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A Prefatory Approach Towards Monitoring and Detection of Fire Outbreak Using Artificial Neural Network

Onyemauche U. C[1], Osundu, B. U[2], Okere, S. C[2], Anyadike, L. N[3], Onyemauche, C. U[4].
[1]Department of Computer Science, Federal University of Technology Owerri, Imo State, Nigeria, osigwe.uchenna@yahoo.com.
[2]Department of Health Information Management, Imo State College of Health Technology and Management Sciences, Amaigbo. Imo State Nigeria., Blessingosondu51@yahoo.com, ihenachostella89@gmail.com
[3]Department of Community Health, Imo State College of Health Technology and Management Sciences, Amaigbo. Imo State Nigeria, lilianmbagwu5@gmail.com
[4]Department of Computer Science, Ebonyi State University, Abakaliki, Nigeria, chidirim.ugochukwu@gmail.com

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ABSTRACT
Fire incidents had always been a primary concern in domestic and industrial properties, buildings, sites and offices. The end results of fire outbreaks can be exceedingly devastating and usually amount to serious losses of lives and properties. They also consist of alarm circuits and some manual call points often referred to as detection zones. Recent researches on fire related systems which are adaptations of the conventional fire systems, have dwelt comprehensively on technologies that can provide possible fire detection services by the integration of sensors that are capable of reacting to certain fire based parameters such as rise in temperature/heat, accumulation of pressure, smoke and other combustible elements etc.. The perceived setback of these sensors is that they need considerable time for responding as they require product of fire (e.g., smoke, temperature etc.) to reach the sensors. However, as computing power increases, and its effect is felt across most spheres of human existence, artificial intelligence based systems have been in the fore front of the discourse due to its ability to adequately minimize or exclude human involvement in most emergency or delicate activities. Therefore, implementing a computer vision-based fire monitoring and detection system using low cost surveillance cameras and artificial neural network is proposed and will sufficiently enhance the ability to monitor, detect and generally manage fire outbreaks in deployed buildings. The proposed system seek to significantly provide a more precise and accurate tool for the detection of fire situations and sufficiently eliminate the tendency for false fire alarms since it will be dependent on convolutional neural network trained with captured frames of video images of fire in order to accurately tell a fire situation. The primary purpose of this study is to develop an intelligent system for monitoring and detection of fire outbreak using computer vision and artificial neural network. Other objectives include: to develop a suitable neural network upon which the model will be trained and to implement the model using python programming language..The technology adopted in this study is expected to perform better unlike the conventional fire detection and alarm systems which are heavily reliant on sensors that are only effective with proximity and location of use.

Key words: Artificial Intelligent, Image Processing, Neural Networks, Prototype, Smoke Intensity

1. INTRODUCTION

Fire is a chemical effect (combustion) of petroleum or other materials with oxygen which generates light, high temperature and blaze [1]. In the minutia term, a fire is produced when something that can burn comes in contact with something that is hot. The search community, fire cum emergency management agencies have steadily tried the development of various fire monitoring, perceive and retort schemes via the implementation of varying realistic Hi - tech and tools. The Northeast Document Conservation Centre (NEDCC) has advocated that a fundamental bargain to fire protection is to identify a developing fire emergency in the right time, and consequently alert building's occupants as well as emergency response authorities. Such tasks can be efficiently handled by fire monitoring and detection systems. Notwithstanding on varying constraints such as the foreseen fire scenario, type of building, residents type and number, severity and level of fire, these systems can provide several generic or dedicated functions [2]. First and for most, they offer a way to spot an emanating fire via automatic or manual methods and secondly, they inform occupants of buildings of an impending fire condition and the need to vacate immediately. Another ordinary task is the spread of an alarm warning signal to the fire department or other disaster or emergency response organization. They may also shut down electrical, air handling equipment or special process operations, and they may be used to kick off routine hush-up systems .

Smart systems in this perspective signify the contemporary high-tech in fire monitoring and recognition technologies, which unlike traditional systems are very proficient of monitoring and managing fire incidents by combining input and output devices with signaling capabilities

through sensors, system software and microprocessors. On the other hand, the application of computer vision in fire emergency management is increasingly becoming of prime significance in current discourse as numerous efforts have been proffered using technologies such as physical land and aerial robots for detection of fire, firefighting and prevention, AI based unmanned aerial vehicles (UAVs) equipped with video sensitive cameras for forest fire detection and fighting [3].

