Decision Analysis Model for Cloud Based Grass Surveillance Systems

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Summary
Advancing grass development and maintenances is a novel research area in Indonesia. Among many areas of grass research, real time monitoring with low cost energy usage is underlined within this paper. In order to support cloud based grass surveillance systems, appropriate video streaming technique is considered be applied according to real time monitoring requirements. This study proposes a new decision analysis model for guiding decision makers to perform selection among existing video streaming algorithms to enhance grass surveillance systems on the cloud. A novel decision analysis model is developed and the guidance for using it properly is also presented.

Key words:
decision analysis, AHP, grass, surveillance, streaming algorithm.

1. Introduction

Grass research and development has been extensively conducted in several countries such as the United States and South Korea. Commonly, the results can be easily seen such as in football stadiums or golf fields. In South Korea, research on grass technology has been extensively researched to achieve twofold objectives. Firstly, creating high quality grass that is environmentally friendly with advanced low pollution grass management and secondly to achieve a variety with minimum environmental harms [1].
Following advanced grass reseach in South Korea, a similar approach to explore Indonesian local grass has been started within the Department of Soil Science, Sebelas Maret University, Surakarta, Indonesia. At the time, there are four main areas of research activities namely ecology, soil, pathology, insects, and breeding. Its main aims are to establish Indonesian local turfgrass with eco-friendly grass management systems and applicable to be applied within the country [2]. In the future, the results of this long term and multidisciplinary research will yield the best grass varieties that will meet the needs of grass stadiums throughout Indonesia.

Video surveilance systems for grass monitoring is among collaborative research topics within the scope of the multidisciplinary research in order to support countinuous monitoring for data collections purpose. Currently, grass current surveillance technology is still a client server based on Linux that strongly depends on server capacity to accommodate growing collections of data that has long been collected.

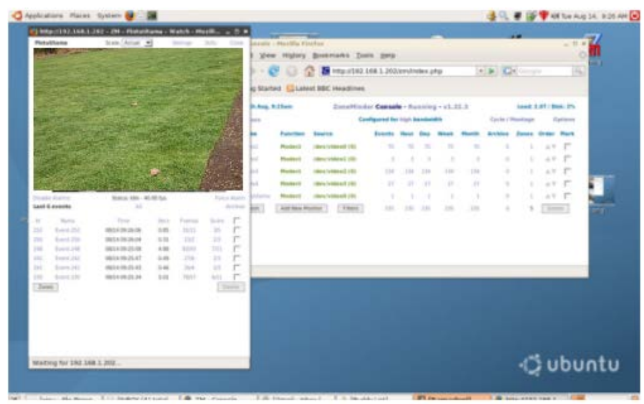

Fig. 1 Traditional grass surveillance systems – client server model.

The issue of limited storage capacity has been realized and searching a more flexible media becomes open research. In order to deal with the issue, an advanced monitoring system for grass development based on cloud computing technology was proposed and implemented.
However, the new cloud based video surveillance systems still questioned in terms of which video streaming technology is capable and approariate enough for handling vast amount and real time video data of grass monitoring on the cloud (see figure 2).

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Fig. 2 Cloud based grass surveillance systems.

Previous studies have shown several video streaming techniques that currently well developed and maintained both in laboratory environment as well as in real implementations that might be taken into consideration [13][14]. In choosing a specific video streaming technology, it is important to take many considerations, looking at from different angles and use various criteria in order to minimize possible risks and at the same time to maximize benefits of the project in the future.

This study aims to deal with the issue by proposing a decision analysis model based on Multi Criteria Decision Making (MCDM) methodology for guiding the selection of video sreaming techniques suitable for application of cloud based grass surveillance systems.

The paper is structured into seven parts. After brief introduction in the first section, section 2 presents literature review on cloud computing technology. Then, section 4 presents the methodology of Multi Criteria Decision Making with an emphasis on the Analytic Hierarchy Process approach. This section also describes advancement in video streaming technology. Furthermore, the decision analysis model for cloud based grass surveillance systems is presented and explained in section 5. Finally, conclusion and future research direction are presented in the final section.

