INTERFACE USABILITY OF A VISUAL QUERY LANGUAGE FOR MOBILE GIS

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Abstract: In recent years, many non-expert mobile applications have been deployed to query Geographic Information Systems (GIS) in particular Proximity Analysis that are concerned with the user who asks questions related to his current position by using a mobile phone. Thus, the new Iconic Visual Query Language (IVQL) has been developed and evaluated using a tourist application based on the map of Paris. The evaluation has been carried out to test the various usability aspects such as the expressive power of the language, the query formulation, and the user interface (GUI). The evaluation of the user interface that is hereby presented has been implemented through the user satisfaction of two subject groups, programmers and non-programmers. The results show that subjects found that the IVQL GUI has an excellent software, a good organization if icons, and is satisfying, with no significant difference between the two groups. The subjects also reported that they found the learning to operate the system easy, exploring new features easy, remembering the use of the icons easy, and performing tasks straightforward.

1 INTRODUCTION

Geographic Information Systems (GIS) are computer-based tools used to handle the geo-features. In Field Worker Services, they are used by fire fighters, emergency workers, inspectors, and utility crews (Fidel, 2007). In road networks, they provide the ability to organize public transportation (Repenning, 2006), and query moving objects (Guting, 2006). Mobile GIS are typically used in tourist and navigation systems for Proximity Analysis which includes querying the *k* Nearest Neighbour (*k*NN) and finding the facilities that are located within a buffer area. The existing Mobile GIS applications have textual or menu-driven input but do not provide a user friendly environment and are aimed at expert users only. Thus, with the urgent need to develop a visual query language that provides the mobile user with the facility to formulate a visual query using expressive icons, an Iconic Visual Query Language (IVQL) has been developed using a tourist GIS system. The evaluation implementation, results, and conclusions are hereby presented.

2 RELATED WORK

In this section we briefly describe some of the state of the art visual query languages showing some of their advantages as well as limitations.

LVIS (Bonhomme, 1999) is a visual query language for spatio-temporal databases. Metaphors are used for Querying Visually Spatio-Temporal Databases (Bonhomme, 2000). The user builds a visual query by selecting a combination of the icons (Bonhomme, 2002). Psycho-cognitive tests have been developed to measure the comprehension of the metaphors. Two subject groups were chosen: persons working with GIS and persons who are non-experts. The results of the experimentation have shown that the recognition of metaphors is effective to users without prior experience with GIS. The results showed that the subjects were able to recognize the relationship between spatial objects easily and that the metaphors are well accepted by both populations.

The Filter-flow (Morris, 2004) and (Morris, 2002) is a visual query language and interface for large spatial databases. The results of the evaluation showed that the Filter-flow simplified the learning process and made the query expression easier.

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The above visual query languages have demonstrated a considerable improvement in the field. However, none of the above is able to provide the user with the ability to formulate dynamic complex queries and none takes into account mobile users. Hence, the evaluation of IVQL has taken into consideration the various aspects of usability and has applied both the user testing as well as the user satisfaction in order to test them. One of the aspects that have been evaluated in the work is the user interface (GUI). The evaluation has been done using the user satisfaction. Its evaluation, results, analysis, and conclusions are hereby presented. The other aspects that have been evaluated are the expressive power as described in (Khaddaj, 2010) and the query formulation as described in (Elsidani Elariss, 2010).

3 DESCRIPTION OF IVQL

3.1 Query Constructs

The constructs of IVQL are an operator, a value, and an object. IVQL is based on smiley icons that are used to visualize operators, values, and objects. A complex query consists of multiple simple queries separated by the 'and' operator. The new visual query language is described in (Elsidani, 2006a) and (Elsidani, 2006b). Figures 1 and 2 show the constructs of a simple query and a complex one.

