Asian Journal of Information Technology 13 (12): 749-754, 2014
ISSN: 1682-3915

Information System of Cloud Computing, Integrated with a Communication System on The Robot-Supporting Urban Search and Rescue in Disaster Areas

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Abstract: Disasters occur oftenly in Indonesia, where its management is still intact from the application of technology, particularly information technology. Efforts of relief conducted for the victims are still very conventional. Meanwhile, the development of information technology has advanced considerably and can be applied to help the victims with the creation of robots that can get inside crevices of the buildings which are damaged due to disasters. Moreover, the implementation of cloud computing technology allows interested experts to not attend the site of disaster, making this technology very useful. The applied technology is also very environmentally friendly as it will very much be able to preserve the environment which results in significantly immense benefits for the safety of the victims.

Key words: Information technology, cloud computing, disaster, victims, robots

INTRODUCTION

The rapid development of Information Technology (IT) today allows it to no longer be seen as a complementary element in an organization but its existence has now shifted to one of the most important elements that organizations need. Formerly, IT was only used as a complement because of the huge amount of funds or the budget required for its implementation and maintenance. Not to mention, there is an issue of lack of human resources to master the IT itself.

Cloud computing is an information system that utilizes the internet communication network. Cloud computing is a natural evolution of the system service-oriented architecture and utility computing. It is also a shape model that describes the shape of the data delivery model for internet-based information technology services. Implementation of cloud computing information systems has been widely used for various purposes in order to improve human life in daily activities. Similarly, this system can also be used in the activities related to the process of rescuing victims due to unfortunate natural disasters such as earthquakes or people entrapped in the rubble.

Based on research of Subramaniam *et al*. (2010), emergency management requires good cooperation and must undergo several stages: planning, response and recovery. This study focuses on the response stage without ignoring the rest of the stages as they are an integrated system to consider two important elements, namely the element of speed of action and victim safety elements by utilizing the internet which in this case is the application of cloud computing. Natural disasters such as earthquakes and landslides and accidental or intentional disasters caused by humans such as fires and explosions, often lead to the collapse of buildings that affects human lives.

Search for victims is generally performed by a group of people in an Urban Search and Rescue (USAR) team with manual equipment to pave the way for people or dogs specially trained to fit inside the rubble in order to the rescue.

Before, one can enter the ruins, observations and actions to strengthen the structure of debris needs to be done to ensure that the possibility of further collapse of the structure is relatively small. Therefore, it would be very helpful if there are many robots that can get into the rubble through crevices which are inaccessible by humans and provide information to people which are important in analyzing the decision-making process regarding the entrance to the ruins.

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Robots can provide assistance by getting inside the area of the ruins of which cannot be penetrated by the USAR team in order to provide information to them in making decisions. Based on, Murphy (2004) in a worse case scenario such as the ruins of the World Trade Center building as a result of the terrorist attacks on 11 September 2001, gaps that open up to the surface generally has a width of less than 1 m, coupled with debris that can make the robot fall. Hopkins *et al*. (2009) in his review stated that the snake-shaped robots are suitable for the condition because they can move through a narrow gap could climb much higher barriers, higher than other robots; more stable and has a stronger thrust than a robot with legs and wheels and reliable to face failure on one or more segment. With, the adoption of Cloud Computing Information Systems, it allows the rescue team to analyze the conditions and situations in the ruins, so that they can take decisions regarding what action should be done for the safety of disaster victims.

Furthermore, according to Kinugasa *et al*. (2010), robot must also be able to move between debris which takes form of long and thin, therefore, robots with a complex external shape become useless because they can get stuck on debris. In order for the robot with such physical form to be able to be implemented in actual conditions in the field, visits to the area also have experienced a disaster were conducted. It is also done in order to obtain an overview of the robot to be created or designed.

With robots that can enter the ruins, computer network installed in the robot as well as use of the internet with cloud computing technology, the data and information submitted by the robot into the system could assist the experts team in making decisions in the rescue activities.

Literature review: Cloud computing is a computational model that uses computer technology to take advantage of the processing capabilities of many computers across a network whose capacity can be adapted to the needs of the user without showing the infrastructure used to run to its cloud computing. The essence of cloud computing is "cloud' that is a very large network consisting of servers or individual personal computer/desktop computer connected on a network.

