DISASTER EMERGENCY SYSTEM
APPLICATION CASE STUDY: FLOOD DISASTER

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Abstract

Human security means protecting fundamental freedoms that are the essences of life. It also means protecting the individual against serious threats or generalized. It's necessary to build on the strengths and aspirations of each individual, but it also means creating systems that give people environmental elements essential to their survival, their lives and their dignity. In this context, we present in this paper a new concept to create an adaptive system to save lives and help the individual in all kinds of danger, the system called Disaster Emergency system "DES".

Keywords: Disaster; Flood; SMA; Sensor; Optimization, user profile, Adaptatif system

INTRODUCTION

The term "Disaster" or "catastrophe" in French means the damaging effects of a brutal phenomenon, lasting or intense, natural or of human origin. The consequences of a disaster are not measurable and we can distinguish particular situations including loss of life or widespread destruction. Contrary to accidents, disasters have resulted in new thinking; how to avoid or to mitigate the disastrous effects. These reflections, which led in particular to the formulation of the principle of precaution, prevention and intervention, can lead to the creation of new standards or new legal requirements. However, in order to establish a prevention plan, reliable information is need, which is not always at hand. The growing development of new information technologies, especially computer and telecommunications has all simplified concept that may be difficult or impossible. These technologies facilitate the extraction, collection and communication of reliable information which will play the lead role in the prevention plan or the rescue.

I- Objective of the System

Seeing the great danger created by disasters and exploiting technological developments, this article presents the "Disaster Emergency System" which manages any type of disaster or accident to meet the needs of those facing a disaster and aims at providing a rescue solution with the lowest cost possible.

The main objective of this system is the implementation of a new mechanism that serves to provide services in a fast and efficient physical or moral danger and help them to cope with less damage or guide their choices according to their profiles and using a solution based on the integration of sensors with network simulation methods via multi-agent systems and constraint programming.

Our interests are the trust and the quality of our support which will guarantee an efficient operation depending on the services offered by the system that occurs spontaneously known as the best rescue system that gives individuals the essential elements of survival and several partial objectives which are:

- Reduce the probability of accidents: After studying the information tree and regarding the existence of an accident, the system can prevent the likelihood of the accident, evaluate the probability of preventing the accident and notify the user.

- Inform the public about preventive behavior to be a disaster or an emergency: If the system receives information concerning a disaster, it shall inform any person who can be exposed to this disaster.
- Reduce the severity, if disasters occurred despite the taken precautions: the severity of a disaster can be judged by the amount of damage and the latter to limit the severity. Our system improves the efficiency and quality of aid by implementation rules such as call emergency rescue, fire …

II- D.E.S Services

To meet the requirements mentioned above and establish a complete system which handles disasters, there has been a process of a chain work to provide multiple services into three categories:

1) Before the Disaster:

This is the first category where we try to predict the existence of a disaster in a region by studying the factors and causes that can lead to a disaster. When a disaster occurs, it's necessary to analyze these factors (root cause) to make sure that a similar accident will not happen again (capitalization of experience). As a result, we will be able to inform the user and any person subject to risk about all measures to avoid in such situations or accidents and make people understand what is the risk and why it is necessary to change (or control) the behavior according to the proposals offered by the system.

2) During the Disaster

During this step, the good deed done by the user can cost more in his life and for the fear and astonishment of the person subject to the catastrophe, he can't make good decisions. That is why our system offers to our users the solutions that can be adopted in a safe and a reliable change as the path to follow, report emergencies by taking into account user profiles.

3) After Disaster

In this category, our system provides means of real-time decision for emergencies and disasters in a strictly minimum time interval. This system is based on the collection of information,

coordination with emergency units and the allocation of available resources to save the victims according to the severity of their situations. To simulate, we use the wireless sensor network to control the spread of dangers and collect data detected as intelligent agents are used to represent the virtual world in a different type of actors that interact to intervene in a situation.

III- Case Study: Flood

In this case study, we wanted to raise the complexity of the factors involved in a disaster to be able to grasp the sequence of components involved. It seemed important to investigate on how to protect a company against risks. This requires a very good understanding of this complexity. In addition, this study should lead users to accurately handle the concepts of hazard, vulnerability, risk and disaster.

