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An Improved Augmented Agent Framework for Disaster Response (AAFDR) in Academic Communities in Rivers State

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Abstract - *Disasters, irrespective of the type, either natural or man-made, always has devastating aftermath on their victims. Losses are always the end product of a disaster. In most cases, the losses are irrecoverable, while at other times, it takes a very long period for the loss to be soothed. Losses range from economic, to financial, to emotional losses etc. and in extreme cases, lives are also lost. As a result of all these discomfort and losses caused by disaster, researchers have in recent years dived into the field of disaster management, proposing methods to curb the effects of these disasters and bring it to the barest minimum using certain technologies to communicate and respond to these disasters. Several frameworks have been proposed and implemented for disaster risk management. However, the problem of lack of a framework that uses distributed communication system to communicate a disaster to the appropriate response teams immediately it occurs, and the lack of a remote sensor that captures real-time disaster data and transmits it, remains an open problem yet unsolved. In this work, a system that uses a remote sensor such as the Drone to capture real-time disaster data and translate it to an intelligent centralized system, which in turn transmits the data to a distributed database (which includes all disaster response teams) for fast response to a disaster have been developed. The Structured System Analysis and Design Methodology (SSADM) is adopted for this framework. We implemented with Hypertext Preprocessor (PHP), JavaScript (JS), HTML and MySQL database as backend. The results show that with the aid of this system, disaster can be responded to very quickly before major harm or damage occurs. This system runs at a very fast speed (seconds), is reliable and proves to be a solution to the lapses in disaster response. This work could be beneficial to tertiary institutions in Rivers State, Nigeria, especially the University of Port Harcourt, which have an organized system and technological advancement infrastructures, to disaster management agencies and to any other disaster-prone areas around the country.*

Keywords - *Emergency, Public safety, Multi-Agent, Virtual reality, Hazard, Augmented Reality Put.*

I. INTRODUCTION

Events such as poorly designed urban development and infrastructure neglect to ecological changes have incessantly led to an increase in the rate of disaster outbreaks. Disaster epidemics can occur in different ways; they could be natural or man-made. Natural disasters can be in the form of Hurricanes, Cyclones, Earthquakes, Tsunami, Floods, Mudslides, Avalanche, Tornadoes, volcanic eruptions etc. These disasters are unplanned and usually comes abruptly. The harm or effect left by this form of disaster is usually pathetic devastating and takes a lot of time for recovery from the effects. The other form of disaster is man-made. It is caused by man, both intentionally or unintentionally. They include Fires, Water contamination, Structure failure, Mining accidents, Explosion, Acts of terrorism and violence. This form of disaster can be prevented or easily controlled if the proper prevention, response or management measures are put in place.

Disasters can occur anywhere, at any time and to anyone. It could occur in the homes, academic community, business centres, industries, religious centres, and our communities at large. Wherever and whenever these disasters occur, the occupants of that region suffer grave losses both in terms of life and properties. Between 2006 and 2015, 6270were recorded in five continents of the world, which resulted in 8,197,666 deaths, 70,597 casualties and $1,989,866,263,000 worth of economic damage [1]. Machine learning is also referred to as predictive analytics.

Since disasters are bound to happen (as recorded in so many scientific projections and even in the Holy Writ), the focus has become how to effectively manage these disasters so that when they occur or preferably how to reduce their rate of occurrence. Recent research is geared toward Disaster Risk Reduction (DRR). DRR is a concept that deals with reducing the risks associated with disasters. This technique is feasible since disasters are a result of an interaction between hazard and vulnerability. It has also been discovered that areas that have a higher number of women and children suffer more in the face of disasters, and it takes them more time to recover in those areas.

Preparedness for disasters is crucial for households, businesses, and communities, but most of them pay little attention to it. The concept of disaster preparedness encompasses measures aimed at enhancing life safety when a disaster occurs, such as protective actions during an earthquake, hazardous materials spill, or terrorist attack. It also includes actions designed to enhance the ability to undertake emergency actions in order to protect property and contain disaster damage and disruption, as well as the ability to engage in post-disaster restoration and early recovery activities.

The manpower used during disaster response and management may be well trained, but the need for them to get handy information on time for proper and prompt utilization. This is indispensable to reduce the much-needed response time for relief operations. Timely dispatch of relief materials from various distribution centres to hospitals in coordination with the schedule of the medical teams is also a critical activity in disaster management [2].

