Real Time Monitoring and Fire Detection using Internet of Things and Cloud based Drones

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Abstract: Smart cities with smart infrastructure is a rapidly flourishing field of research in the modern days. Open areas, agricultural land, forests, office, homes and several areas can have occurrences of fire accidents leading to loss of significant resources. Unmanned Aerial Vehicle (UAV) and wireless sensor network technologies are used fir detection of fire at an early stage in this paper. This helps in avoiding serious fire accidents. The environmental parameters are monitored using the sensor architecture. The sensors uses IoT based applications for processing the gathered environmental data. Cloud computing, IoT sensors, wireless technology and UAVs are combined for the purpose of fire detection in this paper. In order to improve the accuracy of the system, integration of image processing schemes is done in this system. The rules are formulated such that the true detection rate is improved. The existing state-of-the-art models are compared with the proposed system. The simulation results show that the rate of fire detection of the proposed system is improved for up to 98% when compared to the traditional models.

Keywords: Unmanned Aerial Vehicles; Image Processing, Fire Detection; Internet of Things; Wireless Sensor Networks;

1.Introduction

Various researches are focused towards fine tuning the concept of smart cities in the recent days. This paper provides an efficient solution for improving the safety of smart cities and smart environment from disasters like forest fire [1]. Image processing, Internet of Things (IoT) sensors, drone technology and wireless sensor networks (WSN) is used for detection of forest fire. Real-time and continuous monitoring of the environmental parameters is done by the IoT sensors. The information obtained by these sensors are processed to detect the occurrence of fire. Image processing schemes are used for further validation of the event occurrence [2]. WSN, IoT, information and communication technology (ICT), and other relevant technologies are dedicated towards providing a better living in smart cities. Information technology enables infrastructure can manage and monitor resource scheduling, monitoring, transportation and various other factors that involve regular operations in smart cities [3]. Along with efficient utilization of resources, the living standards of the residents can also be improved to a great extent in smart cities. In the recent days, several nations are implementing their pilot project on smart city. This is directed towards improving the living standard and the environment. The power of information is used along with IoT and ICT in smart technology for the development of smart applications [4]. The comfort everyday life can be improved with efficient infrastructure and resource management in smart city environment [5]. The learning parameters are adapted on continuous and real time monitoring of information in smart cities. Smart grid monitoring, public surveillance, heath monitoring, intelligent traffic, smart water system, pollution detection and smart buildings are

some of the applications based on IoT and sensor networks that are used in smart cities [6]. Figure 1 represents a sample setup for data transfer through sensor nodes.
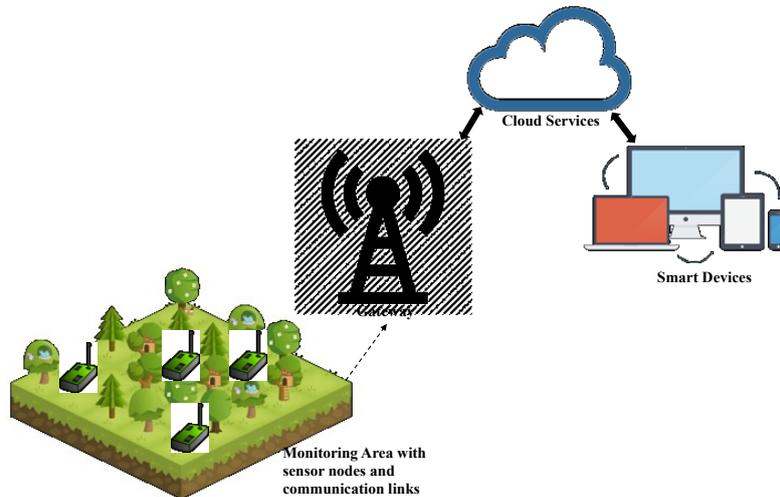

Figure 1: Data transfer through sensor nodes

Beavers, squirrels, birds, wild animals and so on have their shelters in forests in an ecosystem. The global forest cover averages to up to 35% of the land. Natural processes like plantations can be done for improving and extending this forest cover [7]. However, due to deforestation, forest fire and natural disasters, the forest ecosystem is affected greatly. Humans and global temperature rise are also major contributors to depletion of forest resources. A lot of resources and time is consumed for the challenging task of monitoring the forests. The global human life, wildlife, infrastructure, economy, environment and smart cities are greatly affected by forest fire. This paper proposes an optimal solution to this issue by proper monitoring and control of such disaster [8].