Fig1: Levels of areas risk

For the first category "before the disaster", we try to provide a disaster and for each case study of the tree of cause and collect the only information that leads us to reality. In our case that is flooding, the main causes of this disaster are due to:

- Rain and snow precipitation: Part of rainwater or snow is retained by the soil, absorbed by vegetation or evaporated floods occur when soil and vegetation can't absorb any water and runoff cause an elevation of the bed of the stream. Most often, it doesn't overflow, but sometimes the water runs in quantities that can't be transported in the beds of rivers, or retained in natural ponds and artificial reservoirs behind dams. The river overflows and then produced a flood.
- Temperature: We also include the influence of temperature changes: the thaw causes an increase of the amount of water in the soil and rivers.

- Infrastructure: the nature of the terrain, the height of the region to study existence of rivers, dams ... are elements to be considered for a clear decision.

After identifying the critical factors influencing on having a disaster such as flood, we establish the tree causes or effects to notify users. Taking this case, it's assumed that the main factors of flooding are: rain precipitation, infrastructure, nature of earth ... Based on these elements, we construct the following tree:

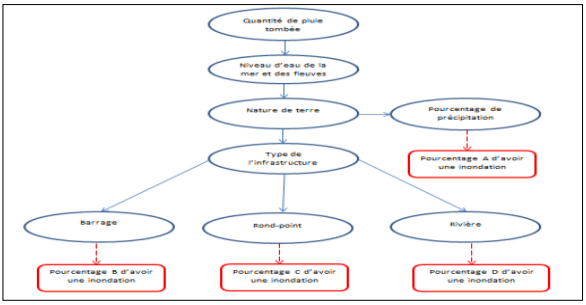

Fig2: Example of a tree cause

According to the values of photometer, causes of a disaster, our system can predict the percentage of having a disaster and informs users who may be exposed to this disaster so that they can be careful. The information received will be a message, a ringtone or alert according to the configuration of the system by the user.

The disaster system offers several services according to user situation:

- Person affected by the disaster: if the user is hit by flooding, it may notify the fire department, a person emergency ambulance ... and all these issues will be configured by the user before using the system. Given that, the call is made automatically after user authorization. Thus, if the user has the possibility to move, he can see his own card to know the most secure way to get away with less damage. The system can also provide backup solutions most suitable for the victim.

- Person exposed by the disaster: if the user is near a flood by a distance, that is also configured, the system sends an alert to the user so they can make a decision or seek the most secured and the less

costly path, notify a person or not to move. The right decision will be made using the system map. In this case, the system receives information from the network of wireless sensors that detect the level of water in the place flood.

- After the flood and after each disaster, there is more material and human damage. This point is addressed in this class: how can we intervene to save people? According to several reports entered by users and collected automatically via sensors, the system can establish the action plan according to user states starting with the living that are in critical cases or dying.

IV- Adapted Solution

To meet the needs identified and implement a robust system and develop the functionalities planned, we made reference to the following technologies:

1) Multi-Agent -System

MAS is a system composed of a set of agents situated in some environment and interacting according to some relations. An agent is an entity characterized in that it is, at least partially independently. It can be a process, a robot, a human being, etc. The main purpose of our project in SMA is to form an interesting type of modeling companies and have a wide application, up to the humanities.

2) Wireless Sensor Network

Our system uses dynamic data such as temperature, distance, acceleration, tilt, displacement, pressure, humidity, pH ... These variables are called variable instrumentation to be picked up by a sensor. The latter provides an output data of a specific physical quantity. The input value is called the measurand (the physical quantity that we want to know) and it causes a response in the sensor. To capture a series of values in different regions, we use a wireless sensor network: is a set of devices, wirelessly connected and are able to obtain information from the environment. They have no wired infrastructure or centralized administration. Its main features are as follows:

- They have limited processing power
- They have very low power consumption

• They are low cost

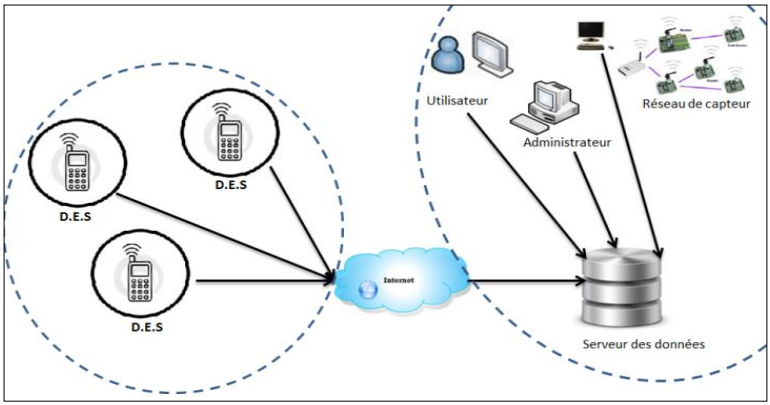

Fig3: D.E.S functional Schema

As shown in this diagram, our system will monitor the client-server architecture: the server has data that constitutes indispensable information for the system and the client enjoys the services offered by the system. These services are based on the data stored on the server and accessible by the Internet.

