

Study and Implementation of Internet of Things (IoT) Based Forest Fire Automation System to Detect and Prevent Wildfire

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Abstract

The study and development objective of this project is to mitigate the regional and global phenomenon known as wildfire or forest fire through the implication of Internet of Things technology. 'Early fire detection is recognized as a key element in improving protection of forests from fires' (Sheikh Mohammad Ferdoush, 2014). The working principle of forest fire automation incorporates blocks of the functional circuit and sensor modules that are assembled as a unit thus, functioning to monitor the circumstances of a particular forest. Environmental sensors such as temperature and gas sensors are deployed to analyze the heat level and detect smoke presence generated by fire respectively. The utilization of passive infrared motion detector also helps in preventing disturbance from wildlife to the sensors scattered in the forest hence cutting down unnecessary cost and achieve its purpose of the secured system. The proposed system enhances the effectiveness of forest fire prevention by providing a solution for early discovery and quick response to combat forest fire.

Keywords

Forest Fire, Internet of Things, Environmental, Temperature, Gas, Passive Infrared Motion

Introduction

Forest is the lung of earth that preserves its ecological balance. It is a home for flora and fauna that reside within. Forest is a vital component of earth and must be protected its existence. There are countless benefits that forest has contributed to environment, humanity and etc. However, forest in contact with fire has become the worst nightmare causing countless detriments as well.

Fire begins a vital natural process by turning organic material into soil nutrients. Next, rain will move these nutrients into the soil, giving rejuvenated fertile seedbed for vegetation. With more sunlight and less competition, speed up the growth of seeds. However, fire doesn't greatly contribute to biodiversity conservation anymore through-out the years as it's getting out of control and causes devastation.

This devastating phenomenon is widely known as wildfire or wildland fire. It is defined as an uncontrolled fire that occurs in forest, countryside or rural areas that are filled with combustible vegetation (Vivek.P. J et al. 2014). Researchers have concluded that wildfire

began right after the occurrence of terrestrial plants 420 million years ago from the fossil charcoal investigated (Andrew C Scott, 2007). This discovery proves that wildfire has had pronounced evolutionary impacts on most ecosystem flora and fauna.

The automation system of forest fire defines the solution for early detection and prevention of wildfire in the forest. These two techniques have been proposed as the primary approaches to alleviate the matter of wildfire and thus reducing the rate. The system incorporates both software and hardware components to achieve its objectives.

Methodology

There are various data collection techniques that can be deployed by the author to acquire the information relevant to the proposed project. Should the author be given choices to select the appropriate fact-finding technique(s), the below underlying elements are the factors at which the author refers to study the subject matter:

Scope, nature, and object of inquiry – This contribute to the most crucial factor influencing the selection of the method. The technique chosen should be suitable for the type of inquiry of which to be carried by the author. This element also determines whether the secondary data are to be used or primary data are to be gathered.

Availability of fund – Finance is a big constraint that determines the limit on author action. The availability of funds can decide to which extent the method of data collection to be used. If funds are comparatively limited, the author might have to select the cheaper method that may not be as efficient compared to other costly methods.

Time constraint – The author also needs to take into account the time factor to decide on which method to be selected. Some methods might take relatively long time while others can be used to retrieve data in shorter duration.

Precision – Precision required is another factor that leverages the method selection.

As such, the author has thoroughly contemplated to which to come up with the most appropriate and suitable fact-finding technique(s) taking into account the above-mentioned factors. Eventually, the author has decided in selecting the two most suitable methods to be conducted for the proposed system. These two chosen techniques are interview and secondary data collection method. The motives behind the method selection will be justified below.

Firstly, interview as primary data collection technique. The area of study of the proposed project is related to forest fire and the contribution of the Internet of Things (IoT) technologies to the matter affected. Such specialized focus area is directed to individuals who are proficient enough, having sufficient knowledge and insight, in-depth understanding of the topic discussed. Hence, the respondents that are required for data gathering purpose will be mainly forest and environment preservation or even fire management people. The general public can be involved in this process however, their knowledge can be limited. Few may know the information regarding forest fire and so-called IoT technology, especially the non-educational people. Regardless of that, the author has made the decision to conduct several interview sessions with the public, in this context, INTI's student that have knowledge in Information Technology (IT) field. The purpose is to investigate their conceptions of the

utilization of IT to provides a solution to the phenomenal disastrous event. The responses given are crucial for the analysis part at which the author knows that providing solution associated with IT can be relatively complex. Since the expert subject matter is essential for the proposed project, interviews are to be conducted with on-field skilled personnel. The responses gathered will be extremely significant, identifying and determining what could be part of the proposed system requirement while others might specify the credibility of the data gathered in secondary data collection.