With the emergence of Augmented Reality (a computer technology that merges a view of the real world environment upon a digital image), the possibility of better training for disaster management has increased to a great extent. Other technologies are also available that help in the fast and effective response to disasters, such as virtual reality, and these technologies have so far helped to an extent to reduce the impact of disasters by a timely response to the area of the disaster before grave damage is done in those areas by the disaster. These technologies, however, need to be deployed to the academic community, which houses the future of every country or race, in order to avoid extinction.

A. Aim and Objectives of the Study

The aim of this research is to develop an Improved Augmented Agent Framework for Disaster Response in Academic Communities. The specific objectives are to:

- design a platform that works with a remote sensor that reports real-time disaster signals promptly to the stakeholders of the academic communities and relevant response teams in the face of a disaster.
- Develop a homogeneous distributed database connected through the Internet that allows information to be passed speedily to the response teams to ensure certainty of response.
- Implement using Hypertext Preprocessor (PHP) programming language and MySQL (Structural Query Language) as the database.
- Compare our results with the performance of the existing disaster response systems.

II. RELATED WORKS

RajitPimpale [3] proposed an Application of Virtual Reality in Disaster Response Work Training. They reviewed the method of training systems using Virtual reality against other conventional methods and found the advantages, disadvantages and challenges associated with it. The initial proof of this concept was shown through a fire emergency scenario, which depicted its hazard and mitigation strategies. However, they could not design a disaster response system for an actual academic community disaster.

Gehbauer [4] proposed a software system that supports decision-makers, surveillance and intervention teams during disaster response. It was as well designed for training and mitigation tasks to respond to disasters, especially strong Earthquakes. The system was connected through a network, and the participants communicated using PDAs, e.g. mobile phones. However, they could not develop a system that responds to disasters that occur outside that particular environment in which it was programmed to function in or respond to other disasters except earthquakes

Jillson [5] proposed a study that would improve on the science and evidence base of disaster management and response using Purposive and Snowball methods to select study participants. Their study yielded findings that could be used to strengthen planning and response by taking into account, where possible, evidence-based research that has been carried out with the engagement of community members and with support by key stakeholders. However, they could not inculcate any automated tool or software, and this yielded low results as the world has progressed from using manual tools to solve problems in a global society that has vast computer-aided technologies.

Dufty [6] proposed that disaster resilience learning should also include learning about the community itself, including how to reduce vulnerabilities and strengthen resilience by capacity building (e.g. social capital formation). Opportunities for disaster resilience learning were identified in four broad learning domains behavioural, cognitive, affective and social. Their findings demonstrated that many current ECE programs are only using limited parts of this learning spectrum, although this would be significantly increased by further embracing social media as a disaster resilience learning medium. However, he could not implement their findings using an I.T based approach by developing a platform that handles these disasters when they happen.

Luchetti [7] proposed an Augmented Reality system called Whistland, which makes synergistic use of augmented reality (AR), crowd mapping (CM), social networks, the Internet of Things (IoT) and wireless sensor networks (WSN). The system exploited technologies and frameworks of Web 2.0 and GIS 2.0 to make informed decisions about the chain of events. The social network integration was made through an efficient pointer-like mechanism that keeps the storage requirement low through a mobile application based on an augmented reality engine and provides qualitative information that sensors are unable to capture. However, they could not develop a model that supports a two-channel mode for the mobile application, which would have made the application more flexible.

Cumbane and Gidofalvi [8] proposed a framework for disaster management and response using the concept of Big Data. This was done by providing a short description of each big data processing framework, and a comparison of processing frameworks in each group is carried out considering the main aspects such as computing cluster architecture, data flow, data processing model, fault tolerance, scalability, latency, back-pressure mechanism, programming languages, and support for machine learning libraries, which are related to specific processing needs. However, they could not establish a link between big data, processing frameworks for different types of disasters (wildfire, flood, hurricane, earthquake, typhoon, landslide, volcano, etc.), and disaster management phases to support the researchers and disaster management institutions.

Sinha [9] proposed a study to analyze the requirements for planning rescue operations for such natural disasters and proposes an IoT based solution to cater for the identified requirements. The proposed solution was further validated using the task-technology fit (TTF) approach for analyzing the significance of the adoption of IoT technology for disaster management. They made significant contributions in the development of appropriate constructs for modelling TTF for IoT Technology in the context of disaster management. However, the scope of their research was narrow and covered only a few scenarios of which the academic community is not apart. Another limitation of the proposed model is that it does not consider utilization as a precursor for strategic value.

