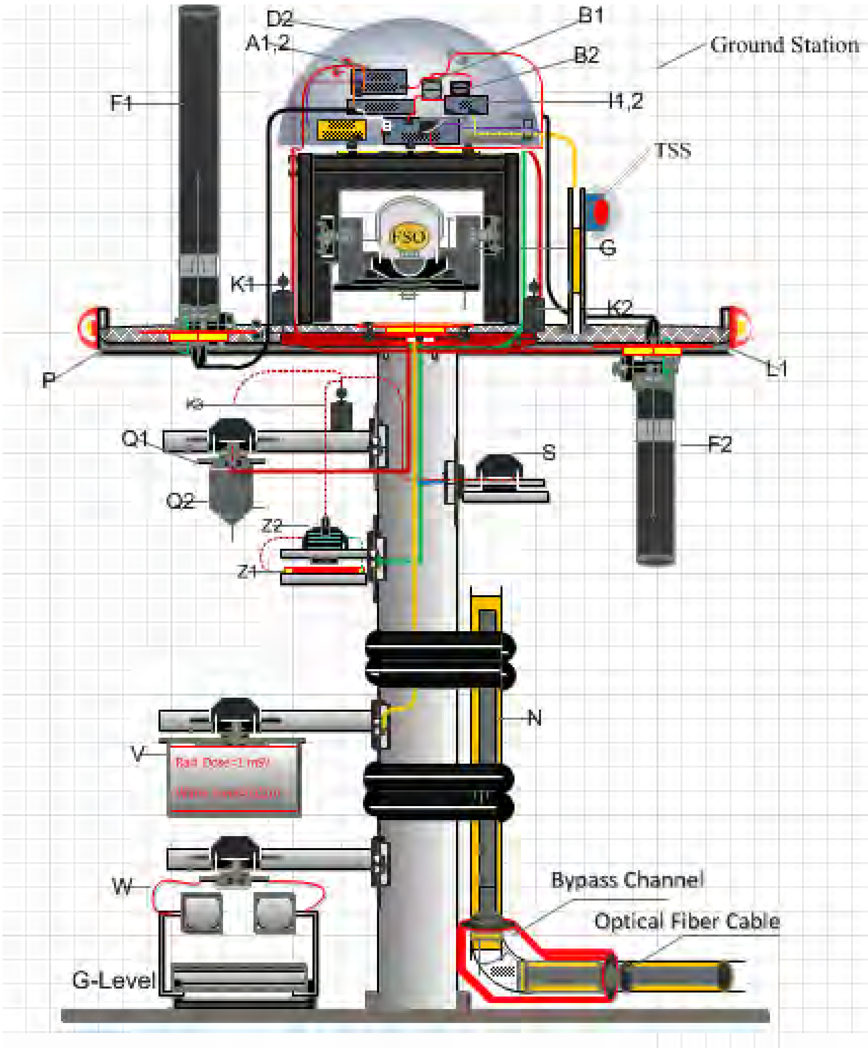


Fig.2 Architecture for Ground Units

The lower part of the platform includes Detection and Early Warning (DEW) system. Each unit consists of four parts; each section contains a system which has an independent function. Information and data from these units are sent across the MP unit to the remote control room. DEW unit consists of four separate systems, each of which has a specific function, i.e., 1) flood monitoring platform Gauger-GSM [5]. 2) For nuclear disaster; Geiger counter - Radiation Sensor Board to detect radiation levels [6]. 3) The data collection platform measures wind speed and direction, temperature, pressure, and humidity; remote sensors are attached to the DEW network stations to take meteorological measurements periodically, and all data are available immediately on the data access page. 4) Hand and foot contamination monitors are used to detect contaminated surfaces of the body after radioactive incidents.

The aim of this paper is to assess the efficiency of the transmission systems among ground units. Besides testing the effectiveness of the control system, the importance of this system is, i.e., 1) to ensure the network connections in the pacific areas which are constantly exposed to natural disasters such as tsunami, which leads to damage of the traffic systems and electronic guidance. 2) To speedup rescue operation. The public in the affected areas during and after the incident becomes panicky, leading to traffic jams.