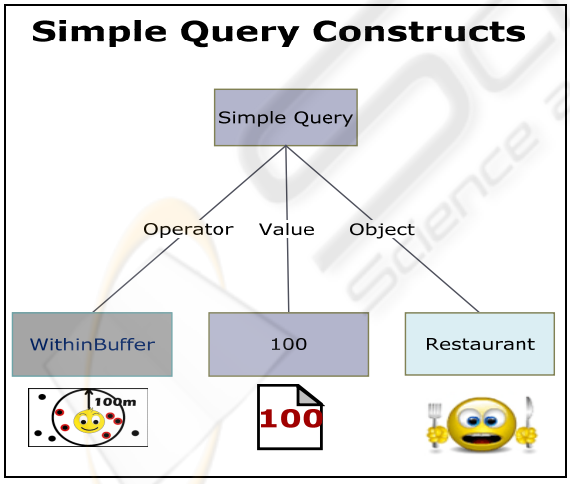

Figure 1: Simple query constructs.

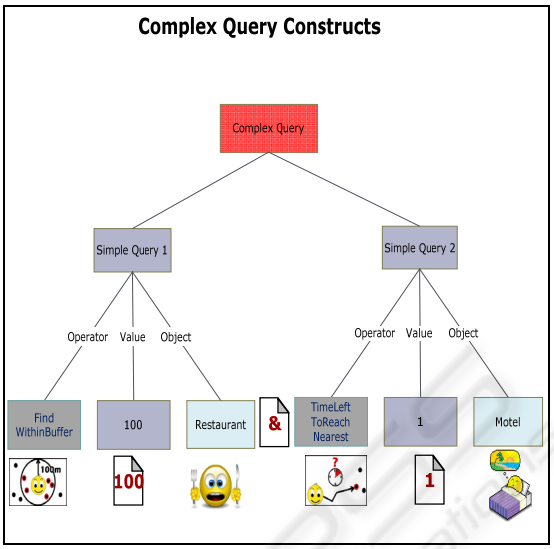

Figure 2: Complex query constructs.

3.2 IVQL Architecture

The system consists of a number of components to process the visual queries. The IVQL user interface forms the front end of the software. It is installed on the target mobile device where the user can formulate the visual query that is translated into a text query called the Pivot Language where each icon is replaced by its name, sent to the GIS server and saved in a file for later processing. The query processor, which is implemented as a middleware between the text query and the Geodatabase, processes each visual query separately as described in (Elsidani, 2009). The software architecture is shown in Figure 3.

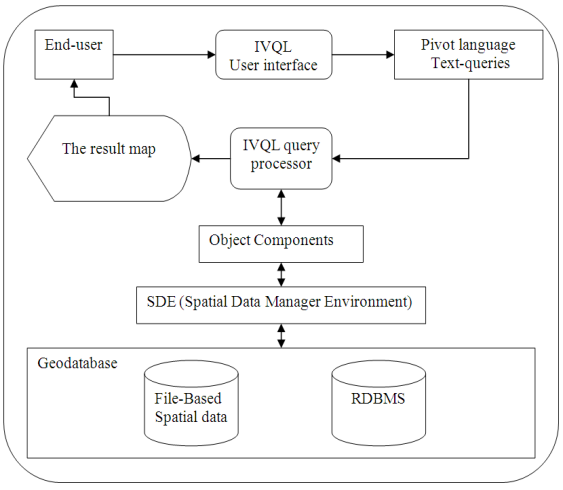

Figure 3: Software architecture.

3.3 IVQL User Interface

IVQL provides the user with two major toolbars and a middle area where objects are displayed and a query formulation area at the bottom of the interface. The horizontal toolbar contains the smiley icons that represent operations. The vertical toolbar displays icons that represent themes. The middle area displays the objects of the selected theme. The query formulation is done first by selecting a smiley icon from the horizontal toolbar. The icon is automatically moved to the query formulation area which appears at the bottom of the interface. Second, the user selects the object needed. The selected object is then moved to the query formulation area. Figure 4 shows the user interface after formulation.

Figure 4: The GUI after query formulation.

4 IVQL EVALUATION

A questionnaire consisting of twenty five 7-point Likert scale questions is used to measure the level of difficulty, user interface, expressive power of the visual query language, and the query building. The subjects are 56 undergraduate university students divided into two 28-subject groups classified as programmers and non-programmers. The programmers are familiar with computers and the non-programmers are not. Their age varies between 18 years and 21 years. The testing session was conducted in a classroom equipped with 30 desktop computers, a teacher's desktop, and an LCD projector. The NetBeans version 5.0 Software was installed on all computers with the J2ME Mobility Pack and the Wireless Toolkit. The emulator DefaultColorPhone was used to emulate the prototype of the IVQL user interface. Each session started with a presentation of the user interface then each subject was provided with the questionnaire. Each session lasted around 2 hours.