2. Related Works

The characterisation of Internet has been transformed with the evolution of IoT and other cutting edge technologies since the last decade [9]. Users and things can be connected at all times and locations using IoT. The concept of bigdata consists of the huge volume of information obtained from the things connected with IoT. Real time data processing and efficient storage is essential for the information gathered from smart devices. Remote processing of this information can be performed by means of cloud computing at a reasonable cost [10]. The edge device information is stored and processed using the extensions of cloud computing architecture namely edge and fog computing. Smart cities can develop sustainability using fog computing technology [11].

Various applications of fog systems along with their potential and challenges in smart city environment in discussed [12]. Smart parking application using WSN and IoT is presented. Data security, privacy, reliability and design issues are emphasised in this application. The smart city network lifetime can be improved with the deployment of WSN in an efficient manner. Continuous supervising and storage is essential for the data gathered by the sensors. Periodic collection and storage of information is done by the sensors and this data is processed in the cloud environment. It is essential to efficiently process all the sensor data due to its large volume. Real-time data processing requirements are met by big data analytics. The power consumption of processing this voluminous data can be reduced by implementing efficient protocols for data communication [13-25].

3. Proposed Work

In this paper, we focus on fire detection and validation. Confirmation phase in fire detection is the major challenge in most of the systems. In this system, image processing is performed to confirm the fire using the images gathered from the affected region. Figure 2 provides an overview of the Smart fire detection system (SFDS) elements that play a major role in data collection and fire detection. IoT and WSN applications in smart city environment is demonstrated using this technique. Data from the IoT sensors and devices can be used by industries, authorities and users for developing various applications. The proposed system can be used for detecting fire in smart city environment. The decision making is performed based on the information gathered by the sensors as well as the result of image processing, thereby improving the efficiency of the system. The interaction between smart devices, real time image processing and IoT sensors enhances the competency of smart cities. Cloud gateway is used for transferring the collected sensor information.
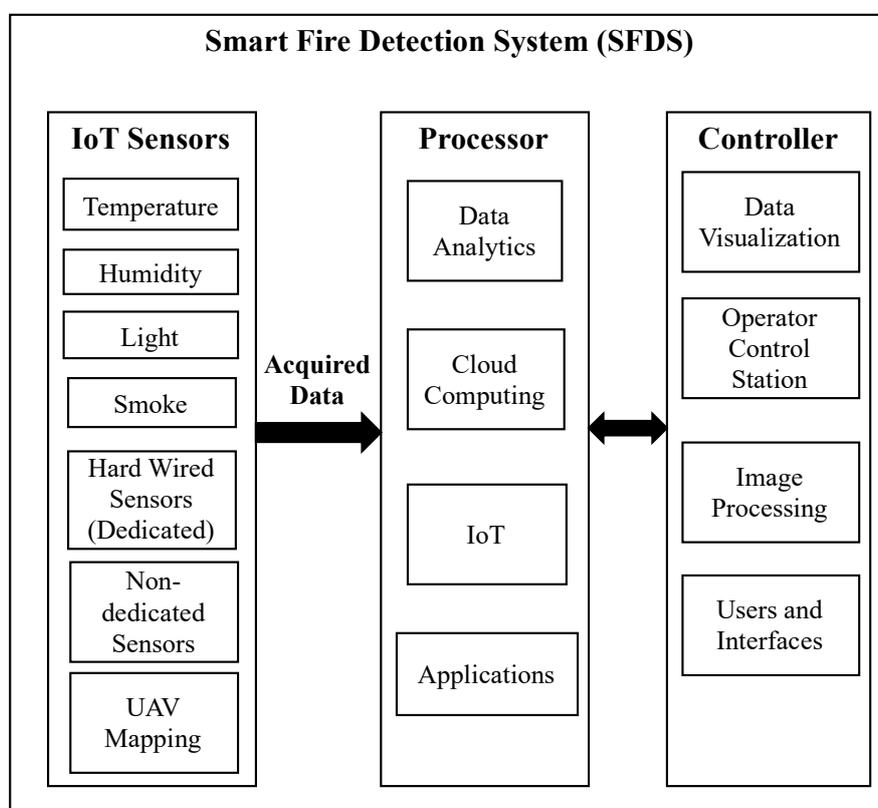

Figure 2: Smart fire detection system (SFDS) elements

Smoke, light, humidity and temperature sensors are deployed for collection of environmental parameters on a random basis in the initial phase. The sink node aids in storage and processing of the obtained information from every sensor nodes using the ThingSpeak cloud platform. The information obtained is analysed for performing application specific tasks. The environmental parameters related to fire occurrence are monitored continuously by deploying the sensor nodes at the sensing stage. The information from the sensors is updated in the cloud platform regularly for continuous monitoring and analysis. On detection of abnormalities, the data gathered from the sensor is analysed and decision is made in the processing stage. Remote users can access the cloud information using their credentials. Any adversary and fire occurrence can be detected at an early stage by the user with regular monitoring of information. An image processing scheme is applied for confirming the fire

using the UAV that provides real time image data from the location of occurrence. Any number of controllers and users can be placed at the remote location for accessing this information stored in the cloud. The communication is managed and controlled by the control station. The regions of fire are detected by the image processing algorithms. On confirmation of the occurrence of fire, an alarm is invoked and the management team is sent an alert message for taking further action.