To mount the usefulness of this architecture, we can give the example of the configuration of a card: Each user can describe a geographic area by positioning several objects that have different properties, which is why each user will have its own database which will be adjustable to give greater freedom to manage the additional information needed or to be stored in the server. Also, there is a sensor network that collects real-time information and stores so that they are accessible and usable at all times.

For the proper management of the server, there are two types of users:

Administrator: a person who has all the rights to manage data grapple for general information stored, delete unnecessary information...

Customer: the person who uses our system and doesn't have all the rights, but he has the rights that are related to their profile.

3) Meta Data

The data provide essential information for the system so that each user can describe a geographic area by positioning several objects that have different properties, which is why each user must have its own database which will be configurable. To meet the needs of all users, we use a meta-database.

Meta-database is an appropriate technique giving users the freedom to add as many fields and tables as they want without ever having to fear either their volume or ease of interrogation. And all this without changing the architecture of the database which will be ontology for the global schema definition on which different users query the database. It's the management of the ontology which is a meta-database that manages other database that will be stored in a data server accessible via the Internet.

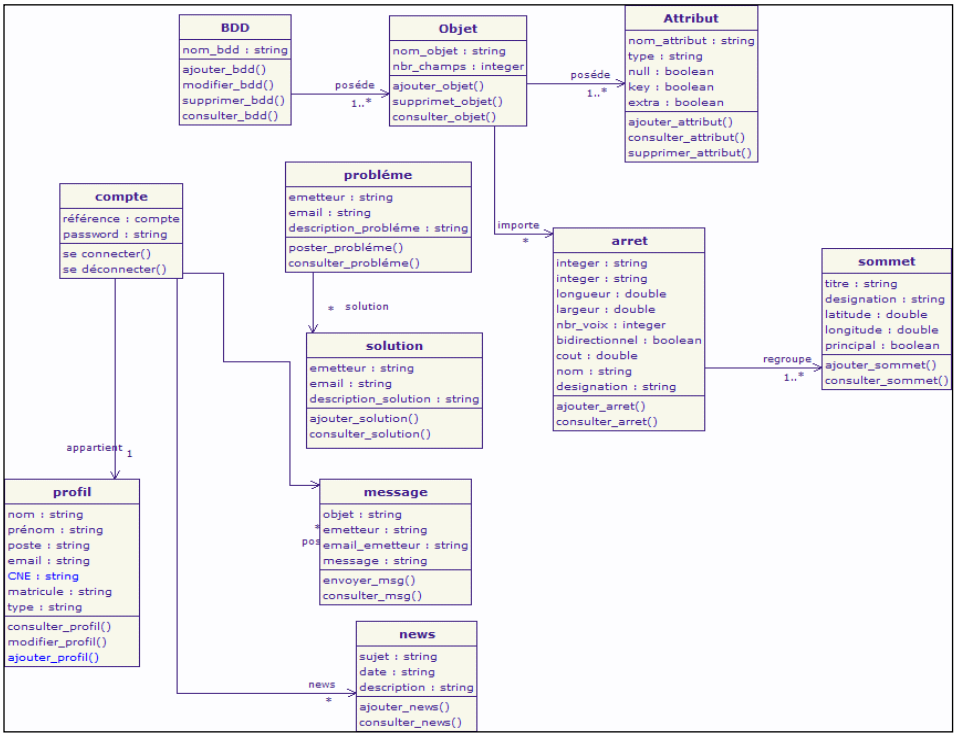

Fig4: Class diagram of meta-database

4) *Architecture of the D.E.S System*

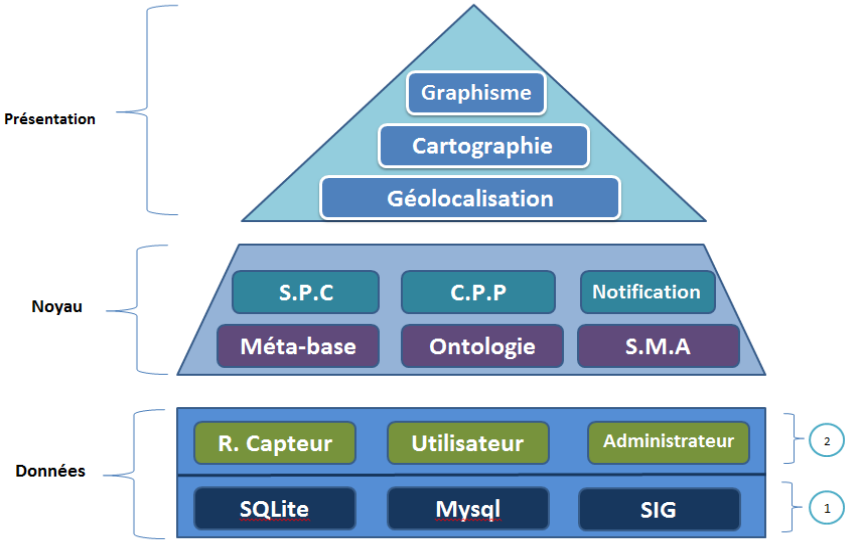

Fig5: Architecture of D.E.S

Our system consists of three layers:

Data: This is where the base layer manages the data that is essential for our project. The information data can be classified into two types: data static data (1) and dynamic data (2).

Static data is stored as different SGBD SQLite and MySQL and information sources such as GIS.

The dynamic data is a changeable data and interacts with the system as sensors which transmit to each of the different time values depending on the situation.

Core: This is the layer where the system performs its functions based on the data layer. In this layer, we find the performance of different algorithms of our system as the shortest path (CPP), the position of objects on the map (SPC), user notification, management of the first layer...

Presentation: This is the final presentation of solutions to the user on the screen of his mobile and it is used for geolocation and mapping to create maps and graphics for the message to be sent in a proper way.

The development of component technology for years played a crucial role in the development of computer science and in

