Spatio-Temporal History of Islamic Inventors Based on Mobile

Liwan Tadwini Abdullah, Entin Martiana Kusumaningtyas, Ali Ridho Barakbah
Department of Informatics and Computer Engineering
Electronic Engineering Polytechnic Institute of Surabaya, EEPIS
Surabaya, Indonesia
liwantadwini@it.student.pens.ac.id, entin@pens.ac.id, ridho@pens.ac.id

***Abstract*— The book discusses the history of the Islamic inventors have been widely published, but the history books that have been known so far are textual-based so the search process for the aspect of the place and time aspects of historical events are sequential. Surely it makes the reader difficulties when trying to examine the history based on place and time-based historical events. This paper proposed new model to learning the history of Islam inventor during the Islamic civilization. This model using spatio-temporal to present Historical information which are displayed based on the time as year timeline and the location on map. This paper also provides a search feature to searching the highest similarity of historical information, using text-mining and clustering methods. This makes it easier for users to learning historical event. We compare result of our idea into several device and several keyword to searching history. The experimental result show the effectiveness of our idea to solve this learning. Tests on some users, showed that these applications can be used as a medium for teaching history of Islamic inventor during the Islamic civilization.**

Keywords*— *Spatio-temporal; History of Islamic Inventors; Automatic Clustering; Text Mining

I. INTRODUCTION

History was never separated from the aspect of location and time of occurrence of the event aspect of history itself. The book discusses the history of the Islamic inventors figures have been widely published. Unfortunately the history books that have been known so far usually doesn't discuss two aspects of this history in detail. During this study history through the medium of books or other media can only be done by reading the contents of the text sequentially corresponding book or the media. This will certainly make complicated of the reader to be able to know a historical event in more detail based on the location and time of the historical events. In addition, sequential learning method makes readers feel bored and tired to continue reading in the long term.

In the history of Islamic civilization, many Moslem inventors as a major contributor to the current civilization. At that time, Islam as a beacon of the world in all fields, particularly in science and technology. Daily life in this modern age cannot be envisaged if there were no traces of the work of Islamic scholars in it. One figure about the history of Islamic inventor, namely Maryam inventors Ijliya al-Asturlabi, Moslem woman astronomer who was nicknamed "al-Asturlabi", she has an outstanding contribution to the technology now under development Astrolab −an important tool in astronomy such as satellite navigation and GPS [1]. Not only Ijliya Maryam al-Islam Asturlabi as inventor who contributed a great deal, but there are a lot of Islamic inventors had been unknown by the society, intellectuals, and even by Moslems themselves.

Some research also try to examine the history of Islamic inventors during Islamic civilization. Among them there is a paper entitled Principles of Science and Technology in the Qur'an compiled by several students of the Ahmad Dahlan University that explain one of the huge Islamic contributions to the modern world now, namely to pass a number of theories about the universe and the ways to apply the knowledge of it. Muslim scholars around 9-13 century AD has been widely cited and tested the relationship of science by means of implementation (technology) [2]. The second reference was compiled by students of Sekolah Tinggi Ilmu Ekonomi (STIE) Perbanas Surabaya as a report task Islamic subjects. This paper describes the leaders and Islamic scholars who have successfully studied the sciences of Greek and Sanskrit, has provided significant development in their respective fields, long before Western scientists find theories about science [3]. The third reference comes from a paper entitled Islamic Contribution for Science and World Civilization by Muh. Asroruddin A.J. This paper examines the history of the development of science at the time of the Prophet, the first four caliphs, Umayyah Caliphate, and the Abbasiyah Caliphate to discuss the major Islamic contribution of by Moslem scholars on the development of science and civilization of the world today [4].

Based on the research that has been there before, we concluded that by using visual media can improve the effectiveness of learning History [10]. But in general, some books and applications with the theme History of Islamic Inventor are available in the market and have been using mobile devices are still based media textual [15,16,11].

Methods of studying the history of Islamic inventor of the Islamic civilization that had been used, are generally sequential. The history of the media spread in the form of books or other media which can only be done by reading the

978-1-4673-9345-4/15/$31.00 ©2015 IEEE

text sequentially according to the contents of books or the media. This makes it difficult for the reader to be able to study a historical event inventors Islam in detail based on the place and time of the event. For some people, learning history with a conventional text book feels very boring. The use of media and the latest technology tries to give a different experience to further enhance the spirit of learning history.

