A Multimedia-Based and Time-Sensitive Interactive Web Survey for Road User Opinion on Traffic Condition

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Abstract— Web Survey has increased in popularity because of its convenience, ease of use, low cost, and quickness in knowing the result of a survey in real time. Web survey is widely used to gather user opinions on various purposes. However, most such systems are plain-text, and sometimes with a few graphical images. This paper presents an innovative Multimedia-Based and Time-Sensitive Interactive (MTI) Web Survey to collect user opinions on the traffic condition. Open source development tools and emerging web technologies, such as PHP and AJAX, are used in implementing the system to achieve event-sensitive user opinions. This MTI web survey, though presented and illustrated by using road user opinion on traffic condition data, is a general technique that can be applied to any time-sensitive data collection. The usability testing on MTI web survey was also conducted to gain insights on usage issues and the results are discussed.

Keywords: web survey, usability, intelligent traffic system

I. INTRODUCTION

Accurate traffic reports are essential for congested and over-crowded cities such as Bangkok. Without which, commuters could get stuck in traffic for hours. Intelligent Traffic System (ITS) with automated congestion estimation algorithm can help produce such traffic reports. However, the congestion estimation technique usually requires a considerable amount of data to train and provide good estimates. The reason is that congestion degrees are usually subjective to several factors include types of road, the time of day, the day of week and demographic factors, such as, age, region and so on. To achieve this objective, a tool to obtain accurate user opinions about traffic condition from a larger number of subjects with easily accessible at anytime from anywhere is needed.

Web surveys are widely adopted because of their convenience, ease of access, ease of use, low cost, and real-time results. Generally, questions in the survey are in the form of texts and graphics. Users then click a mouse to select answers. However, our application posts several different and unique requirements to the traditional web survey. First, user should experience the real traffic condition in order to make their judgment accurately. Therefore, traffic conditions should be offered in the way that mimics their experience in the congested road. Video clips recorded street-view traffic conditions were chosen to achieve such purpose. Second, users must be able to provide their opinions continuously according to the changing traffic congestion observed. Third, the system must record both the time of judgment and opinion synchronously with the video clip. Finally, the system should interact with users to provide confirmation and acknowledge-ment of the judgment.

In order to achieve above requirements, we proposed an innovative **M**ultimedia-**B**ased and **T**ime-**S**ensitive **I**nteractive Web Survey (MTI Web Survey or simply MTI). MTI is specifically designed and developed to collect user opinions of traffic condition. The usability of MTI was evaluated against five perspectives, i.e., learnability, efficiency, effectiveness, satisfaction, and reliability, to ensure the accuracy of user opinions and correctness of the collected data.

This paper is organized as follows. In Section II, we describe related works concerning web surveys and their usability. Architecture of the proposed system is presented in Section III. In Section IV, we discuss the usability evaluation. Section V gives the conclusion and future works.

II. RELATED WORKS

In this section, we give an overview on two main areas contributing to our MTI web survey design, development and evaluations. Web survey is described and followed by usability guideline reviews.

The advantages of web surveys are speed of data entry, accuracy, and ease of use [11]. In essence, the respondents enter the data directly into the database. The data can then be collected and entered into a statistical package within minutes. Using relatively flexible Web page layouts, researchers can ensure accurate data entry and eliminate error caused by entry of the responders, misreading handwritten forms, or scanning errors [10]. The above functions incorporating with multimedia and the proper interface between the user and the web survey fulfill our requirements to heuristically obtain user opinions on traffic congestion levels. User opinion is one of the key data that is used to estimate the congestion degree properly. The proper interface design has to be evaluated, which we utilize the systematic approach of the usability testing. The comprehensive review of the usability guidelines is elaborated in the following paragraphs.

Usability has become an established field of activity in the software development process. Usability mainly referred to ‘‘user friendly’’ [4]. The term usability was replaced with the term ‘‘quality in use’’ [2] in most recent fashion. The usability concept is important to the designing of the web page and becomes the key factor to accomplish the web site design that bases on organized objectives. As a result, the usability is the tool for indicating software or web quality.