This study therefore will put into operations a system that is suitable for monitoring and detecting of fire outbreaks through the use of computer vision a in conjunction with artificial neural network. The purpose is to provide improvements to the conventional systems which are heavily reliant on sensors for smoke detection, temperature variance and other products of fire combustion. The conformist sensor based smoke detector systems for fire emergencies have been established in scientific literatures to be less proficient and are restricted by space and location of use. The computer vision technology adopted in this study is a cost efficient, high definition (HD) camera that captures real time video images within the deployed vicinity to be used for prediction of potential fire situation.

2. LITERATURE REVIEW

The major crux of any fire outburst system is the call to correctly perceive the occurrence of fire and to quickly alert occupants of building, important fire and crisis management authority, and also in most circumstances, swiftly make active any emergency fire security strategies. It is seldom said that humans make very good fire detectors since through their God-given senses, they are able to feel heat, see and probably smell smokes, perceive flames, and feel a fire. However, since fire outbreaks are emergency cum crisis situations, humans are not always reliable or available, hence the use of Hi tech as trusted substitute [4].

Fire monitoring is perceived as a method of observation and control of fire danger in a given location based on certain constraints and parameters such as weather conditions, condition of combustible materials and potential fire sources, so as to timely develop and implement measures of prevention and (or) minimize damage from them. Fire monitoring provides the essential media for forecast of factors that can make a fire outbreak to emanate even before it show cases [5].

Fire detection can be seen as the method of discerning fires early in their development stage when there will still be time to get the occupants evacuated. When technologies are involved for this purpose, it becomes crucial to put in place proficient fire revealing algorithm, as it plays very important task in the whole firefighting stages .

Types of Fire Monitoring and Detection Systems

According to [6], Fire Monitoring and Detection Systems are assembled into three categories; Satellite Systems, Ground Systems and Unmanned Aerial Vehicle Systems.

Ground Systems: Conventional ground systems which are also called terrestrial systems, has its foundation on human supervision that is they are being supervised by human. Fire detection and monitoring is performed by supervising sections locally or by analyzing data provided from local sensors such as flame, smoke cum heat detectors, and gas sensors. Ambient sensors are also incorporated so as to increase systems efficiency and detect the exact location of fires. These sensors are used during the day and night to detect fire and smoke and identify their characteristics. The core sensors used in terrestrial systems are apparition or infrared (IR) camera, IR spectrometers and Light detection and ranging systems (LIDAR) [7].

Satellite-Based Systems: Satellite-based systems has its genesis on space sensors, the major build up fire remote sensing devices. These sensors are known by their steadfastness and massive regions monitoring since they get images in multiple spatial and temporal resolutions. Space sensors have many applications in earth observation such as road extraction, Building detection, land cover classification and fire detection and monitoring.

Unmanned aerial vehicles (UAVs) systems: UAVs (popularly known as drones) are aircrafts devoid of a human pilot. This technology are vividly used for both military and civilian essence. UAVs commune with the ground station by means of a data transmission system that portrays both the real time order coming from the ground and the information acquired by the UAV that can be delayed and usually intermittent.

Essence of Fire Monitoring and Detection

The essence of fire monitoring and detection can neither be comprehended nor exaggerated. The following are the major significance reasons for fire monitoring and detection:

i. The main import of fire monitoring and detection is that it aids in detecting potential fire in its elementary stages.
ii. Exploring such, one can progress upon the reaction time of residents evacuating and initiating any feasible crisis response actions.
iii. Early detection of fire is of paramount importance and plays a very crucial role in protecting and saving lives and properties.
iv. Fire monitoring and detection systems can momentously minimize spoils and maximize fire control exertions.
v. Early detection has a significant task towards the protection of the safety of first responders or emergency/ crisis response personnel.
vi. It can also bring to a barest minimum the amount of wasted time for corporate and/or business operations.

3. METHODOLOGY

The methodological process used here include the Statistical and Artificial Neural Networks (SANN) , Image Processing along with the fire detection Algorithm. SANN are computational models which are enthused by the interior functioning of the human brain. ANNs are created by programming regular computers to behave as though they are interconnected brain cells. ANN is often used as a surrogate model or a response surface approximation model because of its robustness to solve multivariate and nonlinear modeling problems, like function approximations and classification. Here we adopted color segmentation as the basic principle for initial fire detection in the fighting robot. It was achieved by extracting the two basic properties of fire, namely the color property and the luminance property, through suitable thresholding in RGB and YCbCr color spaces respectively. The obtained threshold binary images were combined, giving rise to the fire detected image. The fire detection algorithm's process flow as put forward by the researchers is shown in figure 1.