order to develop an application that fits with the latest trends and new news, we must seek the latest updates and the latest devices on the market. To achieve this system and meet the needs of our users, we have used new technologies to make it a complete system of these technologies that includes:

Research in the field of graph theory led to the creation of several algorithms to compute the 'CPC'. The majority of these algorithms carry almost the same principle of calculation, except that the major point of difference lies in the ability of individuals to treat a dense graph. More concretely, some algorithms calculate the 'CPC' between two vertices only known both in advance (one-to-one or one-to-all), which is reflected in their calculation speed, others allow to know the 'CPC' between input vertex and all other vertices remaining (one-to-all-in-one or all), there are even those who are widespread and can thus calculate the 'CPC' between any input vertex and any vertex of destination (all-to-all or in-all). While the latter type of algorithm has better processing capacity much denser graphs, but this goes at the expense of speed.

An algorithm to compute the shortest path is distinguished by the speed, but it should be noted that this speed depends primarily on the ability of an algorithm to deal with a large graph. This gives rise to a compromise-speed processing capability. This point has been a main axis in our research because it operates the system as the change of the solutions proposed by the acquired data for very high speed at informing users or in response or rescue case of danger. Among the algorithms, we chose the algorithm and Floyd algorithm we:

- G = (N, A) Graph evaluated positively with N and A are respectively the set of vertices and the set of edges.
- dist (i, j): Weight of edge (i, j).
- i0: Summit input.
- d (i): the shortest distance found at the top of i0 i

```
//initialisation
d(i0) = 0
Pour tout i∈N ;i ≠ i0 faire
d(i) = c(i0,i)
si (d(i) <∞) alors p(i) = 1
sinon p(i) = NULL
fin_si
fin_pour
//Itérations
S = {i0}
Tant que (S ≠ N) faire
Choisir i ∈ (N-{S}) tel que d(i)= minj ∈ (N-{S}) (dj)
S = S U {i}
Pour tout j ∈ Γ+(i) ∩ (N-{S}) faire
Si d(j) > d(i) + dist(i,j) alors
d(j) = d(i) + dist(i,j)
p(j) = i
fin_si
fin_pour
fin_tant que
```

Fig10: Algorithm of shortest distance

V- Geo-location and sensor deployment

Geolocation is a method for positioning an object (a person, a place, a car, etc.) on a plan or map using geographic coordinates. It is done by using a terminal capable of being located through a satellite positioning system and a GPS receiver for example, or by other techniques, and publishes real-time geographic coordinates. Recorded positions can be stored in the terminal and be retrieved later, or be transmitted in real time to a software platform geolocation.