Khushbu and Lucienne [10] proposed a framework for developing a disaster resilience society (FDDRS). Its basis was a detailed display analysis of three projects aimed at developing resilient disaster systems. Its structure was derived from existing user-centric design methodologies. FDDRS includes novel methods, like coupling, and existing methods and concepts such as redundancy and modularization. The framework was unique in its focus on including users and other stakeholders throughout the process and in advocating dual functionality and decentralization of infrastructure and services. FDDRS facilitated the development of systems that ensures their applicability in daily life. This was expected to result in a more intuitive, i.e., faster, response to a disaster, thereby reducing a community's vulnerability and improving the chances of survival and recovery. However, they could not implement this framework using an IT-based system.

Savova [11] proposed the AR Sandbox. The AR Sandbox was created by Oliver Kreylos, is just one of the many examples in which reality is supplemented with computer-generated input. In this case, the reality is a box full of sand, and the input is hypsometric colouring and elevation contours. A Kinect sensor detects the microrelief forms in the sandbox, and after unnoticeable computer estimation, a relief map is projected over them. If the sand forms are changing, the colouring and the lines are changing with them to project the new accurate relief. Actually, AR Sandbox represents important conceptions of geology, hydrology, ecology, topographic mapping, etc., in a very entertaining and spectacular way for children and students, and this is the main reason this system is to be part of our equipment in the Laboratory of Cartography in UACEG. Included in lessons and games, the AR Sandbox was an irreplaceable tool for improving their knowledge of disastrous events such as floods, drought and fire, especially when it gives the opportunity of making virtual rain and isolating flooded areas depending on the relief and the watersheds. In this paper, after the detailed presentation of the AR Sandbox as a working system, proposals for educational activities for a large age range of children and university students are made in order to use augmented reality as a special instrument for displaying disastrous events. Some new ideas are suggested in consideration of future improvement with which AR Sandbox will meet more needs of the educational training for disaster response of children.

Eguchi [12] carried out a review of how remote sensing technologies have or could be used in the management of natural disasters. The focus was on methods that improve our understanding of the built environment and its vulnerability to natural hazards and on methods to better assess the impact of large natural disasters on urban areas. In order to demonstrate the efficacy of remote sensing technologies for disaster management, a number of cases studies are presented, including applications for the 1999 Marmara, Turkey earthquake, the 2003 Bam, Iran earthquake, and the 2004 Indian Ocean earthquake and tsunami. Their paper also provided a brief discussion on possible future directions for remote sensing in disaster management.

Wani [13] proposed a system for improving collaboration between different agencies and decision-makers involved in a fire emergency situation with the help of wearable augmented reality (AR). This field considers the possibility of transcending the physical and territorial boundaries of a real space; it is applicable to all time-space configurations of the hybrid (Real + Virtual) world. User interaction is through the use of hands and/or gestures. The rapid flow of information across different devices involved in the process, such as head-mounted display, PDA, laptop, data walls, and desktop, is critical to allow this form of collaboration to be integrated with adaptive context-aware work environments based on workflow management systems. The functionality of such a form of collaboration system is illustrated in the scenario of a fire emergency situation. However, they could develop a distributed database that connects all the stakeholders of an EMT for prompt disaster response.

Shapira [14] proposed a study to survey expected behavioural strategies among residents of a high vulnerability risk area in Israel and assessed factors that could influence their behaviour. Their results demonstrate that residents with low socioeconomic status are more vulnerable. They also discovered that several personal and socioeconomic characteristics are associated with residents' expected behaviour. Levels of earthquake preparedness and dwelling type are significant predictors of the choice of a recommended behavioural strategy.

Markus [15] proposed a Disaster management Tool (DMT) which are fast and reliable damage and casualty estimation tool that use up-to-date reconnaissance techniques such as damage detection based on airborne laser scanning data and the support of disaster management personnel with communication and information tools. The included decision support system helps to coordinate the allocation of the limited number of rescue personnel and machinery to enhance their overall efficiency. Onsite rescue operations will be supported by an expert system analyzing damage information acquired after the earthquake, combined with data about the buildings' construction and occupancy collected prior to the earthquake.

A. *Our Approach*

We have successfully reviewed a number of related research papers on the different systems and tools which has been used to predict response and train disaster response and management teams in the paragraphs above. But our main focus is on related work by [9]. They analyzed the requirements for planning rescue operations for such natural disasters and proposed an IoT based solution to cater for the identified requirements. Their proposed solution was further validated using the task-technology fit (TTF) approach for analysing the significance of the adoption of IoT technology for disaster management. Results from the exploratory study established the core dimensions of the task requirements and the TTF constructs. Results from the confirmatory factor analysis using PLS path modelling further suggested that both task requirements and IoT technology have a significant impact on the IoT TTF in the disaster management scenario. Their research made significant contributions in the development of appropriate constructs for modelling TTF for IoT Technology in the context of disaster management.