These computers work in parallel to generate computational capabilities like a supercomputer. In other words, cloud is a collection of computers and servers that can be accessed by the public via the internet. The hardware used is usually owned and operated by third parties on one or more data centers. Cloud computing can run a variety of combinations of operating systems, because the greatest role in cloud computing is not the appearance of desktop processing capabilities or operating system.

Cloud computing is the next generation in computation. It is the next natural step in the evolution of on-demand information technology services and products. The cloud is a metaphor for the internet based on how it is depicted in computer network diagrams and is an abstraction for the complex infrastructure it conceals. It is a style of computing in which IT-related capabilities are provided "as a service", allowing users to access technology-enabled services from the Internet (i.e., the cloud) without knowledge of expertise with or control over the technology infrastructure that supports them (Vouk, 2008).

Cloud computing is a paradigm that focuses on sharing data and computations over a scalable network of nodes. Examples of such nodes include end user computers, data centers and web services. We term such a network of nodes as a cloud. An application based on such clouds is taken as a cloud application.

The main idea is to use the existing infrastructure in order to bring all feasible services to the cloud and make it possible to access those services regardless of time and location.

Based on research by Gonzales *et al*. (2012), security is considered a key requirement for cloud computing consolidation as a robust and feasible multipurpose solution. The many similarities in these perspectives indicate a grave concern on crucial security and legal obstacles for cloud computing, including service availability, data confidentiality, provider lock-in and reputation fate sharing.

The analysis of security concerns in the context of cloud computing solutions shows that each issue brings different impacts on distinct assets. Aiming to create a security model both for studying security aspects in this context and for supporting decision making, in this study we consider the risks and vulnerabilities previously presented and arrange them in hierarchical categories, thus, creating a cloud security taxonomy. The main structure of the proposed taxonomy, along with its first classification levels are depicted in Fig. 1.

Technology as generally known to provide benefits at the same time raises the risk of the application including cloud computing. This provides critical views and raise questions regarding the application of cloud

Fig. 1: The way users connect to the cloud (https://community.emc.com/community/support/blog/2013/07/15/5-cloud-computing-trends-for-2013)

computing technology and its impact in specific. Top level overview of the security taxonomy is proposed, highlighting the three main categories: security related to privacy, architecture and compliance (Fig. 2).

Because of the critical nature of the applications, it is important that clouds be secure. The major security challenge with clouds is that the owner of the data may not have control of where the data is placed. Due to the extensive complexity of the cloud, the contend that it will be difficult to provide a holistic solution to securing the cloud, at present. Therefore, the goal is to make increment enhancements to securing the cloud that will ultimately result in a secure cloud, it is based on research Hamlen *et al.* (2010).

Humans still play an important role where in this case the structural experts provide important input to the human element of the robot controller. To be able to support the work of the SAR Team, then the robot must be able to be used to help provide information in the form of images of the ruins of which can be used by an expert team to evaluate:

- Situation at the scene after the disaster
- The location where the victim is trapped
- The decision from the building components structural that override/confine the victim, whether it is possible that it has to be lifted or moved without endangering the safety of the victim and changing the structure of the building

Several robots move by adopting natural ways like a snake that can move without the use of wheels or legs. Snakes move using scaly skin which is driven by the stomach muscles and the spine is supported by hundreds of spine. Joints in the snake's spine only has 2 degrees of freedom so that it can move to the left or right and up or

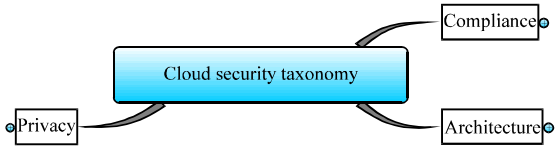

Fig. 2: Cloud computing security taxonomy (Gonzalez *et al.*, 2012)

down. Hopkins *et al.* (2009) mentions several mechanisms that include movement of the robot, they are lateral undulatory, concertina, sidewinding and rectilinear. In this case, the rectilinear movement is proposed for use on the robot because it can move in a very narrow gap.