Our proposed idea is make a new approach to learning history of Islamic inventors which using spatio-temporal in order to ease user to examining history. Spatio-temporal means display a historical event based on place and time simultaneously. Application also provides a search feature historical stories using text mining and clustering methods. Learning applications that we made contains the history of Islamic inventor during the Islamic civilization, i.e. since the time of the Prophet Muhammad until the expiration of the Turkish Caliphate. This application be concise and practical for mobile devices using the Android platform and packaged offline, so it does not require resources from outside the system in its operation.

Several journals related to the discussion of spatio-temporal [12,13,14], we conclude using spatio-temporal approach it can be easy to examine the historical conditions in a certain place by a certain time. When user performs a study of history, it cannot be separated from the explanation of the historical location and time of historical events.

II. BASIC THEORY

1. Spatio-temporal

Spatio-temporal is a new model which is manages both space and time information. At first glance, spatiotemporal are an extension of spatial databases. A spatiotemporal database embodies spatial, temporal, and spatiotemporal database concepts, and captures spatial and temporal aspects of data and deals with geometry changing over time and/or location of objects moving over invariant geometry (known variously as moving objects databases or real-time locating systems) [5].

Spatio-temporal comes from two words, spatial and temporal. Spatio-temporal meaning that relates space and time [6]. Two types of data used in this case is the spatial data and data nonspasial:

1) Spatial Data
   Spatial data is a real picture of a region that is contained in the earth's surface. Generally represented in the form of graphs, maps, pictures with a digital format and stored in the form of coordinates x, y (vector) or in the form of image (raster) which has a certain value.
2) Non-Spatial Data (Attributes)
   Non-spatial data is data in a table where the table contains information-information that is held by an object in the spatial data. Data in the form of tabular data are mutually integrated with existing spatial data.

Temporal terms included in the non-spatial data, namely attribute / time column in the table. Attributes time marker when the historical events occurred, thus providing more options to the user in learning the history of the time.

2. Text-mining
   1) Tokenizing
      Tokenizing is the process to split stream of text up into words, symbols or other elements called tokens. The token list became input for further processing such as parsing or text mining. Tokenizing often relies on simple heuristic such as all contiguous strings of alphabetic characters are part of one token likewise to number. Tokens are separated by whitespace characters such as line, space, break, or punctuation. Therefore, punctuation may not be included in result list of tokens
   2) Filtering
      Filtering is a process to remove tokens which is contained unused words. The unused words called stoplist. Stoplist contained of word preposition, language particle. Stoplist is undescriptive word which is going to be sent to words bag
   3) Stemming
      Stemming is process for reducing infected or derived word to their base by removing prefix and postfix contained in word. Root form is generally written word. Stem need not to be identical to morphological root of the word. It is sufficient related words map to the same stem. Even stem is not the valid root, stemming algorithm have been studied in computer science. Many search engines treat words with the same stem as synonyms as kind of conflation
   4) Analyzing
      This process is aimed to get the value that represents how word related to other words in a document. This value is called term frequency, that can be obtained by counting the number of token in document itself. [9]

3. Automatic clustering

Automatic clustering is clustering formation without state the total cluster so it is automatic. The way to implement this automatic clustering is by using centroid linkage hierarchical method (CLHM), measuring variance and valley tracing.

The calculation between data or cluster is done by Euclidian Distance especially for numerical data [7] .The process of grouping documents by using CHLM according to the following steps:

1) It is assumed that any data is considered as a cluster. If n = number of data and c = number of clusters, there is c = n.
2) Calculate the distance between clusters using Euclidean Distance.
3) Finding two clusters that have a distance between the cluster centroid of the most minimal and incorporated into the new cluster (so that c = c-1).
4) Return to step 3, and repeated until the desired cluster is achieved.
5) Calculating the distance between objects, as well as the distance be-tween cluster done Euclidian, especially for numerical data is used Euclidian equation.

To find the distance of each cluster, Euclidian Distance is really needed. Besides that, Variance Cluster (Vc), Variance Within Cluster (Vw), Variance Between Cluster (Vb), and Variance (V) is also really needed to count and find the match cluster that was not known the number. Those Variance has been combined to count the Global Optimum (∂) of automatic clustering process. The number of cluster with the ∂ highest value is the best number of cluster.