TABLE I. GNS COMPONENTS

N	Specifications	Description
A1	Microcontroller	Shield
A2	Microcontroller	Board
B2	Microcontroller	GPS- Shield
B1	Sensor	GPS
N	Optical Cable	
G	FSO	
F1	Antenna Omni directional	802.11a
F2	Antenna Omni directional	802.11b/g /n
D2	Transparent Plastic	
TSS	Traffic Surveillance System	TSS
P	Platform	
K	Battery Pack	
Z1	Geiger counter	Sensor
Z`2	Radiation Sensor	Board
S	Smart Meter Sensors	
Q2	Flood Sensors	
Q1	Board installation	
L	solar cell	
W	Contamination detector	
V	screen display	LCD

III. NETWORK DEPLOYMENT

In an FSO connection behaviour, this technique provides bi-directional transfers for the gigabit Ethernet, free-space, optical system. It is capable of sending up to 1.25 Gbps of data; the system is installed on a GS platform, as shown in Figure 2 (G).

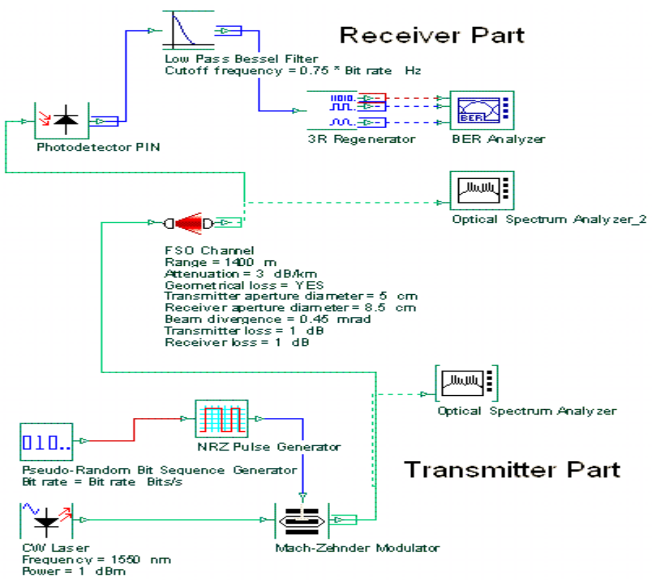


Fig.3 Architecture for FSO channel

There are some issues in FSO channel connectivity. The carrier medium (air) between the sender and the receiver is meant here to mean the weather forecast, and its impact in the process of signal transmission. Therefore, it is important that an FSO system considers weather conditions. Figure 3 shows the essential concept and the devices that were used to design the bi-directional system between two GS. The transmission part of GS1 includes a pseudo-random bit generator, an non-return-to-zero (NRZ) pulse generator, continuous wave (CW) laser diodes, and a Mach-Zehnder Modulator, while the photo detector (PIN) and low-pass Gaussian filter were used in the receiver part in of GS2. This approach provides a high reliability broadcast from point-to-point connection that reaches up to 1400 meter (m).

Based on Table II, the aperture angle between the two GS nodes was simulated using the optical simulator software "*Optisystem*^{TM}". Parameter's specification which was adopted in evaluated performance between the both sides of the FSO channel, e.g. transmission power, wavelength, link range, and the impact of weather conditions.

TABLE II .BI-DIRECTIONAL FSO CHANNEL

Dynamic Range	1400 m
Attenuation	1to 10 db/km
Diameter Of The Aperture Of The Receiver	8.5 cm
Diameter Of The Aperture Of The Transmitter	5 cm
Transmitter-Receive/ Loss	1dB
Transmission Power	1 db
Frequency	1550 nm
Divergences Angle	0.45 mrad
power	1dbm

A. *FSO PERFORMANCE*

In order to assess the performance of optical communications link, it is important to examine the quantitative expressions and factors which cause degradation in system performance.

The divergence angle factor for laser beam was obtained via the simulator, depending on the BER in different conditions. To evaluate received signal to the analyzer, "*Optisystem*™" was used as a visualizer that allows calculating the BER in an electrical signal. Furthermore, the paper will demonstrate in detailed profiles of optical data patterns and eye diagram's window. The study then focuses on eye diagram- parameter analysis in the laser performance under working conditions. To analyze the results, one must focus on the jitter deformation in the eye area. Eye area refers to the distance between levels of bit "0" and bit "1" and the distance between right and left embedded derivatives for time crossing. The experimental continues by modifying the FSO channel configuration until the signal arrives at the unacceptable of BER. Note that the jitter distortion that happened progressively in the eye pattern increases which coincided with the increase in the angle of deviation. External factors are working on signal attenuation. Accumulated jitter led to more losses in BER, causing more difficulty in distinguishing between ones and zeros in the data signal. We can conclude from this that any increment of beam divergence will increase distortion jitter and narrows the eye pattern; this, in turn, leads to an unacceptable BER, which was close to $1x10^{-9}$ [7].

