Literature Survey

Date	03 September 2022
Team Id	PNT2022TMID11775
Batch Id	B10-4A6E
Project Name	Industry-specific intelligent fire management system

PAPER 1: An IoT Based Intelligent Fire Evacuation System.

AUTHOR: Afsana Khan

PUBLISHED YEAR: 2018

Abstract:

Nowadays fire accident in buildings has become a very common incident. As the structural design of modern buildings are complex and augmented, fire accident victims often find it difficult to identify a safe path to exit the building. As a result, they panic which causes more injuries and deaths. In this paper, we have proposed an IoT based intelligent fire evacuation system that will effectively guide people along an evacuation path in case of fire accidents. A* search algorithm has been used to control the central module of the proposed model. This will help people navigate out of danger by guiding through the shortest safe path possible. It shows the next best path if the first optimal path is already crowded. A grid-based floor plan simulation both in software and hardware has been designed and implemented to accomplish the desired goal. For a real time, active, intelligent guidance system, here a wireless sensor network including sensors like PIR sensors, smokes sensors and heat sensors have been combined together. The system will not only help evacuees reach the exit but also automatically notify the fire brigade for rescue operation.

Methodology:

The overall system comprises of two parts i.e., the software module and the hardware module. Data from the sensors of hardware module is passed onto the software module through the server. The software module performs the necessary calculations and sends the results to the hardware module.

A. *Software Module*

The system is shown as a software-based simulation on a floor plan that has been designed based on the practical implementation. The designed floor plan contains rooms, walls, free paths and fire exits which is a graph representation using grid system. Each grid indicates a node and each node contains a cost generated by the cost function. Here the node where human presence is detected is considered as the source and the fire exits are considered to be the goals. Since our aim is to show the shortest safe path to the human towards the fire exit so it can be said that it is required to find the shortest path to the algorithm has been implemented using JavaScript where 2D arrays have been used to store the cost of the nodes. The values from the sensors are stored into the MySQL database using PHP. For the design and layout of the grid view, HTML and CSS has been used.

The software system works on the server side where the values from the hardware components are passed into.

B. Hardware Module

The whole floor is considered to be divided into 17 nodes for our software simulation among which 14 nodes are assumed to be the active nodes which contains the sensors for fire and human presence detection. Figure 1 shows the block diagram of the hardware system.

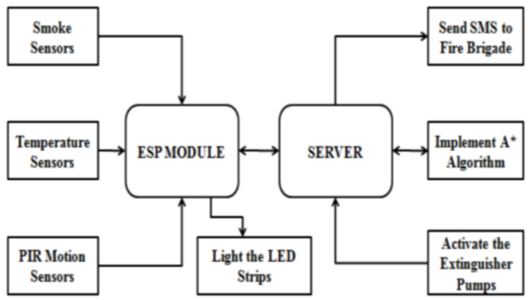

Figure 1: Block diagram of the hardware system

The major components used in the system are

1) Arduino Mega: The Arduino Mega is a microcontroller board based on the ATmega1280.

2) Passive Infrared Sensor (PIR): PIR detects infrared radiation (IR) from objects having temperature above absolute zero within its view field. It is widely used in detection of human motion.

3) Smoke Sensor (MQ-2): The MQ-2 smoke sensor is sensitive to smoke and to the flammable gases LPG, Methane, Hydrogen etc.

4) Heat Sensor (LM35): The LM35 series are precision integrated-circuit devices which have an output voltage proportional to the temperature in degree Celsius.

5) ESP Module 8266: The ESP8266 Wi-Fi Module, which is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor.

6) LED Lights: LED, a semiconductor device that converts electricity into light.

7) Buzzer 5V: Buzzer is an audio signaling device which has been used as an alarm for detection of fire hazard.

Conclusion:

This paper proposed an intelligent evacuation system which operates using both hardware and software components. The hardware and software modules are interlinked with the help of a server. All data sent from the hardware module is received through the server and is used by the software module for implementing the A* search algorithm and calculating the shortest path to the exit.

This system can be very useful in cases of commercial buildings and industries which are more prone to fire hazards.

PAPER 2: A Framework for Intelligent Fire Detection and Evacuation System

AUTHOR: Islam Gomaa

PUBLISHED YEAR: 2021

Abstract:

Fire conditions can become uncontrollable without warning to those located in remote sections of the building. Application of Artificial Intelligence (AI) could help guide occupants to safe evacuation routes and first responders into the building. Here, propose an integrated trained AI and data collection system that can make short-term predictions on fire behavior, structural integrity and optimal egress path(s). The system can distribute guidance to users via mobile devices or public address systems. Most real-time evacuation systems rely on a pre-populated database of fire scenarios. However, real-time fire behavior could be different. Hence, an AI based system is proposed to provide short-term prediction of fire behavior faster than real-time during a fire incident.

Methodology:

The system comprises the following components:

1. Detection

2. Fire Dynamics

3. Structural Response

4. Evacuation Navigation and Routing and

5. AI Emergency Management and Decision Support

The Detection component gathers spatial and temporal data from fire propagation sensors, structure health sensors and population sensors. The Fire Dynamics component is trained to predict fire growth, smoke movement and fire decay. The Structural Response component is trained to predict structure behavior in fire based on data from structure health sensors. The Evacuation Navigation and Routing component finds optimal evacuation routes based on input from the other components and an embedded representation of evacuee response. The AI Management and Decision Support system combines results from all other components and convey directions to occupants and first responders through a smart handheld device.