III. DETAIL DISCUSSION

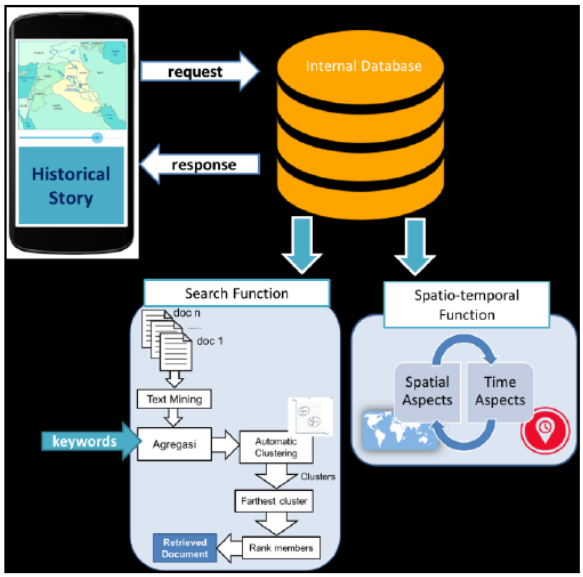

Fig. 1. System Architecture

Fig. 1 is a general overview of the system architecture which will describe the system of the application. To learning history of Islamic inventors takes some input variable used as spatio-temporal function, or some input keywords that will be searched using search function.

Spatio-temporal function has two variable as parameter. There are two input variables that will be obtained from user input. These variables are:

- Time
  Year variable used to store the value of time specified by the user. This variable is used as a filter in database queries so that data generated only the data for the year. The logic of this variable (state time) was at one time there could have been many histroical stories in different locations. Query results based on user-specified time that shown in Fig 2.

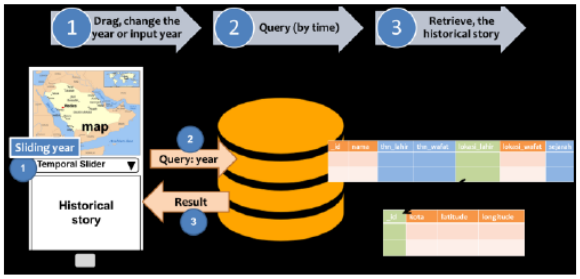

Fig. 2. Time query

- Location
  This variable is used as filter on the database query so that the historical document is displayed only documents at selected locations, then displayed its historical information. The logic of this variable is the location (one place) can have many stories at several different times. Query based on the location as shown in Fig 3.

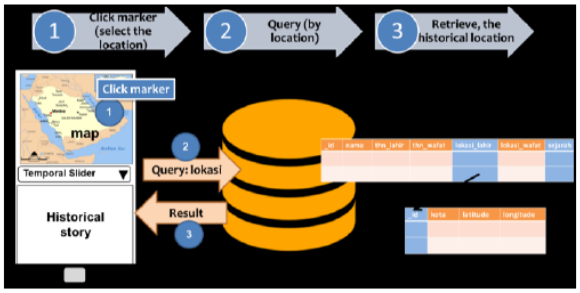

Fig. 3. Location query

Search function has one variable that is keywords. This function will search keyword variable that are obtained from user input then variable will be process text mining and clustering. Fig. 4 is a general overview of the search function mechanism which will describe the search function of the application.

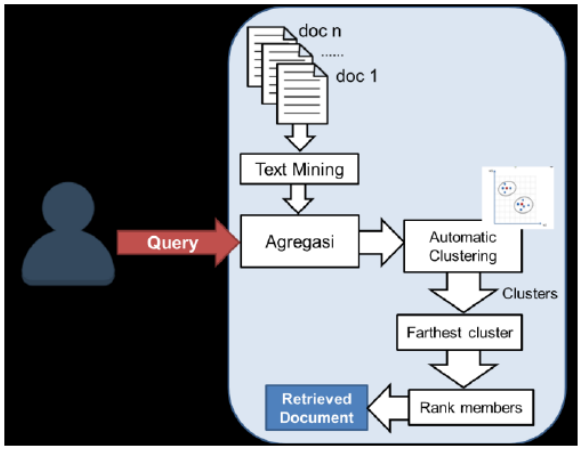

Fig. 4. Search function mechanism

Based on search function mechanism Fig. 4, there are several steps, start from keyword extraction, keywords as query input, automatic clustering, cluster, ranking and the final step is retrieved result. Here the details of explanation in each step.