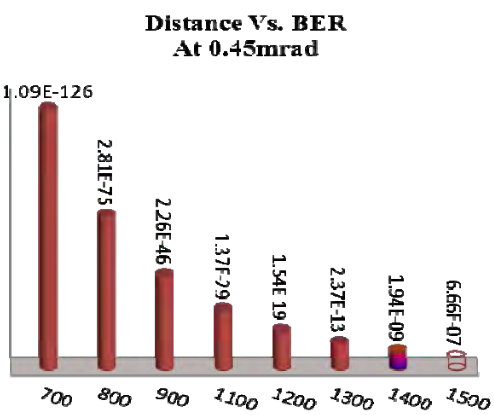
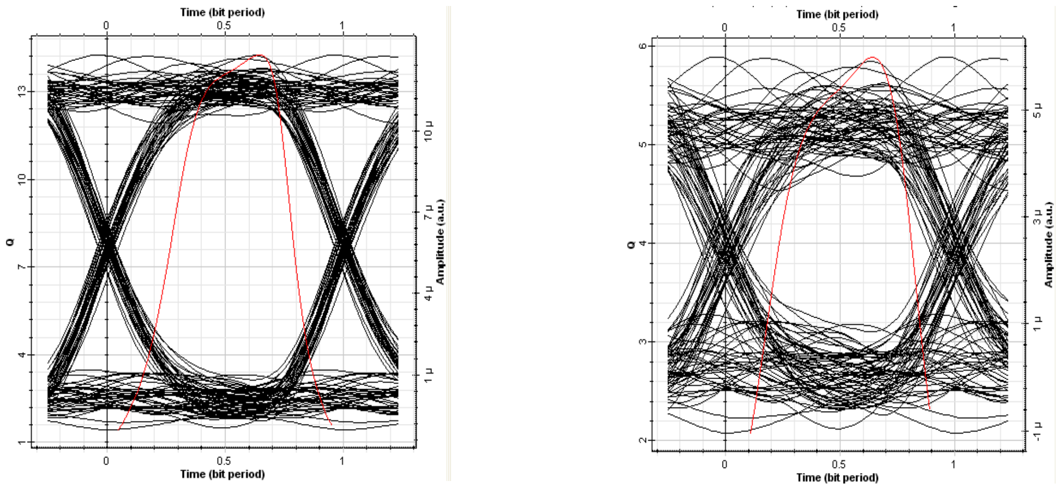


Fig.4 Path Attenuation

Figure 4 illustrates the correlation between the BER versus distance. The effect of BER begins to emerge, starting from 1.94×10^{-9} at 1400m. Increase the distance between nodes cause distortion of the transmitted signal due to the increased proportion of BER.



(A) (B)

Fig.5 Eye Diagram at (A).1000m and (b).1400 m

Figures 5 shows the eye diagram at 0.45mrad [4], beam-divergence angle in two different distances, 1000m and 1400m. The eye pattern is a technique that provides the necessary information for the received signal. Distortion in an eye pattern reflects the influence of the BER received signal. As a conclusion, any increment of beam divergence increases distortion jitter and narrows the eye pattern; this, in turn, leads to an unacceptable BER, which was close to 1×10^{-9}.

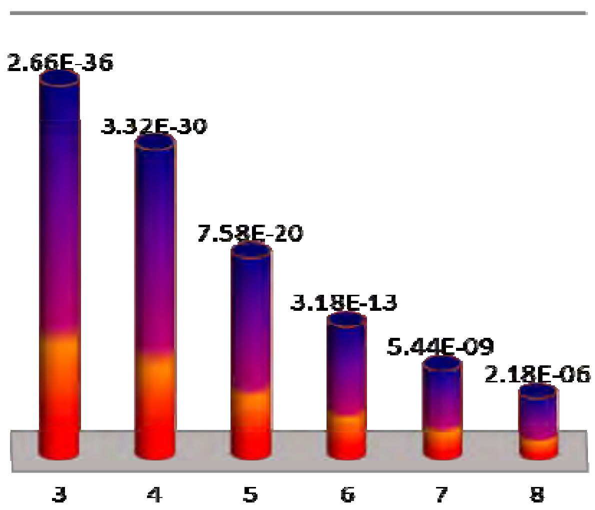


Fig.6.Weather Attenuation (dB/Km) Vs. BER at Distance1000m

Figure 6 represents a weather attenuation coefficient in dB/Km versus BAR, at spaces of 1000 m. Through the curve note; that is the value of attenuation at 7dB/Km which represents the threshold before losing signal transmitter.

