Controls and Intelligence Behind "NISTARA-2"-A Disaster Management Machine (DMM)

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Abstract - **Evolution comes before survival only in dictionary. We are creatures of reason, programmed to preserve energy and maintain equilibrium. However in this era of electronics and communication it is important to not merely survive but to thrive, we must occasionally consider the role of autonomous machine at times of disaster. Having a disaster management machine will help us through early evacuation which will eliminate panic situation and reap the ultimate rewards in saving precious lives. This paper discusses NISTARA(which is a Sanskrit word meaning rescue and pronounced as Nistar), a system built to detect and handle disasters in physical environments. It is based on different sensors (water, fire, seismic) deployed at different vantage points, which send their signals to a base computer which implements fuzzy logic based detection and evacuation response. It sends camera images to output displays, and information to end user cellular phones through specially designed android app. This paper also discusses the feasibility and effectiveness of implementing this device in premises such as schools, offices, colleges and hospitals.**

Keywords – fuzzy logic; disaster; master-slave; NDMA; evacuation

I. INTRODUCTION

NISTARA is made for helping in emergency situation. Its design helps in evacuating the premise at such times. It works on the swarming technique thus taking inputs from surrounding as well as from the user and thus providing the safest path to evacuate the premise. The effectiveness of this device is that it informs about the situation to the Nation Disaster Management Authority of India (NDMA) by sending a distress message. The receiver module of nistara would be installed in the NDMA office and will show the coordinate of the location where the disaster has strike.

II. DESIGN CONCEPT

The master slave connection is used to analyze the situation and respond accordingly. Each master computer will take inputs from various fire and seismic sensors present at each exit and are mounted on display module. This makes up the slave system. Every slave comprise of two main sensors which are thermal sensor, seismic sensor for fire hazard, earthquake respectively. On sensing any activity through the sensors the master computer activates the alarm. Now any user can send an acknowledgement signal to the master by using a switch or a voice recognition system present on the slave demanding for instant images and an evacuation route of the building. These images can also be used in case of terrorist attack and burglary. The evacuation route in case of fire is calculated by the use of fuzzy logic (discussed in section III-E) and every information about the evacuation route along with the images is send to specially developed android application installed in every users phone. In case of small earthquakes the system will set an alarm giving warnings about the aftershock that usually follow. During earthquakes of large magnitude in case there is damage to the premise the device can get images from various parts of the building for the people trapped. Due to a display screens installed at each exit and all of them self powered, there is a quite good chance of access to those display screens by the people trapped. The alarm can also be set on by a switch installed at every slave system, in case the user detects an alarming situation before the system does.

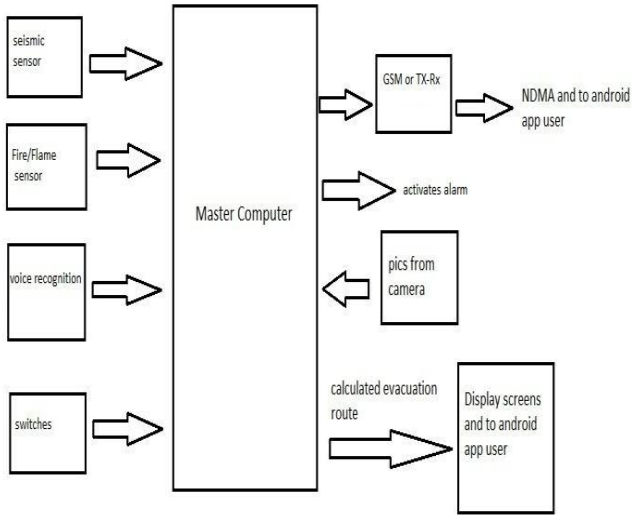

Fig. 1 Block diagram of the master computer of NISTARA-2

III. MOTIVATION

The inspiration was drawn from a device "Suraksha" [1] which is a security and protection device specially designed for women in distress. It is a easy to carry device with simple magnanimous functionality. The basic approach is to intimidate instant location to the police so that unfortunate incidents would be prevented and to provide real time evidence for action against the perpetrators of crime against women .NISTARA is an extension to Suraksha's technology as well as one of its versatile applications. NISTARA works on the philosophy of intimidating the NDMA about the disaster location.

IV. CONSTRUCTION

A. Microcontroller

The controller used here is ATMEGA 8(8 bit controller) due to its high memory and low-power**.** It is based on Advanced RISC Architecture and has High Endurance Non-volatile Memory segments. And has special features like Power-on Reset, Internal Calibrated RC Oscillator, Programmable Brown-out Detection, External and Internal Interrupt Sources.