We hope to improve the work carried out by [9] by adding a different perspective that does involve a better data collection tool. The system uses a drone; an augmented agent that merges real-world scenarios with a digital image in real-time is used in place of the geo server to collect real-time disaster data. The proposed system is an intelligent system that reports real-time data, acts on the data and responds to the information gotten in the shortest time to ensure that the minutest damage or no damage is recorded.

III. MATERIALS AND METHODS

A. *Methodology*

The system development life cycle (SDLC) is also referred to as the application. It is a term used in systems engineering, information systems and software engineering to describe a process for planning, creating, testing, and deploying an information system. The systems development life cycle concept applies to a range of hardware and software configurations, as a system can be composed of hardware only, software only, or a combination of both. SLDC is a process followed for a software project within a software organization. It consists of a detailed plan describing how to develop, maintain, replace and alter or enhance specific software. The life cycle defines a methodology for improving the quality of software and the overall development process.

• Forecast of pos

B. *Analysis of the Existing System*

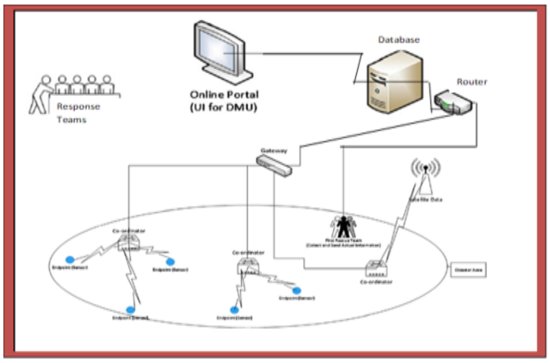

Fig. 1 The architecture of the Existing System
(*Source: Sinha [9]*)

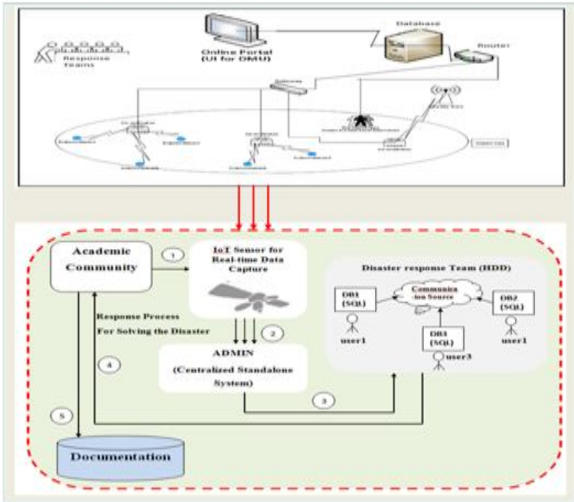

Fig. 2 An Improved Augmented Agent Framework for Disaster response Architecture (Proposed System)

The existing system surveys the emergency management system in India. Their research work will be analyzed under the following processes:

Process I

a) Identify the information required for deploying relief operations in the disaster area.

This phase summarizes the contents of the information that is to be sent to the response teams for relief operations to be dispatched to the disaster area. This information is gathered by the sensors. Information required for deploying relief operations in the disaster area can be summarized as:

- Date and time of the disaster
- Location information of the affected area
- Topographical knowledge of the affected sites.
- Number of victims (dead, injured, and missing)
- Effect on the animal population at the disaster site
- Effect of the calamity on the natural environment of the affected area
- Damage to the property

sible future developments including new risk.

Knowledge about the location of the distress scene alone may not be sufficient for inferring the route of relief operations by the land party. Information about the location in conjunction with the topographical information of the disaster site is more helpful in determining the best route to the site. It shall also contribute to the prediction of the magnitude of the disaster. Knowledge about the number of victims is of prime concern for planning the number of relief resources required for planning the rescue operations.

Process II

Analysis of how and where IoT technology can be applied for addressing the required response challenges.