Borenstein *et al.* (2007) claimed the need for the robot to move through gaps that are very narrow in the disaster area to make rectilinear movement mechanism and it is quite popularly used by robots designed for disaster areas. OmniTread OT-4 robot that have examined the chain wheel that cover almost the entire surface of the fourth segment of the robot so that the robot can still move despite the skewed and inverted. However, the problems faced by OmniTread OT-4 is when it has to walk on sandy terrain and through shrub, due to the influx of sand and twigs into the wheel chain system which could create damage to the robot.

To overcome this, Kinugasa *et al.* (2010) design mono-tread mobile track robot which uses only a single flexible chain wheel which covers the entire length of the long snake-shaped robot. This construction reduces the risk of the robot from some sharp material to part of the segments of the robot. Murphy (2004) found that the condition of the robot's ability to move in a state tilted or inverted is more useful than the ability of the robot to be able to fix the position in a disaster situation. However, mono-tread mobile track robot remains vulnerable to sand or other particles that can enter from the side of the robot which can interrupt the movement of the robot system.

Data and information provided by the robot from the disaster area can be communicated with experts outside the disaster area, by using cloud computing facilities. The term cloud is used as a metaphor for the Internet, based on the cloud drawing used in the past to represent the telephone network and later to depict the internet in computer network diagrams as an abstraction of the underlying infrastructure to represent.

Cloud computing is a natural evolution of the widespread adoption of virtualization, service-oriented architecture and utility computing. Details are abstracted from end-users who no longer have the need for expertise in or control over the technology infrastructure "in the cloud" that supports them.

Of course, the application of this technology would not have been able to develop in the absence of reliable human resource, considerably good understanding of the application of technology and also experience in the field of IT and Telecommunications.

Scope of discussion: Indonesia is a disaster-prone area be it natural disasters or disasters as a result of human errors. The search for victims are done most of the time by a group of people called Urban Search and Rescue (USAR) Team with manual equipments to pave ways for people or trained canines in order to provide them with entrance to the rubbles, something which can endanger the rescue team themselves.

And also should be analyzed the information systems of cloud computing that would be applied in dealing with disaster victims and the communication system that will be used by the robot to help finding the victims and give the information about the way and how to bring the victims get out from the ruins.

In order to ease USAR in searching for victims, robots which are able to enter the gaps in the ruins which are inaccessible to humans and provide information to the rescue team are developed. Using the cloud computing technology, we can generate sets of data and information regarding the building's condition existing beneath the ruins as well as the paths which are accessible to the USAR teams when they decide to go in. Such robot is also equipped with computer network which enables them to communicate or interact with USAR team which stands by outside the ruins. Also, attention to security data on the condition from the victim, especially when the victim is an important person.

This study is conducted in Jakarta by taking event samples which occured within the area of Jakarta and Medan. Since, both of these areas have experienced natural disasters such as floods or earthquakes. This study has been conducted, since 2013 and is expected to reach its completion by 2015.

MATERIALS AND METHODS

In a research method for this Emergency Response System, 6 main things are needed to support the search and rescue of victims in the rubble from the disaster with a robot that has the support of computer networks that facilitated the cloud computing technology (Fig. 3).

Equipment: The main components in the equipment, this is a necessary element in the implementation and support of computer networks including the robot that uses cloud computing facility.

Process: This component deals with a process that is expected in indicators and research achievement besides the work plan also with related management.

People: Research leader and members that are also members of the Urban SAR Team became the principal component in the research, in addition to the relevant Team in the Process.

Materials: These materials support the required elements in the equipment.

Environment: Rubble and weather condition become major factors.

Management: Management component is in synergy with people in this research.