2. Literature Review

According to the NIST, Cloud Computing is defined as a novel way to enhance on demand access requirements from users to any computing resources such as infrastructures, platforms, software and many others which is configurable and manageable with very little effort from users as well as limited service provider efforts [4]

Cloud computing has been a widely researched and applied in standard and extended environment both within and outside university or research institute such as business and government. In some literature [5] many technical approaches have been put forward to improve efficiency and quality of cloud computing services are being discussed. Moreover, since cloud computing is attractive in creating new business and economic revenue, innovative economic models have been proposed and exemplified in different scenarios [6].

Those benefits might be offered by cloud computing technology bare basically coming from basic idea behind the technology namely cloud characteristic, cloud service model, and cloud deployment model.

2.1 Cloud Characteristics

The first characteristic is known as on-demand self-service. This means that any hardware resources like CPU, storage, memory whenever required by any users might be automatically obtained on time via through on demand cloud with no or very limited interactions with cloud provider [4][7].

Resource pooling means that the ability of cloud computing providers to pool different kind of hardware and software resources according to user need and thus automatically dynamically assigned according to consumers' needs. This can be performed both in virtualization as well as in multi-tenancy model [7].

Then, rapid elasticity is a unique facilities for consumers. Instead of becoming persistent, this scheme lets computing resources to become immediate to users without upfront commitment or contract as usual. In addition, users are given access for scaling up or scaling down any services as they are required any time. Moreover, with this characteristic users will found that resources provisioning looks infinite to even if the consumption increasing rapidly which makes service always be available even in peak condition [7].

Measured service is a special feature for cloud users to let them perform appropriate measuring mechanisms to know in details the amount of cloud resources have been used for any single time. Through this feature cloud computing providers able to measure every single usage of its services by applying its metering capabilities [7].

2.2 Cloud Service Model

According to NIST, cloud computing provides three basic models of service delivery. They are well known as Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) [4][7].

Using SaaS, a user may modelling any access to any cloud based application via variety of end client terminal that are hosted on the cloud in different services [7].

Then, by using PaaS model, cloud consumers do not need to own any platform for development. Instead, cloud services and applications might be deployed seamlessly via PaaS model. In addition, both in-progress or fixed cloud applications might be applied PaaS as development platform which makes cloud more interesting for developer [7].

Finally, through IaaS model virtualization techniques are available to cloud users to utilize hardware infrastructures according to their need. This can be in the form of networks, storage, memory, and many other computing resources [7].

2.3 Cloud Deployment Model

Basically, Public Cloud, Private Cloud, and Hybrid Cloud are three basic types of cloud computing deployment model [4][7].

Public cloud is referred to coud infrastructure in which all platform and software applications are created, operated externally by an commercial cloud providers such as Google and Amazon. In this model, user enjoys simplicity since any applications, platform or even infrastructure offered by cloud provider to users in renting basis like utility goods [7].

In contrary, private cloud is cloud computing resources that created, operated internal organization. Private cloud model mostly preferred by users who put emphasis on data privacy since public cloud model has serious risks in privacy aspect [7].

The third cloud model is a convergence between public and private cloud commonly referred to as Hybrid cloud. This model is preferable when user need to combine simplicity of public cloud and privacy concern of private cloud. [7].

Users from small business usually prefer public cloud considering its low cost in implementation while government is advised to deploy private cloud in order to keep their sensitive data away from public access.

3. Methodology

This study applies Multiple criteria decision making (MCDM), a specific methodology for guiding decision making processes in which multiple, usually conflicting, criteria are existing as well as alternatives [8].