5 RESULTS AND DISCUSSION

The collected data is represented visually using a graphical chart namely the histogram bar chart. The histogram in Figure 5 shows for each question the mean of the answers and its respective value as converted to a score over 100. The score 7 means that the subject had the best and highest preference and satisfaction whereas the score 1 means that the subject had the worst and lowest preference and satisfaction. The mean scores of the two subject group are compared to check if the is a significant mean difference. Figure 6 shows the mean scores of each question of the questionnaire for the programmers sample group in blue and the non-programmers in red. The results also reported that the mean of the questions scores for each of the programmers group, non-programmers group, and both groups are respectively 90.4, 85.9, and 88.1 out of 100. Finally, the *t*-test statistic is used to compare the mean scores of each question then of all queries.

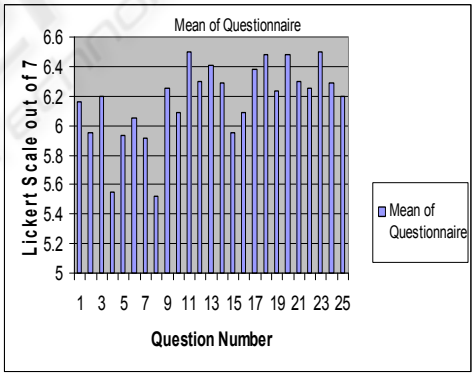

Figure 5: The average of questionnaire scores.

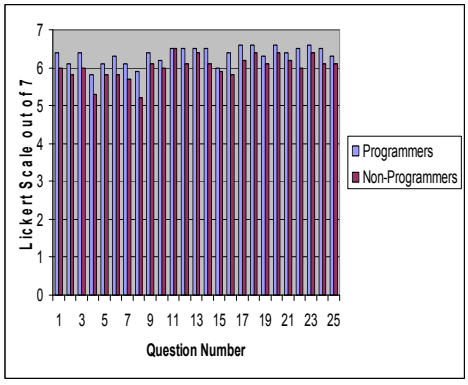

Figure 6: Averages of each group.

The subjects reported that they found the software 88% excellent, 85% easy, and 89% satisfying. They found that reading icons on the screen was 79% easy, that the organization of information was 85% clear, and that the sequence of screens was 86% clear. The t-test analysis of each aspect can report that at the 5% level of significance, there is no significant difference between the means of programmers and the non-programmers groups. Hence, it can be concluded that both groups have the same level of satisfaction about the user interface. The subjects reported that they found the selection of the operators 91% easy, the selection of categories 93% easy, the selection of objects 89% easy, building simple queries 93% easy, the queries 90% clear, the queries 89% legible, remembering the language queries 93% easy, the sequence used to build the queries 90% easy, and using the 'and' operator to formulate complex queries 89% easy. The t-test analysis of each aspect can report that there is no significant difference between the means of programmers and the non-programmers groups. Hence, it can be concluded that both groups have the same level of satisfaction about the query building and formulation. The subjects also reported that they found the learning to operate the system 93% easy, exploring new features by trial and error 90% easy, remembering the names and the use of icons 92% easy, and performing tasks is 90% straightforward. The t-test analysis of each aspect can report that there is no significant difference between the means of programmers and the non-programmers groups. Hence, it can be concluded that both groups have the same level of satisfaction about the expressive power of the IVQL language.

6 CONCLUSIONS

In this paper the graphical user interface (GUI) of an Iconic Visual Query Language (IVQL) has been evaluated. Its constructs, architecture, and user interface have been illustrated using a tourist example. An experimental evaluation has been carried out on two subjects groups to test their user satisfaction with the various aspects of the GUI. The results showed that the subjects reported a very good overall reaction with the system and an excellent user satisfaction with IVQL's GUI clarity, consistency, ease-of-use, and query formulation process. Finally, the analysis reported that subjects with different background had the same level of satisfaction with the user interface, the query formulation, and the expressive power of IVQL.

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