4. Results and Discussion

The image RGB components cannot be improved individually based on the histogram equalization. The RGB components of an image is analysed for histogram equalization. The total pixels and intensity level of the sample images are analysed. Figure 3 and 4 provides the sample image histograms. Histogram equalization is used for analysing the original image frequency distribution. The cloud platform information analysis is done using Thingspeak. It is an opensource MathWork IoT platform. Collection, analysis and visualization of the real time information can be done by the user in the cloud environment to take the necessary action. Live streams of information is used to create instant data visualization on this platform. The ThingSpeak platform can execute MATLAB code for processing and analysing live IoT based data. Both offline and online data accessing capabilities along with remote visualization features are provided for the real time sensor information. App and web based platforms for mapping drones used in this system is drone deploy. The ground station is provided with target area videos and images of high resolution using this platform. The fire event is detected using image processing algorithms in the ground station based on analysis of the images obtained.
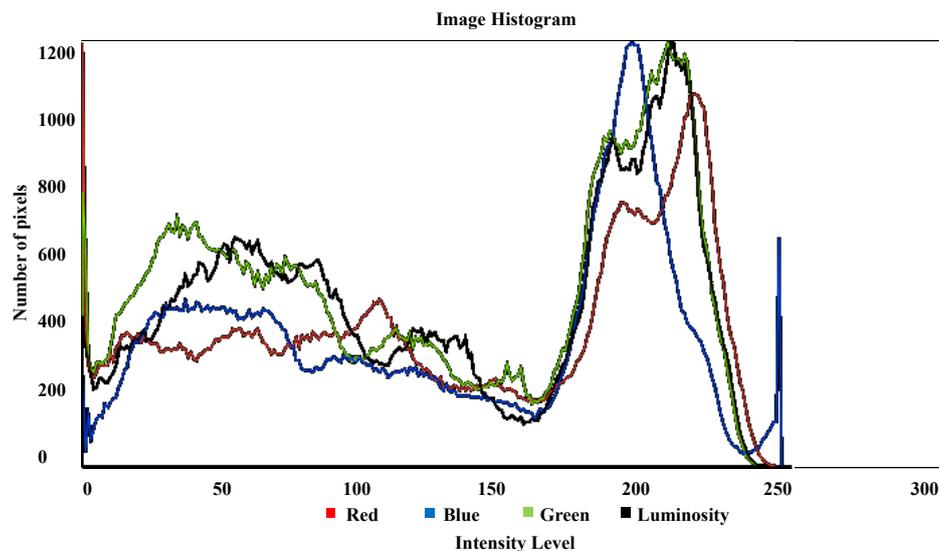

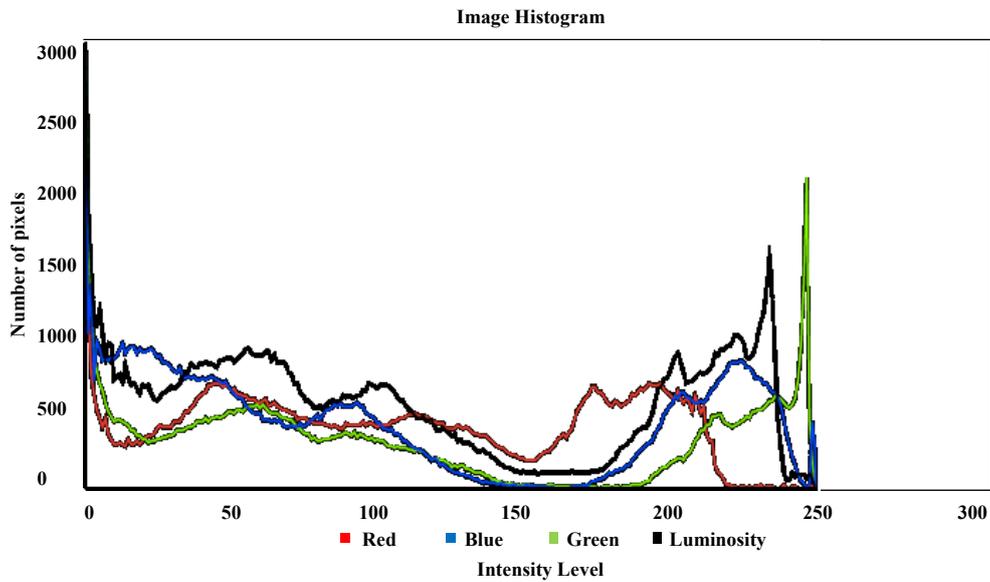**Figure 3: Histogram of sample image 1 based on intensity and pixels**