From above concepts, the ground platform's performance has been investigated according to the effect of the distance assessment and the weather factor. The factors affect directly in losing the path between bi-directional FSO channels. The performance evaluation depends on how reliable is the transferring of frame packets from the surveillance units.

IV. TRAFFIC SURVEILLANCE SYSTEM (TSS)

The TSS system works as a part of sending the traffic view between the GSs that has been installed; the frames captured will be sent from GS1 which works as a server, and will receive by GS2 as client part. The Connection techniques fellow Threads and Berkeley socket programming via TCP/IP. Figure 7(a, b) below shows the diagram of transferring the captured frames.

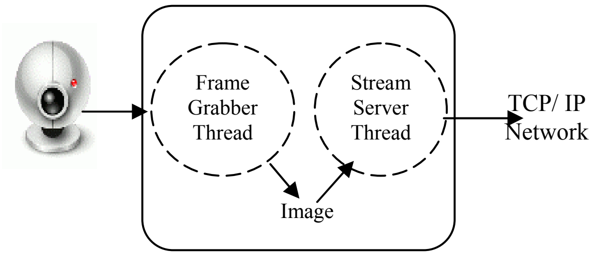


Fig.7.a: Diagram of Server Stream.

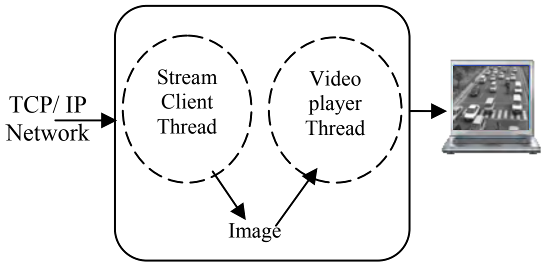


Fig.7.b: Client Stream diagram.

The detecting system was implemented using OpenCV programming which is written under GNU Linux, this type of programming could be used to design a code for traffic surveillance system (TSS). The code is programmed to support the recognition and tracking objects motion in the frames that contain captures either from camera or from a video file. For software Design of Traffic surveillance system it needs several steps in its operation. Figure 8 shows the main steps. The uses of OpenCV videos over TCP/IP network protocols represent the main concepts doing surveillance. The figure illustrates the main steps of TSS software design which are:

1. Capturing the images from camera connected and installed in GNs. All the codes are written using OpenCV under Linux ubuntu OS.

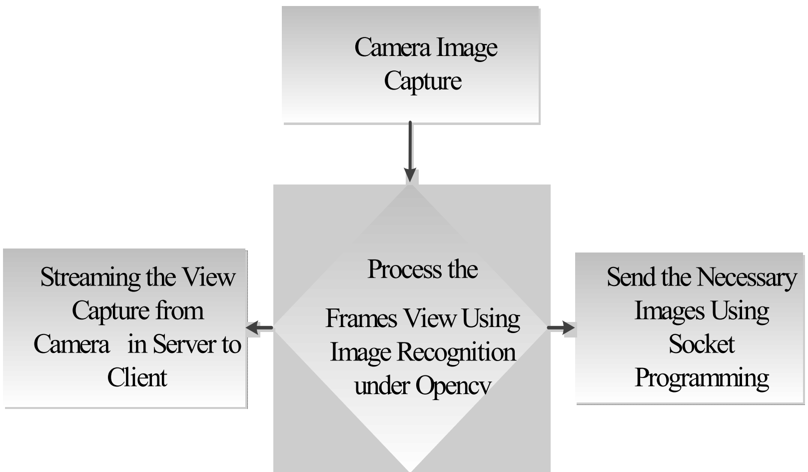


Fig.8. Main Processing Steps

2. Processing the frames captured from the camera are done by converting them to Gray scale image and updating the background of the view to detect the moving objects using Mixture of Gaussians Algorithm; this algorithm is considered as the most used in object detection systems. The original version of this algorithm has been introduced by Grimson et al. in [8]. However it is improved by Kaewtrakulpong and Bowden described in [9].