In MCDM, multiple aspects and criteria involved and combined structurally in a decision levels problem. As a result, by using MCDM methodology decision makers will be clearly guided in handling such kind of problems. MCDM might be applied adequately to any fields which have multiple criteria problem where an effective solution should be taken into account such as in business, government, health, science and technology [8].

Among many approaches in dealing MCDM problems, AHP which stands for Analytic Hierarchy Process is considered as the most widely used one. Since its introduction in 1975 by Saaty [9], AHP has been applied to solve many MCDM cases in business, government, health, science and technology to name a few [3].

AHP is an eigen value approach to the pair-wise comparisons in representing any multiple criteria decision making problems. This might be in the form of quantitative measurement with numeric scale or in qualitative measurement according to human preferences [10].

AHP also offers a group consensus feature. Using this feature, a number of decision makers may make group decision and uses geometric mean to combine all results into a single group decision [10]. AHP proposes the following basic steps to approach any MCDM problems [10] :

a. Define the problem goal
b. Consider all actors, objectives and its possible outcome.
c. Find any possible criteria that influence the behavior.
d. Organize the problem in the form of a four level of hierarchy (goal, criteria, sub-criteria and alternatives).
e. Compare each element in the corresponding level and calibrate them using the numerical scale.
f. The maximum eigen value, consistency index (CI), consistency ratio (CR), and normalized values for each criteria or alternative are calculated.
g. Ranking the results to obtain final decision

The issue to be tackled in this study falls into MCDM problem, where there are many criteria must be considered carefully in order to establish video surveilance systems for grass monitoring over cloud computing infrastructure. Besides, there are also a number of video streaming technology are available as candidate for the systems which are considered as alternatived from MCDM point of view.

Cloud based grass surveillance systems strongly relies on quality of video streaming. Since the media transmission quality varies, commonly video transmission rate will be degradated due to some factors such as bandwidth limit, loss of data and jitter [11] [12] [13].

To maintain quality of service of streamed video data, a number of techniques are introduced using different logical algorithm approaches to make video packets intelligent enough and adaptive with the unfriendly network conditions [13].

In general, intelligent video streaming techniques are grouped into four main categories, namely Adaptation Streaming, Scalable Streaming, Summarization Streaming, and Secure Streaming techniques which are briefly described as follows.

First of all, Adaptation Streaming technique is among the earliest approach forming basic technique of streaming. Its main concern is to deal with instable network environment in which transmitted video streaming must be kept in appropriate quality. Maintaining heterogeneous clients

with adaptive video quality fixed by flexible media streaming that is adaptive to the difference. Several video streaming algorithms have been proposed in this Adaptive Streaming technique such as Simulcast [14] [15], Video Transcoding [16], Wireless Transcoding [17] and intelligent Prioritized Adaptive Scheme (iPAS) [18].
Secondly, Scalable Streaming technique is developed to address quality of stream video data that requires large adaptation according to variations of receivers both in broadcast or multicast environments. The technique is employed in a number of algorithms such as Fine Granularity Scalability [19], Motion Compensated Temporal Filtering (MCTF) [20], Self-tuning Neuro-Fuzzy (SNF) [21] to name a few.
Thirdly, Summarization Streaming technique is applied when large quantity of video streaming data particularly in network environment is the issue. Intelligent smart algorithm for analysis, structuring, and summarizing video content are mostly employed in this scheme by considering different user preferences [22]. The pictorial summary is considered as the most fundamental example of this technique [23]. Another approach is personalized summarization to archive browsing by adding an indexing subsystem according to user preferences [24]. Multi-user model utilized for video communication solution is improved with this algorithm [25] by taking into account fundamental summarization streaming [26].
Finally, Secure Streaming is technique for streaming video by improving security features while keep enhancing the way of video transmitted to various end users efficiently [27]. Secure scalable streaming (SSS Framework) is among the earliest and most widely used algorithm in this area of secure streaming video transmission [28].