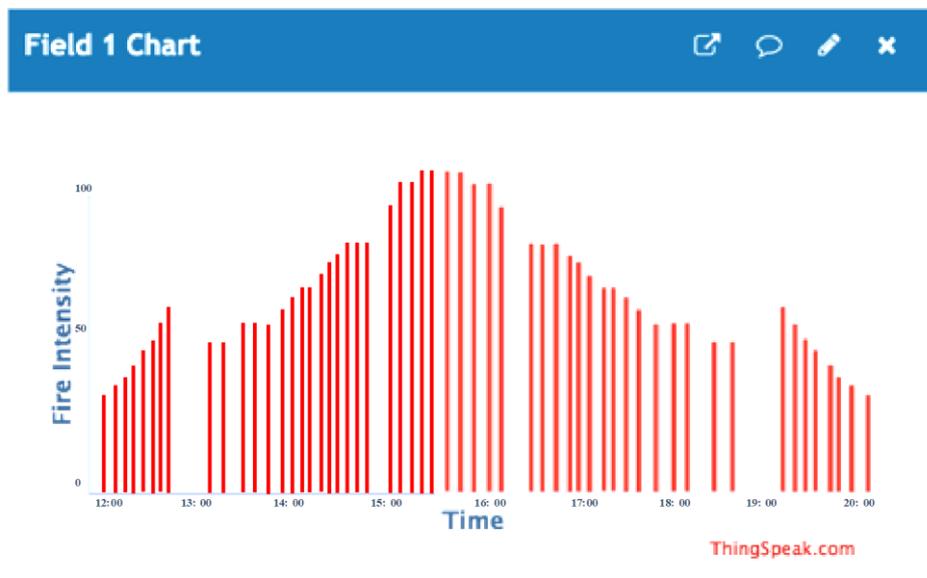**Figure 4: Histogram of sample image 2 based on intensity and pixels**

Figure 5: ThingSpeak based plot for fire intensity level on detection

All the images and information obtained from the sensors are analysed over the ThingSpeak IoT platform. The sensory information are monitored on a regular basis. Smoke, light, humidity, temperature and such form of information obtained from the sensors deployed in the monitoring environment are updated regularly. The ThingSpeak platform stores the sensed information to perform analysis. The users are sent an alert by the system with the coordinate information if any adversary is detected. The wind speed and current temperature are analysed using MATLAB by the system. The recent three consecutive days temperature is also compared by the system. ThingSpeak platform monitors the event detected. ThingSpeak based graph is provided in figure 5. When

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there is a fire event, the sensor data exceeds the threshold value. The fire intensity is also monitored regularly. The distance between the sensors and fire may vary based on the event and the plot spikes may increase and decrease accordingly. UAV is used for capturing images of the fire location and image processing is performed thereby confirming the fire event. Images are collected based on target area mapping and deployment of drone using the logical information obtained by the sensors.

5. Conclusion

With various infrastructural developments and deployment of smart cities, fire detection and extinguishing is of serious concern among all nations. Efficient technologies can operate at their maximum potential when these disasters are prevented on the global level. Early stare fire detection is done using the IoT sensors and WSN platform. Sensenuts platform is used for hosting the WSN. Real-time collection and analysis of data is performed in outdoor or indoor environment using the deployed sensor nodes. Cloud storage is used for accommodating all the obtained information for further analysis. Light intensity, humidity, temperature, smoke and such factors are analysed using the ThingSpeak cloud application. The real time data is analysed based on efficient fire detection and sensor inputs of the environmental parameters. This paper combines the IoT and cloud technologies to offer an efficient system for fire detection. This system enables monitoring and collection of real time information in a cost-efficient and moderate manner. Integration of image processing scheme enables further improvement of efficiency. The accuracy of detection is improved by formulating several rules. Testing of the system is performed with image samples to analyse its efficiency for fire detection at initial stages. The system offers highly efficient classification results. Future work involves reduction of hardware and customizing the sensor networks for fire detection in multiple environment.

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