

Implementation of Google Maps API 3 with Haversine Algorithm in the Development of Geographic Information System Boarding House Finder

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Abstract: Boarding house is a temporary shelter in the blocks of room in various size which are inhabited by students and employees from outside the area. In reality, to find the boarding house on the outside area is need a power, cost, and a lot of time. So it is necessary to the development an information system that can be helping to solve this problem. The purpose of this research is developing the geographic information system that can be find the boarding house according to the criteria of user wishes. This research is uses waterfall development method. The programming language used is PHP, MySQL database and also implemented the AJAX method to taking data to be more interactive. The use of API 3 on Google maps is able to provide a picture of satellite imagery from the boarding house coordinates. This requires a coordinates point to display the satellite imagery on this database. The system is also capable to analyse the distance of the coordinates with haversine algorithm.

1 INTRODUCTION

Boarding house is a residence that is temporary and in the form of blocks of rooms in various sizes which are inhabited by students and employees from outside the area (Anamisa et al., 2016). Some students choose the boarding house as a temporary dwelling place because the place to study and work away from home (Reyes II, 2016).

Lack of information about boarding houses is often an obstacle and an opportunity for boarding house brokers (Setyarsih, 2016). Besides that, the boarding houses must be able to use technology to market their boarding houses (Gommans, 2014). With the development of information technology, it increases the ability of computers to solve problems in various fields that need to provide the best solution (Ichsan and Syah, 2014). So it is necessary to develop an information system that be able to facilitate of the users to find the ideal boarding house in accordance with user wishes (Sulaiman et al., 2012).

To support the information systems that can provide mapping services, a geographic information system that integrates spatial data into geospatial and geographic data is needed (Ponce-Medellin et al.,

2009). Geographical Information Systems or Geospatial Information Systems (GIS) is a collection of tools that captures, stores, analysis, manages, and presents data that are linked to geographical locations (Bhat et al., 2011). GIS Provider facilitates with geo-specific functionality for application including map information, map visualization and directory services. For example, Google maps with its API can be considered as a GIS Provider (Kushwaha and Kushwaha, 2011).

This research used the facilities of Google Maps API 3 that can be visualize the map view into an external website (Garude and Haldikar, 2014). Google maps provide an intuitive and highly responsive mapping interface with aerial imagery and detailed street data (Helshani, 2015). The google maps use latitude and longitude to be able to display satellite images on a map (Sharma and Morwal, 2015).

Beside the uses of Google Maps API 3, the system is used haversine algorithm to calculated and analyse the distance between two coordinates (Essayad, 2011). Haversine algorithm for measurement and estimation of distance with improved efficiency in localization (Ganesh and Vijay, 2015).

To make the system more interactive, the data retrieval is used AJAX method (Sneha and Khatwar, 2015). AJAX allows partial page update without the need of refreshing the full page (Khanna and Mistry, 2012). AJAX can help to improve usability in many situations while implementing an online information system (Sachdeva and Singh, 2013).

2 METHOD

This research uses waterfall model for developing the software. The Waterfall Model is the oldest and the most wellknown software development model. The special feature of this model is its sequential steps. It goes downward through the phases of requirements analysis, design, coding, testing, and maintenance (Munassar and Govardhan, 2010). Waterfall model can be seen in Figure 1. The implementation of this research is in the area around Semarang State University.

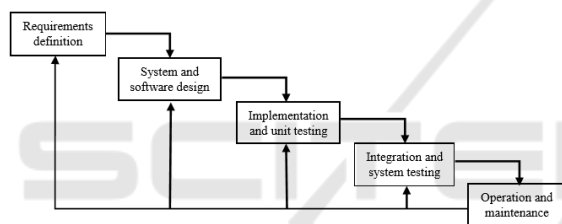


Figure 1: Waterfall Model.

2.1 Requirements Definition

Often known as Software Requirements Specification (SRS) is a complete and comprehensive description of the behaviour of the software to be developed. The tools and materials used to develop this information system consists of software requirements and hardware requirements. Software requirements can be seen in Table 1. While hardware requirements can be seen in Table 2.

Table 1: Software Requirements.

Requirements	Specification
Operation System	Windows XP
Web Server	XAMPP Version 3.2.1
Text Editor	Notepad ++ / Sublime Editor
Photo Editor	Adobe Photoshop
Web Browser	Mozilla / Google Chrome / Safari

Table 2: Hardware Requirements.

Requirements	Specification
Processor	Intel Atom 1,6 Ghz
Random Access Memory	512 Mb
Video Graphic Adapter	GMA 512 Mb
Processor	Intel Atom 1,6 Ghz
Random Access Memory	512 Mb

The data in this study are the variables used to determine the search filter on the system that is the name of boarding house, facilities, type of boarding house, rent duration, price, gender, and radius filter.