There are several guidelines to conduct the usability testing. Table 1 shows the compilation of the items to be evaluated of the important styles in the usability fields. The

	Shackel, 1991 [2]	Nielsen, 2000 [3]	ISO 9241-11 [4]	ISO 9126 [5]	MTI Web Survey
User Performance (Objective)	Learnability-time to learn	Learnability		Learnability	Learnability
	Learnability-retention	Memorability			
	Effectiveness-task time	Efficiency	Efficiency		Efficiency
	Effectiveness-errors	Errors	Effectiveness		Effectiveness
				Operability	
				Understandability	
User View (Subjective)	Flexibility				
	Attitude	Satisfaction	Satisfaction	Attractiveness	Satisfaction
					Reliability

Table 1: The usability core elements from major usability guidelines.

rationale behind each testing items can be found in [4-6] and [8-9].

We concluded the usability guidelines to layout our MTI web survey usability testing. The focus items to be evaluated should cover and in line with the general usability guidelines. Additional experiments that fit the characteristics of our invented system were also conducted along with our MTI web survey usability testing framework. The MTI web survey usability framework covers following measurable attributes: 1) *Learnability* (how the user can learn and be able to successfully use the system from start to finish and whether the user can learn to use it easily or not), *2) Efficiency* (to know that the user can use the survey system correctly and can do it quickly), 3) *Effectiveness* (to know whether the user can achieve the purpose of each system functionality), 4) *Satisfaction* (to know whether the user is satisfied and will continue to use such system), and 5) *Reliability* (to know whether the user believes that the system perform flawlessly).

We planned the usability testing tasks based on the designed framework. The detailed methodology is elaborated in the section IV. The tests were applied on the implemented MTI web survey system that presented and demonstrated in the next section.

III. ARCHITECTURE

A. SYSTEM REQUIREMENTS

MTI is a system to collect congestion degree from the user's point of view. There are five important requirements.

First, users should experience the real traffic condition so they can make the judgment as if they were driving in the street. Second, users should be able to provide their opinions continuously according to the changing traffic congestion being observed. Video clips recording the street-view of a driver perspective were chosen to mimic the driving experience. Third, the system must record both the time of judgment and rated congestion degree corresponding to the scene in the video clip. Fourth, the system should interact with users to provide acknowledgement of the judgment. Fifth, registration to collect important demographic information is also needed. Finally, administrative functions such as user management, clip management, and survey customization should be provided.

B. Development Tools

MTI was developed mainly using two programming technologies: 1) PHP Hypertext Preprocessor (PHP) script language and 2) Asynchronous JavaScript and XML (AJAX). PHP is a script language used to provide dynamic HTML documents. AJAX is a growing web development technique [7] used to provide interactive user interface without refreshing the entire web page. The latter technology is discussed here since it is the key enabler of the MTI idea.

AJAX is an interface between user requests and web server. When using AJAX, the page is loaded entirely only once. Later, all requests for data will then be sent AJAX engine. The AJAX engine then requests information from the web server asynchronously. The engine then displays the information without reloading the entire page. Gmail and Google Map are examples of web applications using AJAX technology.

AJAX enables MTI to interact with the user friendlier and more efficiently. AJAX allows the system continuously record the user's judgment on traffic congestion degree to match the traffic flow occurred on the clips without interrupting the survey. The system also acknowledges the user judgment promptly. Unlike traditional web survey, such time-sensitive data gathering is a distinct feature of MTI. This novel approach can be applied in other types of survey to gain time-sensitive user feedback. Such applications can range from scientific research, such as organic behavior survey, to social research, such as, consumer behavior, or medical study, and all other topics of interest.

C. System Flow

The purpose of the MTI Web Survey is to collect the user opinion on the levels of traffic congestion towards the different traffic conditions via a video-enabled web site. The users will be presented with a video clip and radio buttons to select their judgment. The system will acknowledge the judgment by the confirmation text indicated the user most recent judgment. The users can make unlimited judgments at anytime. Figure 1 demonstrates the overview architecture of the MIT web survey system. We utilize MySQL as the database management systems. The database contains the user opinions, user personal and the demographic data along with associated roads and clips information. The video clips are placed on the web server. The Apache web server embedded with the PHP engine generates dynamically page upon the users' page requested.