3. Streaming the result frames to the connected node or saving the necessary frames of maximum number of vehicles that appears in the view note that the system could count the number of the objects on the road which are a group of moving vehicles. The code below is executed in order to count and detect the moving vehicles in the view.

```
//*****put the moving objects inside Box *****
 define num and reset it; //count the numbers of the cars in the view
Loop:
 for( all moving objects; boundaries of objects, next moving object )
  {
    num=num+1;//start count the moving objects
   // Give a color of object use CvScalar functions
    CvScalar color = CV_RGB (255, 0, 255);
    CvScalar color_rect = CV_RGB (0, 255, 255);
    CvRect m_contour_rect = cvBoundingRect(m_contour, 1);
   if(fabs(cvContourArea(m_contour)) > 100.0 )//boundaries of frame we recognize
   {
    cvRectangle(img1dst, cvPoint(m_contour_rect.x, m_contour_rect.y),
       cvPoint((m_contour_rect.x +m_contour_rect.width)
     ,(m_contour_rect.y + m_contour_rect.height)),
       color_rect,  2, 8,  0);
         printf("\n number of objects in street*****************  %d   ", num);
              printf("\n number of objects detected all frames %d   ", q);
    q=q+1; //Go to count next object
```

Figure 9 shows the frames during the main processing step. The frames in figure 9 shows frame captures in different views during the day, raining day and night, figure 9 (a) the original image captured from the camera is shown, while 9 (b) represents the background updating of the frames which can be obtained by applying a group of OpenCV functions to the present frame and compare it with the previous frames captured, finally9 (c) shows the digital frame of recognition the motion of vehicles in the view captured.

(a) (b). (c).

Fig9. Processing Frames in Different Views

This system could work in any weather during the day and night; and, it has already been tested.

B. TSS Performance

The TSS has been tested in different roads views during daytime, rain and night and it successfully detects the vehicles motion. Processing time of each step has been calculated to analyze the efficiency of it.

Table III. Shows the calculation time average of the processing steps which is measured in melee second (ms). Processing steps are executed using 2.6 GHz Processor Speed.

The step from 1 to 3 is accursed only at the first two captures frames as a pre paration for the next process while step 4 to 7 measure for each of the next frames. In case if the camera faces any sudden power failure then the processing steps will return to the first step. The overall time calculation for capture initializing and tracking the first frames is around 260 ms/f while for the next frames the tracking time will be around 100ms/f.

TABLE III
PROCESSING TIME CALCULATION

Processing Steps	Calculating Time In Ms For Processor Speed 2.6 Ghz
1. Initializing Capturing	14.30073333
2. Convert Gray	69.5599
3. Gaussian Process	76.7865
4. Background Updating	71.57973333
5. Gaussian And Smooth	26.4608452
6. Put In Box	0.850478556
7. Count Objects	0.130006333
Total Time	259.6681967

The frame resolution that is used for the test captures is 320*240 pixels then the calculating number of bits per frame is:

*Number of bit/f = (320*240) pixels *24 bits/pixel= 1,843,200 bits/frame.*

Bit rate=25 f/sec 1843200= 46,080,000 bit/sec.*

Number of bytes per frame = 1843200 bits/frame $\approx 0.21457 \times 10^{-3}$ *GB*

As conclusion, the TSS system works to obtain certain level of safety standard on highways and motorways. Therefore this research development is able to detect the motion of the vehicles, beside it could count the number of moving vehicles in the view, the TSS has been successfully executed in different weather conditions during the day and it is supported by new programming techniques of computer vision functions, moreover all the steps has been calculated in ms which make the system capable to work sufficiently in parts of a second.

V. CONCLUSION

Based on Table II parameters and transmission power were determined by 1dbm at 1550nm. On that basis, the Path Attenuation has been identified between two nodes within a distance of 1,400 meters in 3dB/Km clear weather factor and 1000m distance in weather attenuation at 7dB/Km two conditions represent the threshold before losing signal transmitter. Previous conditions defining the location cameras installed on the platform, commitment to these conditions ensures the transfer of the streaming image frame continuously.

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