1. Keyword Extraction
   Each historical document will be extracted its each word. Fig 5. describe the process of keyword extraction. In general, the keyword extraction is the process of text-mining, at this stage will further be explained in detail.

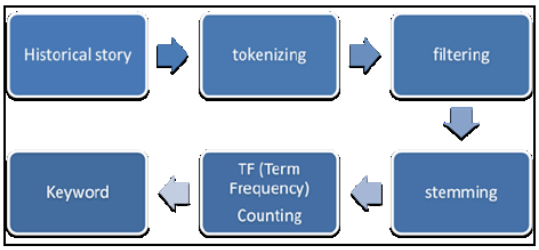

Fig. 5. Keyword extraction

The first step to doing that is doing tokenizing keyword extraction, first stage that must be passed before the next step in the text-mining. At this stage, any historical document separation on every word in it.

The next step is to do the filtering said. This stage waste words less important based stopword list and take important words from the token which is then stored in the word list (save important words). Next is the stage stemming word. This stage seek the root words (basic words) of each word filtering results.

Stages after stemming, which is done TF (Term Frequency) Counting or counting the number of words that would be obtained next-word keywords (keywords). These words that will represent each document history. Value containing the number of keywords in each document is then collected into a separate table in the table aggregation.

The result from text mining will be processed to create keyword metric. Keyword metric aggregation is integration metric of data. The used data is from text mining result. The total dimension is the total of keywords that have been processed in text mining. So every different keyword among documents will be collected and saved as total dimension of aggregation metric. The value is the keywords value that has been calculated in text mining.

After get the aggregation metric, each document will have their position on coordinate in N-dimension according to the number of keywords. But aggregation metric will not directly used to next process. System will select columns that are keyword from user query.

2. Keywords as query input
   Query input of this system is keywords from user. User could type the history of Islamic inventor they want to search such as name of Islamic inventors or the invention of the Islamic inventor.

   When the user input one or more keywords. The word will be filtered to discard words that do not need (filtering) for further stemming, cutting affixes to form basic words. After the user input one or more keywords, followed perform a search query into a database. Search results will be ranked, and then displayed in a list.

   User input keywords, which have been processed into the basic words, will be search at the appropriate aggregation table dimension word entered. For example user input two key words, then the aggregation tables taken the value of each of the two-dimensional documents the word. Keywords entered by the user will be checked on the tables aggregation. If the keywords the user entered the word dimension not found in the table aggregation, then the application will display a message that the key was not found. Conversely, if the dimensions of the word is found in the table aggregation, the values of the dimensions are taken and saved in a variable to be processed clustering historical documents.

3. Automatic clustering
   After get aggregation metric like, system will bring it to the next process that is automatic clustering. So automatic clustering will be applied when keyword of user query is more than one, if there is just one keyword of user query, system will bring it to the ranking process directly.

   Clustering is an exploratory data analysis tool that deals with the task of grouping objects that are similar to each other [7,8]. One of the most famous methods in clustering is the classified method is k-means algorithm because it is the simplest method to make groups of data. To find the global optimum, people usually use the minimum value of cluster variance. This figure below shows the moving variance from each stage of cluster construction based on the variance constraint formula. From the cluster variance, finding the ideal cluster is very

difficult because we cannot apply directly min(V) to find the global optimum as the ideal cluster. For finding the global optimum of cluster construction and avoid the local optima, we use valley tracing method. First of all we try to describe all patterns of the moving variance, then analyze the possibility of the global optimum that resides in the valley of patterns.

After getting the total number of cluster from Automatic Clustering, then we will use Hierarchical K-Means to cluster data by using the total number of cluster that have been get in Automatic Clustering. Each cluster will have some members that have high similarities. And for the result, we will choose a cluster that has a high distance value from zero coordinate. Example from Fig. 7, Cluster 1 has the highest distance value. So member of Cluster 1 will be the result of this paper.