2.2 System and Software Design

The system and software design phase is the planning and problem solving for a software solution. It is begins with modelling the database relation and data flow diagram. The database relation is will be showed the flow of relationship between tables that occur on the database system (Suri and Sharma, 2011). In this table relation, there are several related tables from the primary key to the foreign key in another table. This shows that between table A and table B are interconnected. To provide an overview of the rule of system it is requires Data Flow Diagrams (Ibrahim et al., 2011). The Data Flow Diagram (DFD) that can be seen in Figure 2.

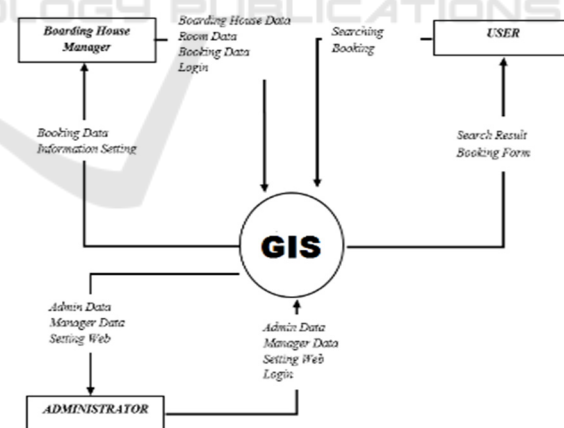


Figure 2: Data Flow Diagram Level 0.

For display modelling is separation of user permissions in which have different features and menus. Based on the Data Flow Diagram, the features and menu for various users are different. The user is only can be searching and booking the boarding house. The boarding house manager is can manage the boarding data, booking data and setting

the information about this management. And the administrator controls the entire activity in this system.

2.3 Implementation and Unit Testing

This phase is where the real code is written and compiled into an operational application, and where the database and text files are created. In other words, it is the process of converting the whole requirements and blueprints into a production environment. At this stage, the system will be programmed into three large sub-menus are users, managers, and administrators. Where each sub menu has different access.

The programming language that used in this research is Hypertext Preprocessor (PHP) because the PHP is have speed and easy to used by programmer (Botwe and Davis, 2015). To access the database, the system is programmed by SQL to manage the query to retrieve the data from database. This programming process becomes a bridge between Google Maps API which is a means of connecting the program with databases and satellite imagery from Google. The data retrieval is used the AJAX method to be more interactive design. AJAX allows the partial page updates which improves the efficiency of the information system (Khanna and Mistry, 2012)

To calculate and measuring the distance of two point is uses the haversine algorithm. The Haversine algorithm is used to calculate the lengths of two points on the surface of the earth based on latitude and longitude (Chopde and Nichat, 2013). The latitude and longitude obtained from the query of SQL that execute from the database.

Equation 1 is the formula used to calculate the distance of two point. The information of the equation 1 is as follows:

d = distance
 r = radius of the earth
 arcsin = inverse sinus
 sin = sinus
 latt = latitude
 cos = cosinus
 long = longitude

In equation 1 of the haversine formula, we can turn it into a function that can calculate the distance between the coordinates that can seen in this code.

```
FunctionHaversineDt(lat1, long1, lat2, long2) {
    Diameter=2*6372,8;
    var dx,dy,dz;
    ph1=degtorad(long1-long2);
    th1=degtorad(lat1);
    th2=degtorad(lat2);
    dz=sin(lat1) -sn(lat2);
    dx=cos(long1)*cos(lat1) -cos(lat2);
    dy=sin(long1)*cos(lat1);
    result=arcsin(sqrt(sqr(dx)+sqr(dy)+sqr(dz))/2)*diameter;
}
```

2.4 Integration and System Testing

The system testing phase is performed by Web experts, GIS experts and system users covering interface mapping, information, and technic aspects. Testing on the mapping interface aspect is aimed at knowing the software quality assurance in the geographic field shown in the map field. While testing on the aspect of information is intended to provide evaluation and assessment of information provided by the system to the user. In addition, the testing on the technic aspect is aimed to testing the critical elements in systems that directly relate to programming techniques, algorithm usage, data security, and programming efficiency as well as the resulting of system.

The testing instrument on this research is using questionnaire to find out the validity of GIS. The questions posed to web experts are reviewed in terms of interface and usability aspects using 9 questions. The questions posed to Web experts are reviewed in terms of interface, information and technic aspects with 8 questions. And the questions posed to users are reviewed in terms of interface, information and technic quality aspects using 13 questions.