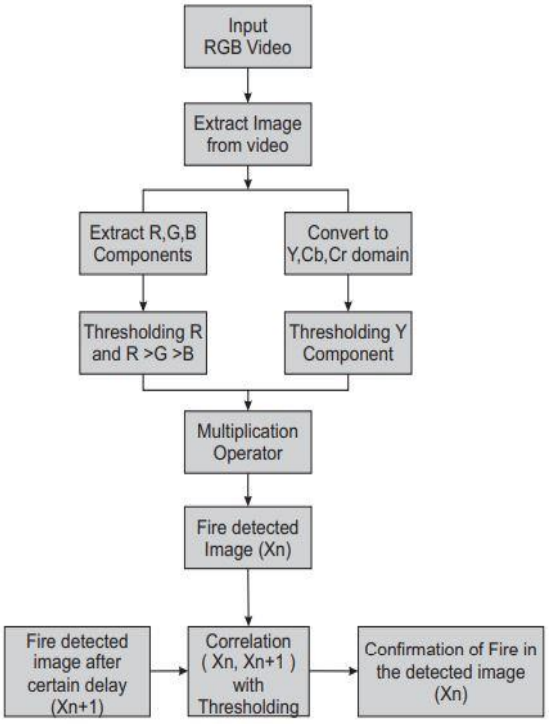

Figure 1: The fire detection algorithm's process flow

3.1 Data Collection and Training

There are several other ways ANN are deployed including to classify information, predict and forecast outcomes and cluster data. As the networks process and learn from data they can classify a given data set into a predefined class, it is then trained to predict outputs that are expected from a given input and discover a special feature of data and then classify the data by that special feature. Here we used a 30-layered neural network to power photos in addition to powering its "watch next" recommendations for YouTube videos.

4.RESULTS AND DISCUSSION

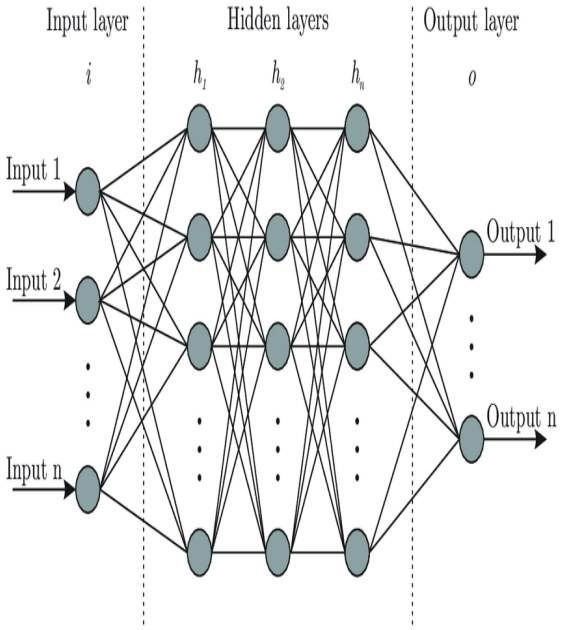

Figure 2: ANN Architecture showing layers

During processing, this neural network will explore four main steps:

(i) Initialization,

(ii) Activation,

(iii) Weight training and

(iv) Iteration used in classification task

However, the steps or activation functions change based on the problem to be solved. The basic information processing elements of neural network begins with neuron connected by links. Each link had its own weight and every neuron consists of more than one weight as well as the adjusted weight. From input neuron, links will move towards the other nodes. This is known as feed-forward (FF) neural network. Each link has numeric and associated weight that connect it through the output. All connected links are called perceptron. After the input links have been individually weighted, they will be summed together to form an activation function. At this stage certain formulations such as the conjugate gradient (CG) formulations are applied to find optimum weight connected to the next layer; layer1 (to 2, 3 or up to layer n). The number of layers in certain network depend on the complexity of a problem to be solved.

4.1 How ANN Works here

Artificial Neural Networks can be viewed as weighted directed graphs in which artificial neurons are nodes, and directed edges with weights as connections between

neuron outputs and neuron input. A typical description is shown in Figure3.

The Artificial Neural Network receives information from the external world in pattern and image in vector form. These inputs are designated by the notation x(n) for n number of inputs. Each input is multiplied by its corresponding weights. Weights are the information used by the neural network to solve a problem. Typically weight represents the strength of the interconnection between neurons inside the Neural Network. The weighted inputs were all summed together inside the computing unit (artificial neuron). In case the weighted sum is zero, bias is added to make the output not- zero or to scale up the system response. Bias has the weight and input always equal to '1'. See Figure 2.