4. Result and Discussion

The decision analysis model in this study is developed according to the Analytic Hierarchy Process approach which is a triad hierarchy of goal, criteria and alternative. The hierarchy is then properly structured in such a way that multi-criteria decision clearly reflects the problems being faced. Description of the decision analysis model, including the goal, criteria, and alternative are described as follows.
First of all, the goal is defined as the research objective to be achieved. It is to select the best one among many video streaming technologies to enhance the cloud based grass surveillance systems.
Secondly, the next level consists of criteria which contains various perspectives or different point of views to address, assess and evaluate the given problem. Criteria act as reflective insight to analyze the given problem.
In this case, we argue that the criteria must reflects various perspectives that commonly incorporated in software engineering field of study in terms of technology evaluation. There are several approaches in literature that supportive to this study such as the ISO 9126 for Software Quality [29], Evaluation Framework for OS [30], ERP Systems Selection [31], open-source EMR software packages [32], asset inventory information system [33], and many others.
Considering the nature of problem being discussed which is video streaming technology selection for cloud based surveillace systems, criteria proposed in Wei's AHP model [31] is adopted with some changes. There are five criteria to be applied in our decision analysis model namely functionality, flexibility, implementation time, reliability, and user friendliness.

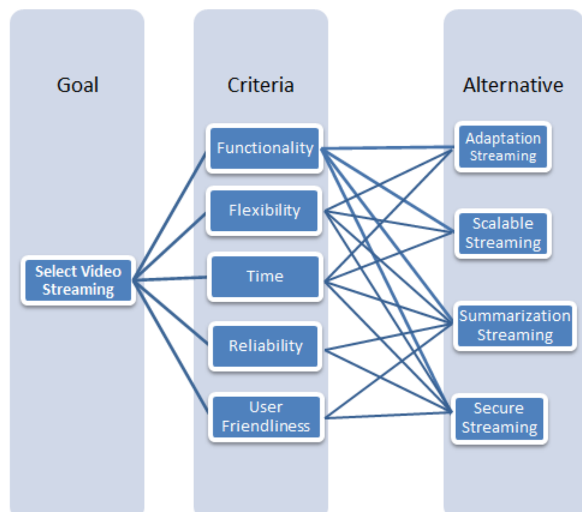

Fig. 3 The Decision Analysis Model.

The criteria adequately meet the requirement for software engineering evaluation in particular video streaming techniques. Readers may refer to [31] for more details explanation for these criteria.
Finally, the last level of the decision analysis model is called alternatives. In this study, the alternatives are four categories of video streaming technologies mentioned in our previous study [3]. They are Adaptation Streaming, Scalable Streaming, Summarization Streaming, and Secure Streaming. The best one will be selected according to AHP approach to fulfill the objective or the goal of the decision making [31].
To assist decision analysis, the following six steps of data analysis procedures are proposed to be followed by decision makers both individual or in group [31][32].

1) Establish the decision survey: The survey is created according to AHP technique which is pairwise comparison by using 1-9 scale of every

criteria with respect to the goal as well as for every alternative with respect to the criteria. The complete survey is provided in Appendix section.

2) Collect the survey results : In this stage survey collected in step 2 are organised into a square matrix. The diagonal elements of the matrix are 1. If the value of element (i, j) is more than 1, then criterion in the ith row is better than criterion in the jth column; otherwise the criterion in the jth column is considered as better than that in the ith row. Then value of (j, i) element of the matrix is calculated as the reciprocal of the (i, j) element. The four steps survey are presented is from Table 1 to Table 5.