In addition, the testing with black-box is to test the function of the entire system was created. And after the system is not have a problems during this test, it will be the next process of operation and maintenance.

$$d = 2r \cdot \arcsin \left(\sqrt{\sin^2 \left(\frac{\Delta latt}{2} \right) + \cos(latt1) \cos(latt2) \sin^2 \left(\frac{\Delta long}{2} \right)} \right) \quad (1)$$

2.5 Operation and Maintenance

The last process in this research is operation and maintenance. It is the launch and maintenance of systems that have been made. System maintenance is also included in the management and software revisions that are likely to occur in the future. In addition, the admin will also be a traffic monitor as well as transaction processing performed within the system.

3 RESULT AND DISCUSSION

3.1 Result

The result of this research is can be seen in Figure 3 to Figure 4. In Figure 3, the Google Maps API showed the marker on the field mapping. Data has been processed based on the position of latitude and longitude on the database system. Data processing does not require the all refreshing of the

page because the data retrieval is used AJAX method.

The result of distance analyses of haversine algorithm can be seen in Figure 4. Function that have been made before can be used and called to calculate the distance. The distance analysis is carried out on boarding house location with several recognizable points.

The Haversine formula gives the most accurate result and the error rate is very small, which is negligible. The survey of the above experiment is shown in the Table 3.

Based of the experiment, the error rate on the Table 4 is the difference from actual distance and calculated distance that have been calculated with the haversine algorithm. The actual distance obtained by measuring the 2 point of latitude and longitude on the Google Maps. The Google maps have a facilities that can be calculated the distance between two points. The result of error rate comparison based on Table 4 is 2-6 meter.

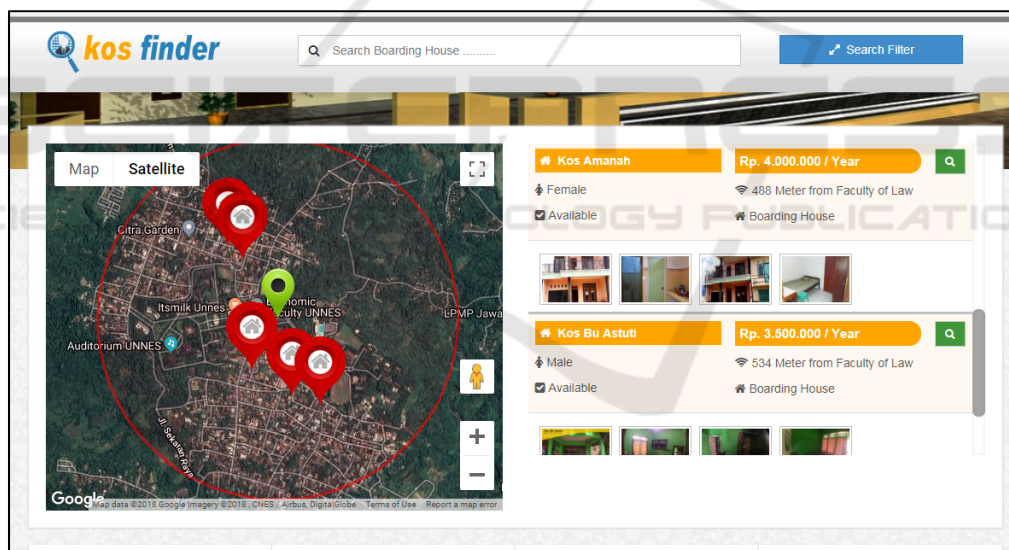


Figure 3: Search Result View.

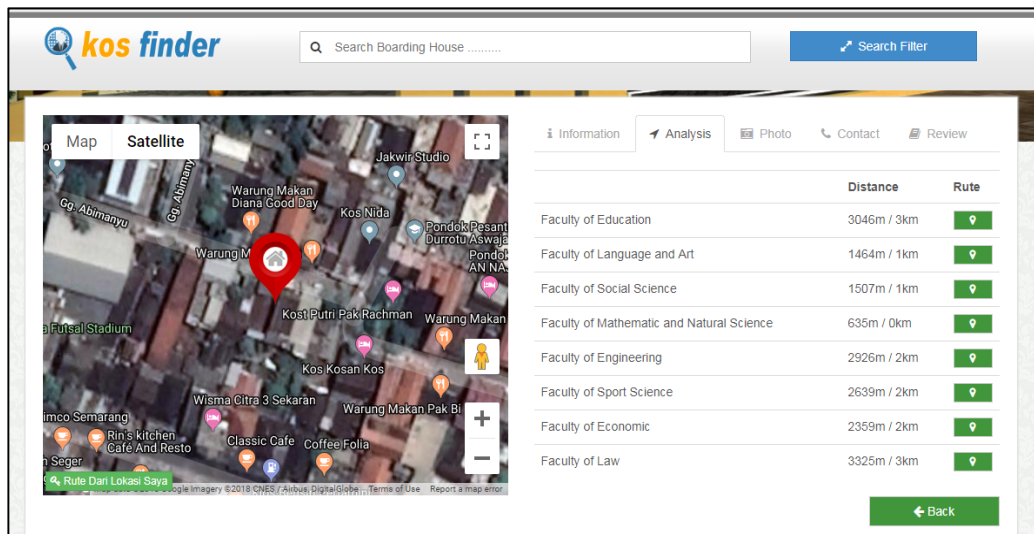


Figure 4: Result of Distance Analysis on Haversine Algorithm.