Internet of Things (IoT) can be applied in information gathering, information transmission, information processing. Information gathering involves collecting data about a disaster incident, and it is carried out by endpoint sensors and satellites. The sensors are able to collect data such as the quality of air (particle matter, air temperature, humidity, and atmospheric pressure), water, as well as the chemical composition of the atmosphere (percentage of CO, CO2, NO2, O2, O3, SO2 etc.). The Sensors were low power and resource-constrained devices used for collecting specific data from the surroundings. In order to minimize energy consumption, these sensors are grouped into clusters. Each cluster has a cluster head that is responsible for transmitting the data gathered by the sensors of that cluster to either the bases station or another cluster head in case of multi-hop routing. Another source of information gathering was through the use of web platforms by first respondents to give vital information about the disaster which has occurred or was still occurring. Web portals, message boards, social networking portals, blogs etc., were useful to get this information posted by the first respondents. The information was posted on the blogs, which is a type of personal diary in cyberspace. The blogs had images, videos and firsthand observations about the disaster impact. Information about the missing persons, locations of the shelter and traces of family members has been shared using message boards. Tools such as ShelterFinder and PeopleFinder were used for obtaining information about people requiring immediate shelter and family tracing.

For information communication, a gateway connected to the Internet was employed. Data collected from the sensors shall be transmitted to the locally deployed coordinator monitoring those sensors. The gateway controlled the locally deployed coordinators, combined the received data and transmitted the data over the Internet to the central database maintained by the response teams. This data was either used to augment the GIS maps maintained at the GIS server or can be viewed on the online portal maintained by the response teams to gather firsthand information about the disaster site. It may happen that the Internet services may be disrupted due to the disaster. In such a case, the response teams would take preliminary decisions on the basis of the last received data. Meanwhile, the gateway shall keep aggregating the data and store it till the connectivity is restored.

For the data processing, once the data has been communicated to the Response teams, it will be processed as follows: When the sensor and satellite data about the disaster site is received at the response unit, this will help in deducing first-hand damage information as well as the environmental conditions at the target site. Secondly, when the actual information is sent by the first relief team, This data shall be utilized for analyzing the actual requirements for the amount of food, medicines, drinking water etc. Long term relief planning shall be based upon this information

Process III

Validate the proposed solution using the Task-Technology Fit approach that involves a survey with the audience involved in relief operations so as to confirm whether the proposed solution can help in optimizing the relief operations or not. The questions are evaluated using a 5-point Likert scale: This phase involves the empirical study of the research problem using Task-Technology Fit as a guiding theoretical lenses. They made slight modifications to the TTF concept such as referring to the 'task' as 'task requirements' and 'technology characteristics' as 'IoT technology, also 'performance impacts' was referred to as 'strategic value' indicating the overall benefits derived by using the IoT technology to cater the information required for disaster management.

The 5-point Likert scale includes:

- Task-technology fit approach
- Task requirements
- Technology: proposed IoT solution
- Modeling TTF for IoT supported disaster management
- Performance impact: strategic value

C. Disadvantages of the Existing System

The system lacks a homogenous database that connects all the stakeholders of an emergency response team for the faster spread of the disaster data, which will facilitate a quick response.

- The system data collection mechanism does not collect real-time data as they claim, because they rely on users to supply the information they will act on via tweets, and the time that elapses between the report, report gathering, analysis etc., will slow down the speed of response to the disaster.
- The existing system does not contain a platform for response teams to document their response details for future reference.
- The system is unintelligent as it requires human intervention for analysis of the received data before necessary relief decisions are taken

D. Analysis of the Proposed System

The proposed system is the AGADR (Augmented Agent for Disaster Response) is composed of augmented reality (AR) and the Internet of Things (IoT) remote sensor. It is a web-based system that contains an automated centralized system that receives data in the form of images captured by a data sensor in real-time. The proposed system is also analyzed under the following phases:

a) Phase I: Data Gathering

Data is gathered by a remote sensor called the Drone. The Drone is a remotely controlled aircraft that surveys a particular region. It has cameras that are used to capture images of an event as they occur. It merges real-world scenes with digital images in real-time and captures the matching image. The Drone is connected to the system via an IP address. The images from the surveillance are captured and sent to a centralized monitoring system in the form of images; the system intelligently generates the corresponding text and sends it to the distributed system. There are several drones dispatched in the various campuses of the University of Pot Harcourt, but they are all connected to the coordinator, which in this case is the centralized system. The drones are connected to the centralized system via an Internet Protocol address (IP). All the drones have the same IP address.

b) Phase 2: Information Distribution

The centralized system receives the signal immediately it is sensed by the Drone and automatically sends the data to the relevant disaster response teams. The data received are in the form of pictures, and their locations are tagged to them. The teams are connected via a network, which in this case is the Internet and runs on a distributed database that is homogeneous (i.e. the same database, e.g. MySQL). The MySQL database is used for storing the reports, which will be documented by the response teams after the disaster has been handled or managed.