B. Sensor

Seismic sensor circuit is used to detect the earthquake as it can detect even the smallest vibration/sounds. The principal behind any fire detection is limited to either smoke sensor or temperature sensor or any IR cameras. Although the smoke sensor has a rapid response time, it has high false alarm rate. In contrast, the temperature sensor provides with a reliable responses but with slow response time. So rather than using only smoke and temperature sensor we can use a combination of sensors. In order find solutions to these problems, research on video based fire detectors (VFD) has been carried out in the last decade. Time-Of-Flight(TOF)[3] cameras or IR cameras are expensive and they are not in easy access everywhere. So we decided to merge these two ways, detect flames through an ordinary camera by processing the data generated by monitoring a scene and to make the system errors free by using PIR sensor.

C. Master computer

It is a computer like a server on which the continuous feeds of cameras are connected. It is this master computer which takes decision about the occurrence of any disaster and sets off the alarm. It responds to the user needs and provide with the camera instances and the calculated evacuation route. A request to the master computer is done through the display screens with a simple switch or voice recognition by the user. In case of a disaster it is the electricity supply that goes off first hence this master computer will have an autonomous source of electricity. The master computer will be different for different floors .The master computer will be located in a safe place. But if damaged then a back up master computer from a different floor will take over as all the master computers are connected and assigned a priority order. A master computer will also be placed outside the building in case all the master computer fails this outside master computer with will take over. This is done for a large magnitude earthquake or a terrorist attack .During a terrorist attack the police can access the situation from outside the building

D. Android application

A dedicated android application would be developed on which the emergency signal, evacuation route and the images from master computer will be sent so that every user gets to know about the disaster and the best possible way out. The android app will be installed in every user's smart phone working in the building. This is the most efficient way of communicating during the disaster .The user has to first set the floor number in the android app, so it is known which master computer should respond. It is also important as the user should receive the evacuation route of the same floor of his presence.

E. Fuzzy logic

It is a multi valued logic that not only deals with logic 1 and 0 but also the intermediate logic between them. It explains the concept of partial truth. It has several IF-THEN rules which are used to calculate the best possible evacuation route. In current model of NISTARA there are four display screens on each floor. This also means that there are four fire sensors on each floor. Fire sensors which NISTARA uses will give analog input to the microcontroller .Let the intensity of the fire sensed by the first, second, third, fourth sensor be I_1, I_2, I_3, I_4 respectively. With help of these intensities the master computer will calculate the evacuation route .The master will take inputs from all the four sensors and compare their values with each other. Now if intensity order is $I_1 > I_2 > I_3 > I_4$, this gives the master computer an idea that the fire is more intense at the exit 1 then it is at other exits, hence the evacuation route will be calculated in a way that avoids taking exit 1 .Similarly all different combinations of fire intensities are fed into the master computer with their corresponding evacuation route.

F. Camera

Closed-circuit television (CCTV) cameras can produce images or recordings for monitoring purposes, and can be either video cameras, or still Image cameras. They provide feeds continuously to the master computer and when the alarm is set on then the instant image is captured.

G. Voice recognition

It uses a Voice recognition system which is a HM2007 IC based device. The speech recognition system is a completely assembled and easy to use programmable speech recognition circuit. Programmable, means you can train the words want the circuit to recognize.

H. NDMA

A transmitter is used to transmit an instant message to NDMA (Nation Disaster Management Authority of India) as to get instant help or rescue. This High Speed CC2500 Based Wireless module is a plug and play replacement for the wired Serial Port (UART) supporting baud rates up to 38400.The

receiver module of this device will be installed in NDMA office.

I. Switch

It is a normal push switch associated with every slave and can be used to initiate the alarm. It is an alternative mode of setting the alarm when every other mode fails.

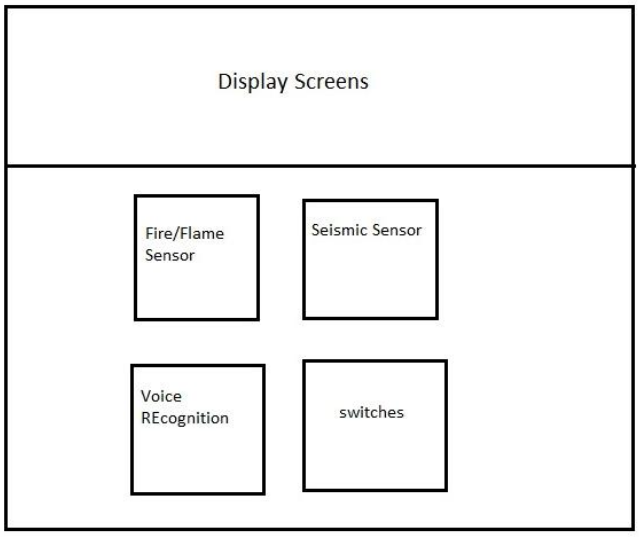

Fig.2 Slave module of NISTARA at all the exits.