The questionnaire was once thought to be involved in data collection process. The author can achieve a larger number of responses compared to the interview method. However, as mentioned by the author that the subject matter is such a specialized focus area. Many not know the things that would be talked in the questionnaire, pretending to be knowledgeable or act ignorance, simply just answer the questions that would cause misleading. The above case often happens if the questionnaire is distributed to normal non-skilled people. The author also once thought of giving out a questionnaire to the associated department of forest and fire.

However, the assumption is made at which these people might not have the time or enough knowledge yet to answer. In fact, the interview is conducted to higher status individuals such as the head of certain department ensuring precise responses to be acquired.

Secondly, secondary data collection method. The author's proposed project is not a new project any longer. Prior to this, many solutions have been made using advanced technologies to mitigate the forest fire issues. In fact, before the decision to commit to the proposed project, the author has gone through numerous of available resources to study for its feasibility against the author's expertise. There are thousands of documents, articles, journals and any other readily available sources to be used. Paper regarding existing project, forest fire, IoT technology are obtained for study purpose. However, the author does make sure to avoid the use of several untrusted websites, at which the credibility is not guaranteed. The author refers to documents, article, journal, online paper and much more that are well known. For instance, data retrieved from Cisco website, International online news, copyrighted documents are more. This way, the data gathered from secondary data collection can be proved its validity.

The observation method conducted is part of the secondary data collection. This indicates that observation is not performed by directly interacting with the environment matters instead, it is an online video watching. There is difficulty in conducting observation for the given purpose. Observation requires researchers to observe and study the related event, in this case in a forest fire. Given the location of where the author resides, it's fairly intricate to gain such data and the associated personnel might be reluctant to show as well. Therefore, this method is omitted by the author. Coming back to the video watching, the content related to the proposed project is the one on which the author focuses on. Moreover, the author is able to gain fundamental insight regarding the implementation of IoT technology and how other systems are able to achieve such objectives based on the developers' invention.

Results and Discussion

First, to investigate the various techniques of forest fire detection and prevention. The author's preliminary strategy was to conduct research on numerous cases of a forest fire, its classification, the factor of ignition, its consequences, and lastly are the detection and prevention approaches. Throughout the analysis, the author is able to discern the concept and

techniques obtained. Eventually, the design of the proposed system is originated from the outcome of the crucial findings, meant to resolve the current issues. A study was also performed on IoT and its corresponding layers.

Second, to implement the relevant method with the integration of Internet of Things technology to detect and prevent forest fire. The proposed system is designed and developed in a way that it can reduce the rate of wildfire ignition in the forest. Solutions are proposed by incorporating two types of environmental sensors and one motion sensor. The two environmental sensors are temperature and gas sensor. These sensors are configured to detect temperature value and gas concentration respectively. The motion sensor increases the durability of devices set in the forest, prevent destruction from wildlife.

The working flow of these sensors is as described. The proposed system is equipped with counteractive devices, water sprinkler, and alarm. These devices are represented by LED's and buzzer. Detection is achieved when all three sensors are capturing the physical data in the associated environment, processed by Raspberry Pi and published to management UI for monitoring purpose. Prevention is achieved by the actions of water sprinkler and alarm. If the threshold set for temperature and gas sensor is exceeded, water sprinkler will be activated to reduce the temperature or extinguish the fire as the first step to prevent dispersion. Lastly, the alarm is activated when there is suspicious movement detected near to the sensors within pre-defined distance.

Third, to incorporate cloud services into the system for remote controlling & real-time monitoring. The cloud service provides the ability to remotely access the management UI by end-users as long as they are connected. The use opensource server, OpenHab, has cloud service feature that allows the author to do so. With this approach, the proposed system yields greater efficiency in accessing, monitoring and controlling the system.

There are two additional points that are not mentioned before. The proposed system has also incorporated the graphical image of the location and notification through telegram application. The end-users are able to view the location when those sensors are deployed, monitoring the status of the counteractive actions. Notification is sent if the threshold is exceeded to alert the end-users of the casualties. Notification is another feature that provides a dynamic operation to the proposed system.

Conclusions

Eventually, the proposed project is completed within the given time. All the experience was worth the knowledge. More importantly, the completion can't be achieved without the guidance and assistance of both lead and second supervisor of the author's. Their encouragement has prevented the author from giving up and staying on the right track. With this, the author ended the documentation of the proposed system with hopes that her readers will be able to know, learn or even improve this project to the advanced level. For the author's supervisors, she wishes this report will reach the level of their expectations.

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