During operation, the AI system receives information from three types of detectors/sensors: fire propagation sensors, structure health sensors and population sensors. Fire Propagation Sensors Smart fire detectors such as gas analyzers, smoke, CO, temperature and IR sensors are connected to a common network. As fire progresses through its phases (ignition, smoldering, growth and propagation), fire detectors are triggered at respective phases depending on their proximity to the ignition source. Input data to the AI system are spatial and temporal distribution of different fire related measurements. Thus, the trained AI system can identify location of the fire, what is burning, rate of fire growth and direction(s) of fire propagation. Population sensors: Approaches to record movement of occupants in and around a building include technologies such as CCTV, footpads, passive or active detectors, WIFI/Bluetooth/GPS counts and dedicated people sensors (infrared, beam, LIDAR, etc.). Given the connectivity of population sensors to a common network, spatial and temporal distribution of occupants are available to the AI system. In addition to the spatial and temporal distribution of fire related measurements, the trained AI system returns optimal evacuation paths for individual occupants.

Structural Health Sensors Structural health sensors such as thermocouples, strain gauges and fiber optics are used to gather information regarding thermal and structural load conditions. Data gathered are the main input to the structure health AI component which predicts information on the structural integrity and conveys it to first responders.

Conclusion:

The ‘‘overall’’ habitable envelope is the intersection of all envelopes from all factors. The envelope’s boundaries shall be time dependent and can be forecast to a hypothetical future point in time, based on input from the detection component. The future habitable envelop informs the Evacuation Navigation and Routing component on the feasibility of advice given for evacuation and entrance routes for first responders.

PAPER 3: Development of an Intelligent Fire Hazard Detection System Using Enhanced Machine Learning Technique

AUTHOR: Odo F , Ituma C.2 , Asogwa T.C , Ebere U.C

PUBLISHED YEAR: 2022

Abstract:

This work was targeted on the development of an intelligent fire hazard detection system using enhanced machine learning technique. The study reviewed many literatures which revealed the problems fire hazard has causes over the years, and also the efforts proposed to solve these problems, but despite the success achieved, there is still great room for improvements This was achieved using Dynamic Systems Development Model (DSDM) methodology which accommodates all necessary functionalities such as modeling diagram, mathematical models, algorithms and simulation based implementation. The model of the wavelet transform was developed and the decomposed output was feed to a Feed Forward Neural Network (FFNN) which was trained with fire data collected from the Nigerian Fire Service Department and back propagation algorithm, to achieve an intelligent fire hazard detection algorithm. The algorithm was implemented with Mathlab and then tested. The result showed a regression performance value of 0.96152, accuracy of 93.33% and MSE value of 0.000103Mu which all indicated system reliability.

Methodology:

The intelligent fire hazard detection system which is reliable and accurate. This was done using signal processing tool designed with wavelet transform which has the ability to process simultaneously fire data in frequency and time domain. This processed wavelet decomposition of fire was then feed to an already trained FFNN algorithm for detection and classification of fire hazard in indoor environments.

INTRODUCTION:

Fire hazard detection and prevention is vital for the safety of lives and properties in residential and public localities such as homes, hotels, industries, bar among other places. This topic has become very important due to the increase rate of fire accidents occurring both indoors and outdoors today. The outdoor involves mainly wild fire events which damages the ecosystem vegetation and wild lives with high economic impact which although can be recovered with time.

METHODS :

The methods used for the development of the proposed system are data collection, data acquisition, data processing, wavelet transform, artificial neural network, training, prediction and detection. This was achieved using Dynamic Systems Development Model (DSDM) methodology which accommodates all necessary functionalities such as modeling diagram, mathematical models, algorithms and simulation based implementation solution.

i) **Data collection:** For the development of the proposed system, data collection was done from the Nigerian Fire Service department (Enugu State Branch) as the primary source of data collection.

ii) **Detection:** This is the process where the neural network collected data of fire, train then to detect its time series behavior as hazard or not hazard.

iii) **Data acquisition**: This is the process of capturing fire data by the image acquisition device (camera sensor) and then feed to the proposed artificial intelligent system for training, prediction and fire detection in real time.

iv) **Data processing**: Fire is a dynamic system when it burns and the data collected are associated with various noises. This process ensured that the fire data is processed using wavelet transform filter.

v) **Wavelet transform**: Wavelet transform is perceived as a very promising technique for this type of applications because it has the capacity to simultaneously localize signal in both frequency and time domain.

vi) **Artificial Neural Network (ANN):** ANN is a biological inspired neuron which has weight, bias and activation function with the ability to learn patterns from training dataset.

Modeling of the wavelet transform filter:

Wavelet transform was used here as a data processing tool which analyzed the fire captured in frequency and time domain. The type of wavelet transform used here is the Discrete Wavelet Transform (DWT) type. In the DWT, the signal is decomposed into two levels such as coarse approximation and detail information. DWT have two sets of functions. Scaling functions are performed by low pass filter and wavelet functions are performed by high pass filter. A signal in time domain is decomposed into different frequency bands by passing it into successive high pass and low pass filters. The original signal is passed through a half band high pass filter which is followed by low pass filter, with the output down sampled.

IMPLEMENTATION:

The system developed was implemented using neural network application software in simulink. This was achieved using the models developed which was used to build a neural network toolbox, image processing toolbox, data base toolbox, wavelet transform toolbox, signal processing toolbox, statistics and machine learning toolbox to achieve the new system.

CONCLUSION:

This research has successfully developed and presented an intelligent fire hazard detection system which is reliable and accurate. This was done using signal processing tool designed with wavelet transform which has the ability to process simultaneously fire data in frequency and time domain. This processed wavelet decomposition of fire was then feed to an already trained FFNN algorithm for detection and classification of fire hazard in indoor environments. The result when tested showed that the new system is very reliable with a regression performance value of 0.96152 and MSE value of 0.000103Mu.