The centralized system is an intelligent system. It can intelligently carry out tasks on its own with or without the aid of a user based on past data used for its training. This system receives the signal transmitted, generates a message that describes the form of the disaster and the location and passes this message to the distributed database. The message sent to the response teams is also stored in the database. The response teams have the privilege of viewing the images in the centralized system in other to enhance their relief actions. The relevant response teams are connected through a network (Internet) in a distributed database system. The importance of this system is that it doesn't have to wait for a human agent to forward the message to the respective teams because in the case where the human agent is indisposed to check the signal immediately it is received, great harm or loss can occur as a result of the disaster, as we know Delay Is Dangerous.

The response teams are connected as nodes to the communication source, which is the Internet. The nodes in this HDD include the stakeholders involved in the prompt response to a disaster. They can include the Vice-chancellor, the Fire agencies, The Ambulance agencies, the security agency (police) etc. These agencies carry out different processes in response to a disaster that is peculiar to them. These processes could range from helping the victims to get to a safe point, rushing casualties, if any, to the hospitals before much harm is done, curtailing the situation to avoid harm etc.

c) Phase III: Information Documentation

Once the response is carried out, the appropriate agency documents the result of the response to their database for the purpose of future reference during subsequent disaster responses. All these activities are carried out in a very fast mode so that needed help is provided for the victims before any serious damage or loss is incurred. The system does not only capture disaster signals immediately they occur but directly provides a quick response based on the information that is provided to it by the sensing system.

E. Advantages of the Existing System

a) The Proposed system is a fast, reliable and user-friendly system that provides adequate and quick response to disaster situations in academic communities through working with real-time data.

b) The proposed system contains a distributed database that connects several stakeholders of the emergency response team, which ensure that signals are sent promptly to all concerned agencies for a prompt response.

c) The proposed system has an easy and simple design, which is less expensive compared to other disaster response systems.

d) The proposed system contains a platform for the response team to report their success in the disaster response process, which is very vital for future reference.

F. Proposed System Algorithm

I. ALGORITHM

STEP ONE:
START
STEP TWO:
INITIATE CONNECTION WITH AUGMENTED AGENT (DRONE) VIA IP ADDRESS
STEP THREE:
DECLARE VARIABLES
HDD, IoTS, CSAS, AC, MYSQLDB, DR, RTD, CS, UND, DRS, RP.
WHERE

IoTS	=	INTERNET of THINGS SENSOR
CSAS	=	CENTRALIZED STANDALONE SYSTEM
HDD	=	HOMOGENOUS DISTRIBUTED DATABASE
AC	=	ACADEMIC COMMUNITY
MYSQLDB	=	MYSQL DATABASE
DR	=	DISASTER RESPONSE
RTD	=	REALTIME DATA
CS	=	COMMUNICATION SOURCE
AA	=	AUGMENTED AGENT
IS	=	INTELLEGENT SYSTEM
RP	=	RESPONSE PROCESS

IP = INTERNET PROTOCOL

STEP FOUR:
INITIATE IoTS
IoTS=IP+RTD+AA
STEP FIVE:
SEND RTD TO CSAS
CSAS= IS
STORE MESSAGE IN DATABSE
STEP SIX:
ESTABLISH CONNECTION = UND + CS
STEP SEVEN:
INIATED ALERT TO HDD
STEP EIGHT:
INITIATE RP.
STEP NINE:
INITIATE MYSQLDB.
STEP TEN:
DOCUMENT DRS IN MYSQLDB.
STEP ELEVEN:
STOP.

IV. RESULTS AND DISCUSSION

A. Discussion of Results

The AAFDR system is built on a web platform for easy connection, access and data communication through a network (the Internet) which is one of the best and most popular networks for great data access and communication. The system has many components, such as the surveillance system shown in Figure 3. The surveillance tool is the Drone. The drones are connected to the centralized system where the real-time data got from the Drone is sent to the system. The drones have already been configured to transmit only disaster data and store every other surveillance data in a separate memory. The IoT sensor has a camera attached to it. The sensor can be controlled manually by the use of a control pad, handled by a controller, or can be automated to fly around specified coordinates to avoid human interference.