Table 1: AHP Survey (Goal)

	9	7	5	3	1	3	5	7	9	
Functionality										Flexibility
Functionality										Time
Functionality										Reliability
Functionality										User Friendly
Flexibility										Time
Flexibility										Reliability
Flexibility										User Friendly
Time										Reliability
Time										User Friendly
Reliability										User Friendly

Table 2: AHP Survey (Criteria: Functionality)

	9	7	5	3	1	3	5	7	9	
Adaptation Streaming										Scalable Streaming
Adaptation Streaming										Summarization Streaming
Adaptation Streaming										Secure Streaming
Scalable Streaming										Summarization Streaming
Scalable Streaming										Secure Streaming
Summarization Streaming										Secure Streaming

Table 3: AHP Survey (Criteria: Flexibility)

	9	7	5	3	1	3	5	7	9	
Adaptation Streaming										Scalable Streaming
Adaptation Streaming										Summarization Streaming
Adaptation Streaming										Secure Streaming
Scalable Streaming										Summarization Streaming
Scalable Streaming										Secure Streaming
Summarization Streaming										Secure Streaming

Table 4: AHP Survey (Criteria: Time)

	9	7	5	3	1	3	5	7	9	
Adaptation Streaming										Scalable Streaming
Adaptation Streaming										Summarization Streaming
Adaptation Streaming										Secure Streaming
Scalable Streaming										Summarization Streaming
Scalable Streaming										Secure Streaming
Summarization Streaming										Secure Streaming

Table 5: AHP Survey (Criteria: Reliability)

	9	7	5	3	1	3	5	7	9	
Adaptation Streaming										Scalable Streaming
Adaptation Streaming										Summarization Streaming
Adaptation Streaming										Secure Streaming
Scalable Streaming										Summarization Streaming
Scalable Streaming										Secure Streaming
Summarization Streaming										Secure Streaming

3) Calculate Principal Eigenvalue and the corresponsing Eigenvector : In this step, the principal eigenvalue and the corresponding normalised right eigenvector of the comparison matrix calculated to find the relative importance of pairwise criteria being compared. The elements of the normalised eigenvector are termed weights with respect to the criteria or sub-criteria and ratings with respect to the alternatives.

4) Evaluate Inconsistency rate: In this stage, consistency of the decision maker in filling the survey will be assessed based on AHP rule. If this consistency index fails to reach a required level of consistency ratio (CR) then answers to comparisons may be re-examined. Saaty suggests the value of CR should be less than 0.1.

5) Final judgment : Once all requirements in step 4 satisfied, the final judgment can be obtained as follows. The rating of each alternative is multiplied by the weights of the sub-criteria and aggregated to get local ratings with respect to each criterion. The local ratings are then multiplied by the weights of the criteria and aggregated to get global ratings. List of the global ratings from the highest value to to lowest one represnt the final judgment.

6) Documentation : The objective of the last step is to provide clear and reasonable decision analysis

both in technical and managerial perspective to apply the chosen video sreaminng technique for cloud based grass surveillance systems.

The main contributions of this study is a new MCDM model as guidance to assist decision makers in the area of streaming video in cloud for grass management which is a specific part in advancing agricultural information systems [34]. This study also would pave the path of using intelligent video streaming that could enhance efficiency in analyzing video data in the cloud environment [35].

In the future, the study might be extended by applying Fuzzy Analytic Hierarchy Process to deal with uncertainty and fagueness in particular decision environment as seen in several previous study [36][37].

5. Conclusion

A decision analysis model for selecting video streaming technique of cloud based grass surveillance systems is presented. The model is structured according to Analytic Hierarchy Process approach which consists of three levels of goal, criteria and alternative.

The objective is to develop a well-organized decision analysis model to aid policy makers in determining the best video streaming technique to be implemented in new grass surveillance systems which is based on cloud computing technology. Several criteria for approaching the problem are used namely, functionality, flexibility, time, reliability and user friendliness. In addition, as alternative, there are four video streaming techniques are selected according to the given criteria nemely Adaptive Streaming, Scalable Streaming, Summarization Streaming and Secure Streaming.

In addition, the decision analysis model is equipped with guidance on how to use it to reach the final decision both in person or in group. The guidance includes the six steps of data analysis which is started by establishing decision survey and ended by documenting final decision.

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