Table 3: Experiment Calculated Radius Distance with Haversine Algorithm.

Recognizable points	Latitude	Longitude	Boarding House Sample	Latitude	Longitude	Distance
Faculty of Social Science	-7.050518	110.393586	Sample 1	-7.045607	110.394436	488 m
			Sample 2	-7.053100	110.397661	440 m
			Sample 3	-7.053534	110.399063	534 m
Faculty of Law	-7.050771	110.397840	Sample 1	-7.045607	110.394436	686 m
			Sample 2	-7.053100	110.397661	260 m
			Sample 3	-7.053534	110.399063	336 m
Faculty of Engineering	-7.049203	110.396964	Sample 1	-7.045607	110.394436	1.074 m
			Sample 2	-7.053100	110.397661	495 m
			Sample 3	-7.053534	110.399063	373 m
Faculty of Education	-7.048162	110.396862	Sample 1	-7.045607	110.394436	390 m
			Sample 2	-7.053100	110.397661	556 m
			Sample 3	-7.053534	110.399063	645 m

Table 4: Comparison Radius Distance with Google Maps Actual Distance.

Experiments	Recognizable points	Boarding House Sample	Actual Distance	Calculated Distance	Error Rate
1	Faculty of Engineering	Sample 1	1.070 m	1.074 m	4 m
2	Faculty of Education	Sample 3	639 m	645 m	6 m
3	Faculty of Law	Sample 2	255 m	260 m	5 m
4	Faculty of Social Science	Sample 1	486 m	488 m	2 m

The system testing phase is performed by Web experts, GIS experts and system users. The first testing about this system was carried out by web expert that experienced on web development or web programmer. In this phase that performed by 2 web experts by obtaining the score of 100 with the percentage of eligibility is 92.59%. So that entry in the category is very feasible. This testing is highlighted to test the system about the information and technic aspects.

The next testing was carried out by GIS experts that experienced in mapping area. In this test, performed by 2 GIS experts by obtaining the score of 57 with the percentage of eligibility is 89.06% so that entry in the category is very feasible. GIS Expert is more highlighted to test on aspects of geographic and information display.

The users testing was carried out by 15 respondents that various regions from outside the city. The scores obtained from user testing are 731

with a percentage of 93.72%. So that the feasibility of web-based is entry into the category is very feasible. The testing on users is to obtain evaluation and assessment of information and interface aspects.

In addition, the testing with black-box is to test the function of the entire system was created. Black-box testing results show that the functional application does not have an errors and in accordance with the expected results with the acquisition of 100% valid test. Black-box testing is use to test the interface and technical function of 63 units.

3.2 Discussion

The development of information systems in the geographical field has been widely carried out. In this study, researchers compared information systems created with previous studies that had already been conducted developing a web-based information system boarding house finder.

In previous studies, geographic information systems boarding house finder were developed by utilizing Google Maps API and success to show the marking map (Mustika, 2017). Similar research have been carried out using codeigniter framework and Google Maps API to develop an application of geographic information systems (GIS) for a web-based help migrants in the city of Yogyakarta in the process of finding and booking boarding houses according to their needs, and help homeowners boarding house boarding in marketing online (Pratikto et al., 2014).

In addition, a web-based boarding house and rented house information system has been developed with PIECES analysis. But the system developed has not been carried out geographically by utilizing the Google Maps API facility (Gunawan and Racmatullah, 2016). The SMS Gateway is also used in the development of information systems for boarding houses using PHP and MySQL. The study did not use the AJAX method as the data collection (Sundari and Komarudin, 2015).

Based on previous research, the system still has some disadvantages. One of them is that there is no analysis of the distance from the boarding house to a particular place. In addition, the system developed does not have an interactive display. In this research, the system will be develop with implementation of haversine algorithm to analyse the distance of the boarding house from particular place that user needed. The system also utilizes the AJAX data retrieval feature to produce a more interactive web display.

4 CONCLUSIONS

The paper has presented design and development of Geographic Information System to find the boarding house with waterfall model. This research was implemented the Google Maps API 3 to embed Google Maps site and showed the satellite imagery from Google. To calculated the lengths of two points on the surface of the earth based on haversine algorithm. With haversine algorithm, the system can be analysed the distance of two points of coordinates. The system has many facilities to filter the data of boarding house according to the user wishes. AJAX was used to optimizing the taking data to be more interactive.

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