The centralized system is an intelligent system, and it automatically sends signals to the distributed system. Figure 4 shows the automated centralized page for the academic community, i.e. the University of Port Harcourt. The institution has various campuses, and there are drones for each campus, and they all report to the same centralized system. The centralized system displays the captures sent to it by the Drone, then it automatically generates a message in the form of text from the information gotten from the image and sends it to the emergency Management/response Teams (EMTs), and the disaster data once gotten is sent to all the concerned teams for their corresponding response.

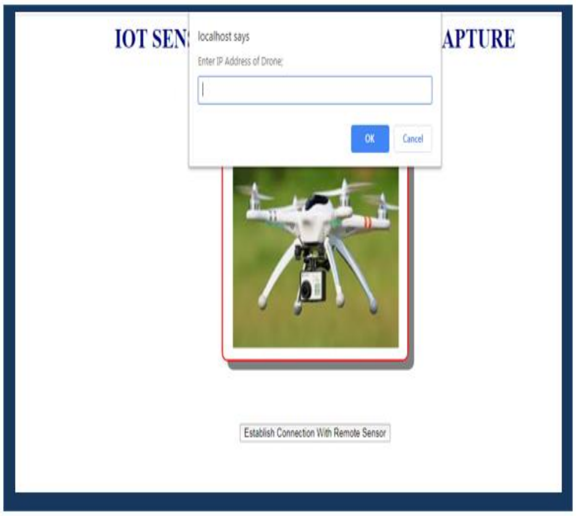

Fig. 3 IoT Sensor Surveillance Connection Page

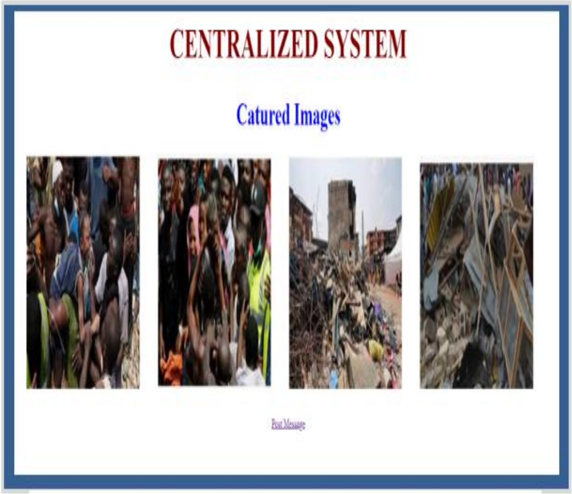

Fig. 4Automated Centralized Platform Displaying captured images

Fig. 5 Distributed Network of Emergency Response Teams

The HDD is shown in Figure 5. It contains several EMTs in Nigeria and Rivers State especially, such as the Police Command Rivers State, Rivers State Fire Service (RSFS), National Emergency Management Agency (NEMA) and Rivers State Ambulance Agency. Once the message is sent to the HDD, the recipient is notified by a prompt which can form of a beep or a pop-up message, and the systems are monitored by operators who are on standby to receive information about the disaster and swing into action. The disaster sent to the EMTs contains enough information about the disaster, such as the location (specifics) and the nature of the disaster. The EMTs can also document their response after it has been carried in the MySQL database for future references. As shown in Figure 6.