V. WORKING

NISTARA works in three stages

A. Stage 1

NISTARA works by first taking inputs of fire or seismic sensors (only fire, earthquake are covered in the prototype). The master computer processes the information and hence activates the alarm. The information about the disaster is also send to every registered user on their android application.

B. Stage 2

Now if the user demands for the images, the microcontroller which is present in master computer extracts the instant images from cameras and sends them to every display screen. On request, the images are also sent to the user on their android app. The user can only access the display screen and not the master-computer. In this way android and non android both kind of users are covered.

C. Stage 3

After calculating the evacuation route, the master computer sends it to every display screen. All this information i.e. the evacuation route and the camera images are send to every user on their android application. In emergency situations the computer sends a distress message to NDMA .The receiver module placed in NDMA office will display the location coordinates of the premise in danger.

VI. CASE STUDY

Fire incident at AMRI hospital Kolkata [2]

A. About the incident

93 people, out of whom most of them were patients, died in the huge fire that broke out in the early morning hours in AMRI. The fire began in the basement where a godown and a pharmacy were located. The area was packed with highly combustible material such as mattresses, PVC pipes, oxygen and LPG cylinders, and even engine oil. When the fire sparked off, dense smoke started filling the basement and entered the upper floors catching many persons unaware in their sleep.

B. What went wrong?

1) The fire broke out at around 2 am in the morning. AMRI people started fire fighting operations on their own without initiating a fire alarm or informing the fire station. This resulted in loss of initial crucial time. Internal fire hydrants/sprinkler system were either nonfunctional or the staff were not trained to operate them in an emergency situation.
2) The hospital staff informed fire brigade and Police only when fire was out of control.
3) The fire alarm system for the building was found SWITCHED OFF to avoid false alarms. This resulted in no fire alarm alert and centralized AC system too did not automatically trip. The running condition of AC in fire situation resulted in spreading of smoke in unaffected upper floors causing huge number of casualties.

C. How Nistara can help?

1) As soon as the system detects fire it will set the alarm on as the alarm system cannot be turned off.
2) If the intensity of fire is high it will automatically send an emergency signal to NDMA/fire station without human interference. This will prevent delay and save initial crucial hours.
3) An important feature of NISTARA is as soon as the system detects fire it will automatically drip the electricity supply of the building.
4) People struck in the building can obtain the evacuation route and take the safest path possible.

D. TESTING

Fig.3- Relationship between inputs A1, D1, A2, D2, A3, D3 and outputs A1, D1, A2, D2, A3, D3.The yellow portion Depicts different inputs under different member function. Based on the different regions in which the input lays the black portion depicts output also lies under different regions. It is the output regions which collectively decide the evacuation route.

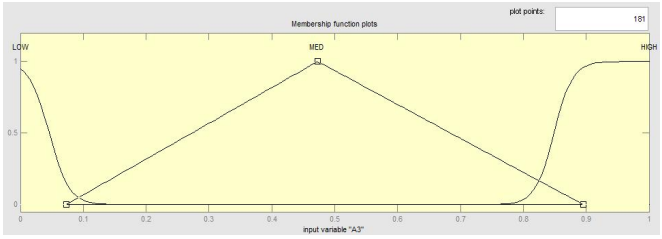

Fig.4 Member functions LOW, MED, and HIGH under which the input is divided.

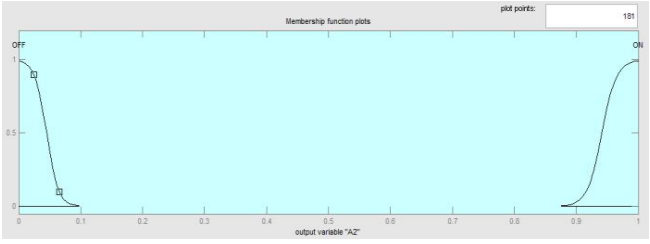

Fig.5 Member functions ON and OFF with divided output.

VII. CONCLUSION

Disaster management is an important area to work on, and technology has an important role to play towards this goal. This can become a large system integration project that can be customized for each environment and each kind of disaster. The main advantage of NISTARA is its versatility. This is a multipurpose device which can be made to fit in different applications. The primary application remains the use as a disaster management machine where we will aim at installing it in hospitals, malls, schools. Later on this device will be used as a surveillance machine in defense as well as in high security regions such as banks and airports. NISTARA is a very polished version of the entire existing surveillance machine available in market as this device alone can sense different kind of problems through its specially provided sensors and based on inputs take its own decision without human involvement.

VIII. ACKNOWLEDGEMENTS

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