4. Ranking member of farthest cluster

We get the best cluster after calculate the distance from zero coordinate. The best cluster have the highest distance. It has some members and will be ranked before display it as result. Ranking that will be made is according to result of distance calculation from each member to zero coordinate. But not only according to the distance, document that have a value for all queries will be the first rank. If there are two document that have value in all queries, then it will be determine by theirs distance from zero coordinate. For the example, the selected cluster is cluster 1 and have 2 members, document 4 and document 5. Assumption the value x,y diimension of document 4 is 14,0 and document 5 is 7,3. Eventhough document 4 is the farthest, but it contain zero values in dimension y. So the first rank will be document 5 then document 4.

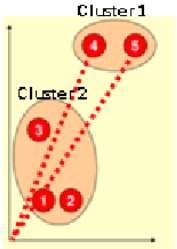

Fig. 6. Highest distance document

After having obtained the farthest clusters, the document cluster members are added to the list in order of documents that have the highest distance. Conversely, if the user entered keyword is not contained in the aggregation tables, then the application will give the message that these keywords are not found.

This ranking method will work only if keyword of user query is more than one. But if there is only one, the document will be ranked based on its keyword value of user query, order by the highest to the lowest value. Because of just one keyword, it means aggregation metric also just have one column.

5. Retrieved historical document

Retrieved result is gotten from the choosed cluster. So the total number of historical document are indefinite and depending on clustering result.

Retrieved result will be displayed its name of Islamic inventor, born year, died year and historical information in user interface. If users click the list, they show historical information to the spatio-temporal form.

So we hypothesized that the result will be the historical document that have much relevant with each other and will be sorted by the calculation of ranking process. That historical document must be in one cluster. This system will only show historical document that have a high similarities between each other and keyword from user so user doesn't need to choose manually again.

IV. Experiment and Analysis

The experiment has been tried using spatio-temporal function in different device dan search function in several keywords.

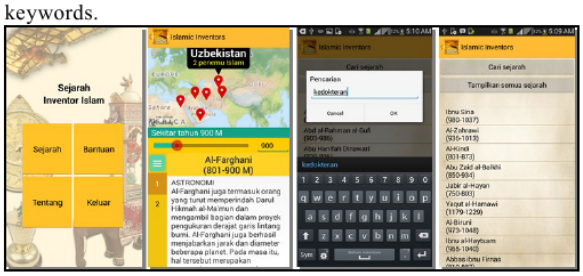

Fig. 7. Display applications on the device

From this experiment related to various menus and features in the application runs well and smoothly. Including testing on other Android devices with different screens and resolution giving the appearance that is not different. Although on a small device that is smaller display, but does not reduce the function of the overall application. Application performance seen from the use of accounting does not overload the system memory devices. The application works normally and smoothly. From the test results in some users, showed that this application applicable to be used as a media assistant for learning the history of Islamic inventor during Islamic civilization.

Experiment the search feature, conducted several experiments by entering some keywords. The analysis of the results is the recall and precision of search results by the program which will be compared with the number of documents that contain the word.

Experiment with using the input query "tentang jam atau astrolab" is obtained six documents have high closeness to the query. Fig. 8 show precision and recall of search words "tentang jam atau astrolab".

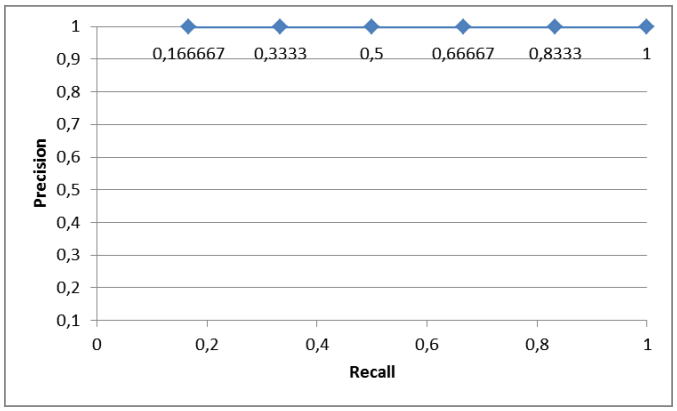

Fig. 8. Search performance

From Fig. 8 all the retrieved results are relevant based on precision value reach 100% and recall value 100%. It means the retrieved results are relevant to user query and they are selected because have a high similarities with user query. Retrieved result from automatic clustering get 100% average of precision. It because of all retrieved result are correlated with query input from user as well. It proves that automatic clustering could group historical document that are related to the user query.