In both congestion degree survey and survey of statistical accuracy page, a video clip is shown with the correlated information along with radio buttons for the users to give opinion. To achieve the time-sensitive data collection, the users must be allowed to provide opinion at any time without interruption. This was accomplished by using AJAX mechanism. When the user clicks on the radio button to give opinion, the web browser will create an object to communicate with the server. The XMLHttpRequest object acts as a mediator between the browser and the server. User opinion will be sent through via this object handling and recorded into the database. Then, the server generates the feedback text and sends it back using the same mechanism and shown on the "acknowledgement" area of the screen. This background interactive mechanism works in the same time as the clip is playing.

D. User Interface

We left out general routine pages, such as registration or administrative pages, and demonstrated only the main function page here. As seen in Figure 2, to the survey page allows the user to rate the traffic congestion degree. Users could start the traffic

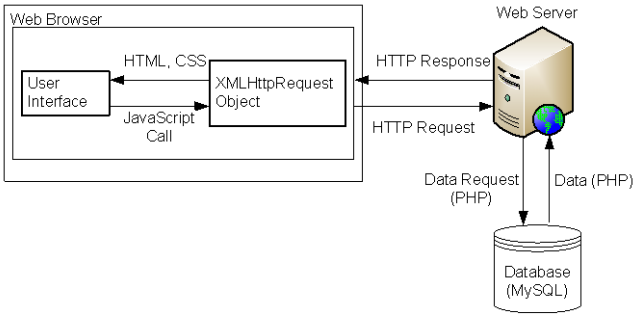

Figure 1: The MTI Web Survey System Architecture

survey by pressing the play button. Then, the users watched a video clip as long as they want. There videos were ten minutes long. The degree of the on traffic conditions were divided into three levels: (1) usable or recommended; (2) can be used but not recommended; and (3) should be avoided. When the user pressed a button to rate the congestion degree, the system acknowledged the user event instantly. The users could continuously provide opinion at any time along the entire clip without interruption.

Another main page, a survey of statistical accuracy verification, is shown in Figure 3. In this survey, the users were asked to rate how they agree with the indicated congestion degree according to the particular period shown on the video clip. The user could start to give his or her opinion by pressing the play button. Then, the user watches a 10-minute video clip. The user's opinion scales are the levels of agreement. This agreement was classified into five levels: (1) most agreeably; (2) very agreeably; (3) agreeably; (4) quite disagreeably; and (5) disagreeably. When the users pressed a button to express their opinion, the system would acknowledge by showing a text with the value that users selected.

IV. Research Methodology

After the MTI web survey system was described, its usability evaluation is explained in this part which is essential to further improve the system. A group of road users went through experimental processes that include filling the questionnaires, observations and interviews.

A. Subjects

According to the literature, the number of usability testing subjects can be as few as 5 persons [1] or 8 to 10 [3] but it should be high enough for detail analysis by statistical tools. In this paper, we randomly selected 30 road users in a university in Bangkok to participate in our usability testing.

Figure 2: Survey about the traffic condition

Figure 3: Survey of Statistical Accuracy

B. Questionnaire

The used questionnaire was a set of questions that asks every aspect for each step of using the web survey. It is divided into three parts: (1) the personal data section; (2) the system usability opinion section, which is the main part; and (3) additional opinion and suggestion section. The questionnaire questions were derived from our 5 elements of focus as indicated in our usability testing framework. The selected questions are listed in Section V, i.e., Results and Discussion, of this paper.

C. Observation

Observation was done in order to record the user behaviors on all cycles and functionalities of the MTI web survey. Some users were encouraged to speak-out-loud on what they see and how they feel while doing the survey. Several worthwhile usability issues were found and explained in the results section.

D. Interview

Open-ended interviews were conducted, which allow users to provide any other additional information they would like to give including comments, suggestions or questions.

V. Results and Discussion

By analyzing the collected data, from the questionnaires, the observation and the interviews, several usability issues grabbed our attention. The following results highlight each usability element and then we give examples of worthwhile user suggestion and other issues on the overall usability elements.