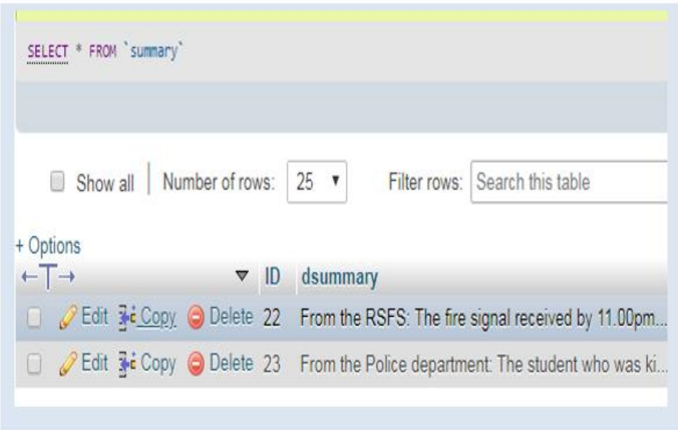

Fig. 6 Database of the Report summary of Responded Disaster

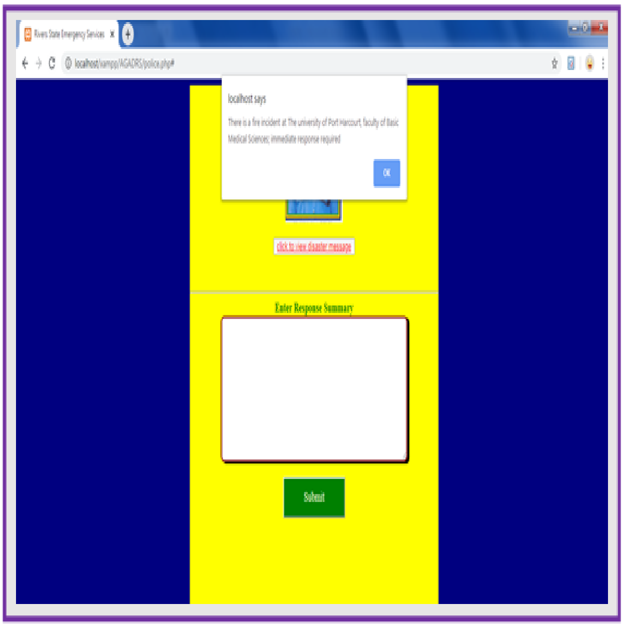

Fig. 7 Interface of an EMT to receive and Give Response Reports

B. PERFORMANCE EVALUATION

A performance evaluation was carried out at the end of the system development, and it was carried out to compare the performance rate of the proposed system against the existing one. Several parameters were used as the yardstick to carry out this evaluation, such as the Speed, Time, Cost-Benefit Analysis, Cross-Platform adaptability and Model Efficiency. The speed to the execution speed of the system, the proposed system has a 5% speed gain over the existing system. This implies that the system is faster (in terms of task execution) than the existing one. The cost-benefit analysis refers to the cost of the development of the system. The proposed system was found to save more cost in development than the existing system. Cross-platform adaptability refers to the ability of the system to run on different platforms such as different operating systems, different browsers, and different hardware. The proposed system proves more adaptable on different platforms than the existing system. And finally, the existing system is a more efficient disaster response model than the existing one. At the end of the evaluation, the proposed system had an overall evaluation score of 79%, which is greater than that of the existing system, with a performance rate of 68%. This implies that the proposed system is a more effective disaster response system than the existing systems.

S/N	PARAMETERS	ASSESSED PERFORMANCE RATE (%)
1	Speed (S)	15
2	Time Saving (TS)	13
3	Cost Benefit Analysis (CBA)	15
4	Cross Platform Adaptability (CPA)	20
5	Model Efficiency (ME)	16

Fig.8 Proposed system Performance79%)

S/N	PARAMETERS	ASSESSED PERFORMANCE RATE (%)
1	Speed (S)	10
2	Time Saving (TS)	14
3	Cost Benefit Analysis (CBA)	12
4	Cross Platform Adaptability (CPA)	17
5	Model Efficiency (ME)	15

Fig.9 Existing System Performance (68%)

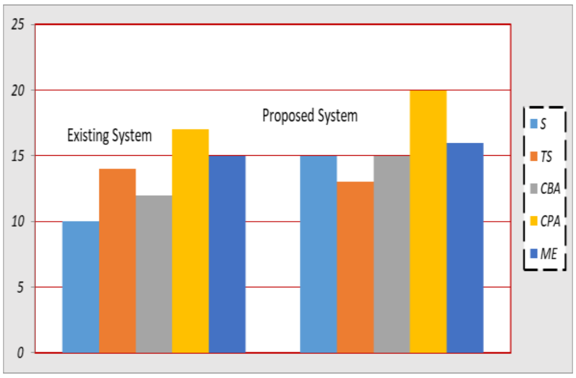

Fig. 10 Performance Evaluation Chart of the Proposed System against the Existing System

V. CONCLUSION

The study concluded on the need to strengthen the movement for a disaster awareness campaign, to enhance disaster management education in communities, institutions and sectors. Disaster management through the use of more efficient tools can be promoted. Tools for disaster prediction or forecast can also be put in place for naturally occurring disasters, and strict adherence to disaster prevention tips should be passed as a law in the country so that some avoidable disasters can be curbed. Disaster response is not a new term; it has become a very major research topic in various sectors such as academia, finance, trade and industry, etc. The study also recorded one of the highest percentages of accuracy in its system performance, from those which has been previously carried out by other researchers.

This work has recorded a high level of correctness and fulfilment; however, there is still room for improvements in the future for better results and use. One of the areas we will improve on is the use of an actual IoT sensor to get actual real-time disaster data from the various campuses in Uniport and report to the centralized system. Another area is the involvement of more stakeholders in the system development and increasing the scope of the system to cover other academic communities in the state.

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