V. CONCLUSION

Nowadays, to learn the history of Islamic inventor conducted sequentially, either reading a book or other text-based media. So that makes the reader become saturated and less attractive. Besides making the reader difficulty if they want to examine the history of Islam that directly refer inventors based on time or location.

Spatio-temporal will greatly impact to learning history of Islamic inventor. With spatio-temporal, can simplify the user or the reader to conduct a study of Islamic history inventor refreing time and place with more dynamic. Also implements learning history of Islamic inventor in the media of mobile devices with the aim of helping the reader to be able to use it whenever and wherever they want. This learning application is built on the Android platform which can be downloaded in the Android Play Store for free and then the application can be used offline for accessing without *resource* from outside of the system.

Spatio-temporal facility in the study implemented in the form of maps that work offline and time line serves to display the events of the history. History of Islamic inventor will be obtained by the integration of maps and a time line that can be operated as needed by users.

In addition, the search feature with text-mining approaches and automatic clustering provides convenience in searching the data of history story. With automatic clustering can retrieves a series of correlated historical documents related to query input from user.

All spatio-temporal facilities that exist in this study had tests on some devices with different screen sizes and show satisfactory results without constraint.

REFERENCES

[1] http://www.fahmiamhar.com/2011/03/ketika-wanita-bicara.html (Last Updated – 15 June 2015).

[2] Mohammad Dedi Kurniawan, Elnanda Ardiyant Saputra, Muhammad Irsan B, Prinsip-Prinsip Sains dan Teknologi dalam Al-Qur'an. Universitas Ahmad Dahlan, 2012.

[3] Nur Qashri Annisa R. R., Jahsy Firdaus Saputra, Indira Ayu Pramatyasari, Dani Wardatil Firdaus, Vivin Dwi Aprilian, Peran Ilmuwan Islam dan Peradaban Global, Sekolah Tinggi Ilmu Ekonomi Perbanas, 2013.

[4] Muh. Asroruddin A.J., Sumbangan Islam Terhadap Sains dan Peradaban Dunia, Institut Agama Islam Negeri Walisongo, 2009.

[5] https://en.wikipedia.org/wiki/Spatiotemporal_database (Last Updated – 04 June 2015).

[6] https://en.wiktionary.org/wiki/spatiotemporal (Last Updated – 04 June 2015).

[7] Ali Ridho Barakbah, Kohei Arai, Determining Constraints of Moving Variance to Find Global Optimum and Make Automatic Clustering, IES 2014, Surabaya, Indonesia.

[8] Ali Ridho Barakbah. Clustering, Soft Computing Research Group EEPIS 2006, Surabaya, Indonesia.

[9] Ali Ridho Barakbah. Text Mining, Soft Computing Research Group EEPIS 2006, Surabaya, Indonesia.

[10] Sylvia, Efektivitas Pemanfaatan Film dalam Pembelajaran Sejarah Sebagai Upaya Mengembangkan Kesadaran Kebangsaan peserta didik, UPI Bandung, 2015.

[11] https://play.google.com (Last Updated – 23 August 2015).

[12] Tao, Yufei, Papadias, Dimitris, Historical Spatio-Temporal Aggregation, 2004.

[13] Aprilia Rachmawati, Ali Ridho Barakbah, Entin Martiana Kusumaningtyas, Spatio-Temporal Sirah Nabawiyah Berbasis Piranti Gerak, Politeknik Elektronika Negeri Surabaya, 2013.

[14] Iwan Kurniawan, Entin Martiana Kusumaningtyas, Ali Ridho Barakbah, Spatio-Temporal Sejarah Islam Masa Khulafa'ur Rasyidin Berbasis Piranti Bergerak, Politeknik Elektronika Negeri Surabaya, 2013.

[15] Raghib As-Sirjani, Sumbangan Peradaban Islam pada Dunia. Jakarta: Pustaka Al-Kautsar, 2014.

[16] Fahmi Amhar, TSQ Stories. Bogor: Al-Azhar Press, 2011.