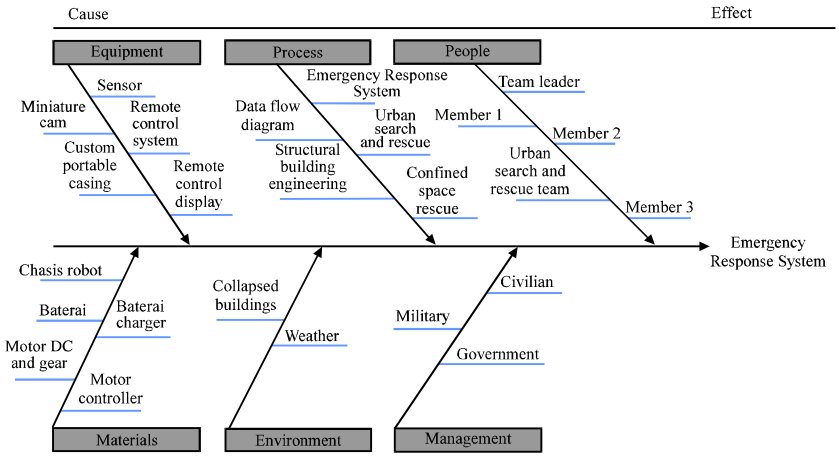

Fig. 3: Fishbone diagram Research-Emergency Response System with robot

RESULTS AND DISCUSSION

In this study, to see the possibility of system integration between robot communication system with the operator as well as integration with Cloud Computing Information Systems, how these two systems could be integrated together.

In tests that has used simulation, robots are instructed to perform several maneuvers from the operator, who control the robot. Also to find out, the capability of the robot in delivering some data and information and how those data and information could be shared using the information system of cloud computing, so it could be easier for the rescue to have a perspective what are they have to be done in their activity.

Such robot is equipped with a connection which enables the robot to provide or transfer sets of data and information as a reference for the decision-making related to the rescue. Some data that send by the robot also about the situation and condition in site the collapsed buildings, especially position of the victim that need more attention in the process of saving the victim. So, when the rescuing process does not cause the victim's condition becomes more severe.

Survey to county: Visits as means of survey to areas which have experienced disasters are also conducted. From those visits, depictions of the physical condition of disaster-struck buildings are garnered as well as information related to the methods of entrance to the gaps inside the ruins which will be conducted by the robots. And look for the building that can describe the conditions that close to the conditions when a disaster has just occurred, so that the simulation can approach the real condition.

It is also important to consider the capability of the robots to penetrate into the concrete as to prevent the robots from acquiring damage when they are sent to the field. The agility of the robots in conducting maneuvers are also important to be calculated.

It can be inferred from Fig. 4 how robot should be able to enter and maneuver inside the ruins. It appears that the existing reproach among the ruins is very narrow. So that the movement of the robot becomes very narrow. It is also, need attention in designing the physical form of the robot, so the robot can move freely in the rubble also the presence of pieces of debris that the form and dimensions are irregular and smooth, so it could be damaging part of the body of the robot.

Communications network that installed in the robot for this study using a specific cable also must be able to send the data and information are good enough, so that the data and information provided by the robot can be accepted by the system.

Fig. 4: Chunks of ruins

CONCLUSION

Cloud computing is a technology which uses the internet and central remote serven to protect data and application. Cloud computing enables consumers and business to use application without installation and it also allows them to access their private files through every computer by using the internet. This technology gives room for a far more efficient computation by centralizing storage, memory, processing and bandwith.

The application of cloud computing, especially in the field of IT and telecommunication is very useful for some purposes. In applying this facility, it costs less, increases benefit, efficient and supports the rescue team's movement. For someone who needs the data and information, it allows a quick, easy and cheap data access.

The hindrance of cloud computing application lies on the issue of security of the data stored in cloud network; something which are still considered a serious issue to some institution. The application of this technology must not be mutually exclusive to high-level security.

An integrated system design in Emergency Response System is a necessary element to ensure the accuracy of information required in making two crucial decisions: promptness of action and safety when USAR is conducted. It can only be done with the support provided by robots and important information from structural experts.

In the implementation of this information system, because the application of cloud computing is an open system, the security level of the data need to get attention. And what data are needed in emergency relief operations also need to be defined first, there are general and specific data, depending on the circumstances and conditions that occur in the disaster area.

Where the robot, used to perform rescue disaster victims with conditions that are usually very limited, in the

disaster area. And network configurations provided by cloud computing. Under limited conditions and parameters that should be defined first is expected to provide useful benefits to the rescue team when they do their operation.

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