A. Questionnaire Highlights

The users were asked to rate the usability questions on the following 5-scale basis. We weight the score for each opinion rating here:

Mark Standard	Meaning
4.51 - 5.00	Very good
3.51 - 4.50	Good
2.51 - 3.50	Medium
1.51 - 2.50	Less
1.00 - 1.50	Least

1. Learnability: Here, the overall learnability of the MTI web survey is at the medium level (Mean = 2.87, S.D = 0.60). This suggests the users can easily use the survey system without hindrance from the registration process until the user successfully gave the traffic congestion degree. The only

major issue we found here is that the user confused on how to change the types of survey. The issue was rated medium to less (Mean = 2.70, S.D = 0.65). This problem can be easily and effectively solved by providing more obvious link or instruction.

2. Efficiency: The overall efficiency usability was rated at the "good" level (Mean = 3.36, S.D. = 0.69) and summary of evaluating is as follow: In short, users felt that they can accomplish the main functionality of the system which is to rate the congestion degree according to observed events. Users felt satisfied with their ability to make a judgment. The number of color levels and their meanings: red, yellow and green, are sufficiently clear to classify the appropriate congestion degree. Users rated this feature with high score, Mean = 3.63 and S.D. = 0.61. Additional efficiency issues are provided in the observation and the interview results.

3. Effectiveness: Effectiveness got the medium level (Mean = 3.38, S.D = 0.70) most of the tasks could be performed successfully and correctly. Other issues were discussed in the observations and the interviews.

4. Satisfaction: User satisfaction usability got the medium score (Mean = 2.80, S.D = 0.74) since we focus on the design and the implementation of the system to serve its main functionality, other attractiveness elements were left out at the moment. We suggest to improve the appearance and to add more interaction to the system to attract the users.

5. Reliability: The overall reliability usability scores 3.73 (S.D = 0.66) that means "good." The users were confident that the system performs accurately since the continuous feedback, and the rated congested degree matched their opinion at the verification survey.

Finally we summarize each detailed elements and group the usability into the core factors presented as follow:

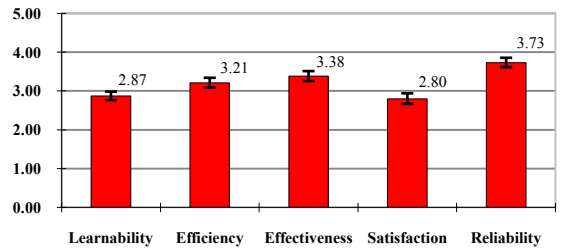

Figure 4: Result of usability evaluation separate by factor of usability

The accuracy of the data collected from the MTI web survey system is crucial since it is used in the dedicated estimation algorithm. The usability study revealed that the system was success on this critical function referred to the highest usability rating score, the reliability. All other usability elements were in the medium range even the lowest one, satisfaction. Then the attractiveness of the system should be improved.

B. Observation Highlights

Most users illustrated only minor confusion when using the MTI web survey. We notice that the interface was intuitive enough so that the users were not required any detailed instruction or intensive training to use it. Particular menus, such as the survey type selection, have to be redesigned.

C. Interview Highlights

We found a controllable issue on the speed of the Internet connection. If the speed of the internet is too slow, the users will not be willing to participate in the survey. Users were particular like the angel of camera displayed in the video clip that simulated the users sitting on the driver or front passenger seat.

Users also suggested very interesting ideas beyond the usability issues, which may benefit the process of doing the congestion estimation. The system should provide opportunities for the users to indicate the cause of the high traffic congestion. Indicating the current position of the overall route might give the user more information to design the traffic congestion degree.

VI. CONCLUSION AND FUTURE WORK

The MTI web survey is an innovative survey tool to record time-sensitive data interactively. In this paper, it was demonstrated by collecting the road user opinion on traffic condition. The data will be further used to construct the dedicated estimation algorithm which is one of the key components of the ITS. AJAX, the emerging technology, is the major enabler of the system. Usability testing was extensively performed to investigate the usage issues to get the most accurate and valuable data. The greatest strength of the system's usability is its reliability. Other elements of the usability were in the medium range. The system attractiveness should be improved. The system should provide better survey course guideline.

Besides making the system easier and more eye-catching to use, several topic-specific data can be obtained from the MTI web survey. The users suggested that the survey should determine the current position of the driver on the entire route. Several suggested that the cause of the traffic jam should be able to be recorded.

Beyond the usability issues and the road traffic perspective of this MTI web survey. This paper opens rooms to further explore several concepts around the MTI web survey. The system might be applied to other research that requires time-sensitive data and interactive experience.

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