Vision Based Intelligent Fire Detection System

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Abstract—In this project we propose a method able to detect fires in forest areas by analyzing the video acquired by surveillance cameras as well as fire sensors. Two main approaches are introduced: first, complementary information, respectively based on clustering and color analysis. The main advantage of this approach lies in the fact that the overall performance of the system increases significantly with a relatively small effort made by designer. Second, the blind zones are installed with fire sensors which will further enhance the detection system. The proposed method has been tested over a broad dataset of fire videos acquired both in real time environment as well as the web. The obtained results confirm steady reduction in the number of false positives, without paying in terms of accuracy or renouncing the possibility to run the system on embedded platforms. There are two types of surveillance – direct human observation by observers located on monitoring spots and distant human observation based on video surveillance systems. The advanced approach is automatic surveillance and automatic early forest fire detection.

Keywords—Video surveillance, Fire detection, Video analytics, L*a*b* colour space, K-means clustering

I. INTRODUCTION

Forest fires are a constant threat to ecological systems, human lives and infrastructure. The only effective approach to minimize damage caused by forest fires is their early detection and fast response to it, apart from preventive measures. Great efforts are therefore made to achieve early detection of forest fire, which is traditionally based on human surveillance. Usually the human surveillance is based on 24 hours of observation by human observers located on monitoring spots. More advanced approach to human forest fire surveillance is installation of remotely controlled video cameras on monitoring spots. Now the human observer is not required on the monitoring spot anymore. The observation station is the monitoring centre with adequate video analysing systems and video storing devices connected with wires or wireless to distant video cameras located on monitoring spots. The video camera based human forest fires surveillance has many advantages in comparison to direct human observation on monitoring spots. The methods based on the consideration that a flame, under the assumption that is generated by combustibles as wood, plastic, paper or other, can be reliably recognised by its colour, so that the evaluation of the colour components in RGB, YUV or any other colour space is adequately robust to identify the presence of flames. This simple idea inspires several recent methods: for instance, fire pixels are recognized by an advanced background subtraction technique and a statistical RGB colour model: a set of images have been used and a region of the colour space has been experimentally identified, so that if a pixel belongs to this particular region, then it can be classified as fire.

II. PROBLEM STATEMENT

The current monitoring of forest fire in India is not efficient enough. It consist of 24 hour surveillance through human observers as well as satellites which have high probability of error and takes a lot of time to detect fire efficiently. So there is a need of better detection systems that is automated and is capable of detecting fire faster and with more efficiency.

Human surveillance is not always efficient enough to detect fire all the time. For constant human surveillance it have to be divided into shifts which leads to a loss of resources. The detection process and response to it through human surveillance is inefficient than an automated system. Human life as well as trees are lost in case the fire is detected late. Satellite system surveillance takes about two hours to detect and inform the ground response team for fire mitigation how is a huge loss of time.

ZIGBEE

The focus of network applications under the IEEE 802.15.4 / ZigBee standard include the features of low power consumption, needed for only two major modes (Tx/Rx or Sleep), high density of nodes per network, low costs and simple implementation. The number of channels allotted to each frequency band is fixed at sixteen (numbered 11-26), one (numbered 0) and ten (numbered 1-10) respectively. The higher frequency band is applicable worldwide, and the lower band in the areas of North America, Europe, Australia and New Zealand.

III. PROPOSED SYSTEM MODEL

The proposed system is a combination of fire sensor as well as video surveillance fire detection system. The fire sensor is an IR/ Temperature based sensor and is used to detect smaller fire in the blind spots of the camera. The video surveillance part keeps constant watch over the immediate areas. This picture is sent to the analysing system which checks the input image for fire elements. The detection is done by means of clustering.
and colour acquisition algorithm. In case fire is detected the system gives an output to the controller informing about the detection of fire. The controller then indicates the detection fire through means of alarm system and the location of the fire place is also informed by GPS module.

IV. METHODOLOGY

This system includes two ways of fire detection in forest areas. The first way of detecting the fire is through the fire sensor and the other way is to detect the fire through video surveillance. Places where the camera’s vision cannot reach, it will create blind spots there. For this reason several fire sensors are installed over the respective blind spots. This fire detecting sensors senses the temperature of the fire and it will send the response to the forest section to notify that fire has occurred. It will send the response when the fire temperature has crossed its threshold limit. After the detection of the fire the forest section Zigbee transmitter module will send the location of fire to the control section, which it acquires from the GPS module. Control section Zigbee receiver will receive the response and alert the respective officers. Now coming to the video surveillance part the camera will take snapshots of the respective place every few interval and send to the analyzing system. The system will analyze the snapshots and if fire elements are detected it will initiate a message notifying that the fire has occurred. This message along with the location is sent to the receiver. Then receiver will receive the response and relay it to the PIC microcontroller. Upon receiving the message the control section will alert the respective officer by sounding the buzzer.

Fig 1: Transmitter For Forest Section

Fig 2: Transmitter Prototype

The above system (Fig 2) is responsible for the fire sensing and surveillance work over the forest area. It generates the message whether fire is detected or not. It also generates the location in case fire has occurred.

Fig 3: Receiver For Control Room
The receiver system (Fig 4) receives the messages from the transmitter. If a positive fire detection message is received, the controller sounds the buzzer to alert the concerned officials.

V. SIMULATION AND RESULTS

Fig 4: Receiver Prototype

The analyser system receives the snapshot of the surveillance area, runs the algorithm for fire detection and generates the output accordingly. The above picture (Fig 5) shows a positive detection of fire.

Fig 5: Image Processing Output

On positive detection of fire, the controller of the transmitter generates a message for the control section, informing about fire occurrence which is also shown on the LCD (Fig 5).

Fig 6: Transmitter/Forest Section Output

VI. CONCLUSION AND FUTURE SCOPE

It is concluded that the proposed system provides a robust and an efficient way for detecting fire. The combination of sensors and surveillance system proves to be efficient in detecting fire hazards in a rapid manner. There is no need for any new expensive equipment rather the preinstalled surveillance cameras can be utilized for the system set up. And other modules such as the sensors and the communication system are dynamic and can be chosen according to the users wish. In future we can install a two-axis robot with pump motor, so that the robot can turn off the fire at initial stages automatically. When fire will be detected the location will be initiated by the GPS system to the controller and the controller will then call upon the robot to mitigate the fire. The robot will then use the water pumps to turn off the fire at an earlier stage.

References

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