At the base of this operation, there are several geolocation techniques such as geolocation geocoder, satellite, WiFi, but according to studies by the team, the decision was the use of GPS.

1) Sensors mapping

Mapping refers to the construction and study of maps and geological. The main principle of the mapping is the representation of data on a reduced space representing a generally real. The objective of

the creation of this map is to make an effective and simplified representation of real data. For our system, we will take this principle to identify or locate an object that can be user, a place, an animal ... on the surface of the planet. This is why we use a different system called "benchmark map".

2) Sensors Connection and Communication

We present in this section the use of the sensor in the DES system after selecting a geographic area as an example to study.

To explore this area, we must seek the real dimension to take into account the distances to see the feasibility of components to use. It can be identified by surrounding area and calculating the distances from the actual geographic coordinates. Deviser and conquer is a practical principle which allows decomposing and identifying the major studies of small studies manageable. The same principle was used to study well and place the sensors in this area.

Fig11: Calculation of distances in the study area

Before presenting the zones made, we present the architecture of sensor chosen to monitor the area.

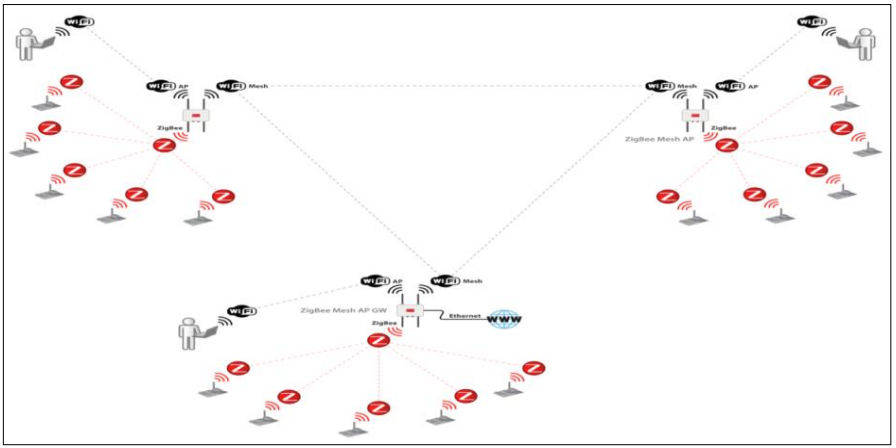

Fig12: Sensor network architecture proposed for the study area.

We will converse the area into three parts and place the selected sensors Meshlium waspmote and respecting the architecture presented before.

Fig13: Sensor positioning on the field

Note: there isn't a standard rule for positioning the sensors but we just take into account the precision and cost study. If we look

more precisely, it should be placed over the sensor. This is why the cost is higher.

VI- Implementation Technology

1) Android

The end result of our system is a mobile application which fits with the latest trends and new news. This is why we decided to develop our system by android; Android SDK is provided by Google, which is based on the Java platform. This is complete: It includes several libraries, debugger, profiler, emulator and sample code to start and more information.

2) Web Service

In computing, the term data processing refers to a series of processes that extract information or produce knowledge from raw data. These processes, once programmed, are often automated using computers. If the final results are intended for humans, their presentation is often essential to appreciate the value. This assessment, however, is variable among individuals.

This information processing can then take the data fusion of information retrieval or processing of representation. For example, the merger may be to combine multiple data sources to compile the information into a safer and extraction can be processed to synthesize data.

The data is very important in any project also in our system because they are essential for the functioning of our system using the web service for exchanging data between the server and our system. The web service is a computer program that allows communication and data exchange between heterogeneous applications and systems in distributed environments. It is therefore a set of functionalities exposed on the Internet or on an intranet, by and for applications or machines without human intervention, and synchronously.

Conclusion

We present in this article the DES system that manages all the type of disasters by presenting the following modules: the objective of

the system, the services offered by DES before or during or after a disaster, block diagram and architecture layer the system and the solutions adopted and the technology used as the sensor network, android and web services.

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