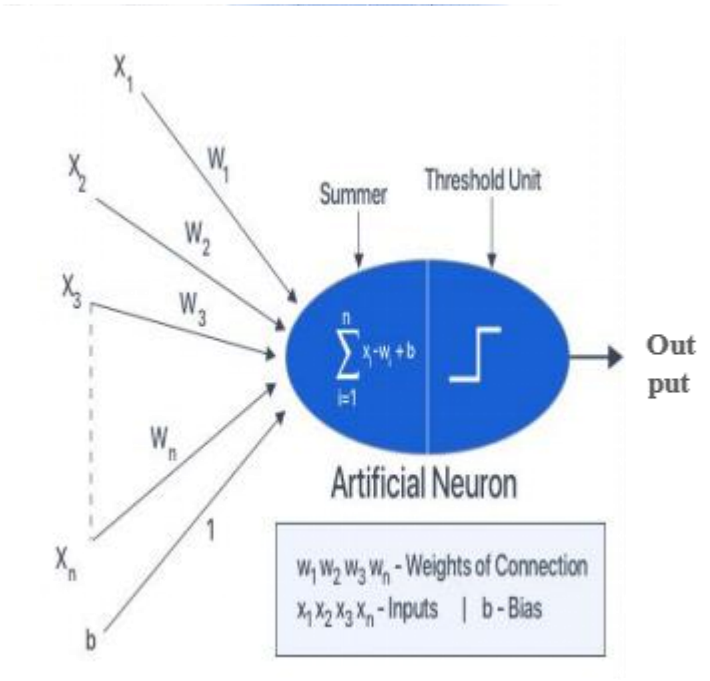

Figure 3: Schematic description of the workings of ANN

The sum corresponds to any numerical value ranging from 0 to infinity. To limit the response to arrive at the wanted value, the threshold value is set up. For this, the sum is forward through an activation function. The activation function is set to the transfer function to get the desired output. There can be linear as well as the nonlinear activation function.

4.2 Artificial Neural Networks in Fire Monitoring and Detection

The function of artificial neural network in fire monitoring and detection is to learn certain fire related features (most especially fire color, flame motion) in order to greatly improve accuracy in the prediction of what is truly a fire situation or not. This is because neural networks have the sufficient learning capability. Hence, a typical process flow for the application of neural networks in fire monitoring and detection goes thus; a neural network is employed to build the flame color feature model (FCFM). Flame images of training samples are fed into the neural network to learn the color features of fire flames according to a specified color model. Based on the FCFM built by the neural network, fire-like color areas are roughly separated from an input image frame. Then, spurious regions caused by fire reflection or with similar fire-like colors are removed by the image difference and color masking techniques. Finally, the burning degree of fire is roughly estimated in the last phase to provide users a proper fire situation notification. Figure 4 shows a four-layer fully connected back propagation neural network used for learning and flame segmentation in this study.

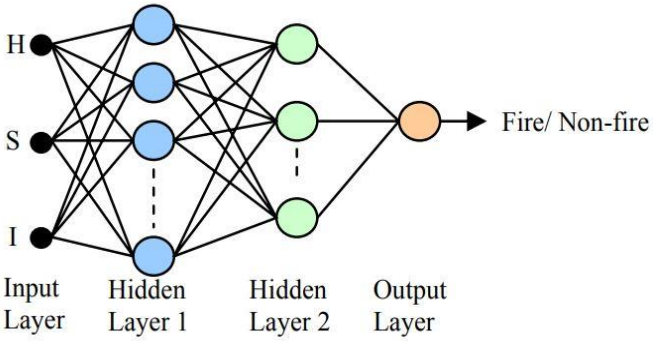

Figure 4: A typical neural network for fire flame segmentation

5. RECOMMENDATIONS

The present work proposed a neural based system for detection of urban fire outbreak. The system indicated the occurrence of fire if the output was close to one. The work is implemented using Python programming language and result showed that if detected the occurrence of urban fires with reasonable accuracy. The system is recommended for use in Nigerian cities because it avoids false alarms.

6. SUGGESTION FOR FURTHER STUDIES

Further studies are encouraged in the area of incorporating Deep Neural networks based on Intrusion Detection System as a means of detecting and out casting false fire alerts using fire colour and smoke intensity.

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