The Proposition of a Framework to Support the Design of Ecological Systems for the Web

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Abstract. Usability evaluation is one of the main steps in a product development life cycle and is responsible for providing a better level for its quality. Applying usability evaluation techniques is an important activity to achieve better definitions that can be used in the software development. Specifically, when is considered the development of interactive systems designed to support Ecological Simulation Environments, this process must be taken with prudence and rigor. So, their Human-Computer Interaction must be taken with efficacy, efficiency and user satisfaction. When the Ecological Simulation Environment is considered, this problem has a special feature that turns it into a special one: the information localization is one of the main important characteristic of its definition. These systems allow the manipulation, maintenance and visualization of geographic data as coordinated sets and the interest for their applications is increasing a lot in the last few years. Nowadays, we can consider the Web Ecological Simulation Environment as a reality, as in these web sites the geographic information and the simulation features for specific ecological environments are being disposed in different pages and their manipulation is being supported by the internet. On the other hand, some of these web sites are usually designed and implemented for specific users, such as the biological community and it makes them too specific for being used and analyzed by "regular and traditional" users that can be able to interact with them, since these sites may be available on the web. The Web mapping services and the ecological simulation systems are being accessed more regularly and most of them can be available through accessing web sites. These applications are based on the possibilities that the technology offers, such as spatial localization for specific interest places or addresses, calculation of simulation taxes and some distances between two addresses or places, among others. In this context, the internet is the better way users can interact with them. This does contribute a lot in the increase of the quantity and diversity of users, their features and restrictions. So, ecological simulation systems utilization is not always an activity that may be considered as trivial or easy. When performing the usability evaluations, we do not just aim to collect the evaluators answers for the questionnaires applied, but we also plan to ask to the evaluators to rank the level of importance for each one of the Ergonomic Criterion, since each question had, at least, one Ergonomic Criterion associated. So, based on these results, we may have conditions to create a framework for designing web sites for Ecological Simulation applications as we can be able to figure out which information is more relevant and, so, propose strategies for making them more usable.

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1 Introduction

Ecological aspects concerning education, research and preservation are important issues discussed nowadays, mainly because past activities damaged many relevant ecological areas affecting the people lifestyle, increasing world temperature, thawing ice caps and many others undesirable impacts. The use of specific software to support ecological activities is a reality and the interest for this kind of environment is increasing a lot in the last few years. These tools could allow many specialists or novice users performing mapping, simulations, manipulations, maintenance and visualization of geographic areas using several interfaces resources in order to present a variety of information that may help users establishing strategies for conservation, public health, development and reconstructing ecological areas (Muñoz et al., 2009). Usually, these applications are based on the possibilities that the software could perform complex activities, for example advanced calculations, spatial localization and distance between two addresses or geographic points. The main and easier mechanism for users to access and perform their tasks using this type of application is through the Internet, i.e., software developed using a website approach.

There are web sites designed for specifics users such as the Biological Community that can be too specific for being used and analyzed by "regular and traditional" users and so, it is possible that they may not achieve their goals effectively and/or efficiently. Because of this, the Human-Computer Interaction (HCI) should be a concern to ecological systems development teams since this area of study can support the development of easy, full and acceptable ecological applications that can be used by all different skilled users, with different equipments, experiences and expectations.

The HCI process development involves some tasks such as analysis, prototyping, development and evaluation. It is aimed to help the development team producing interactive software with high levels of usability, i.e., applications that allow users to realize their task with effectiveness, efficiency and satisfaction (Cybis et al., 2010). The evaluation is one of the main steps in HCI development life cycle. Moreover, some guidelines are proposed to support all HCI development steps. For example, the Ergonomic Criteria proposed by Scapin & Bastien (Scapin et al., 2001) in order to help the designers and evaluators achieving a product with high level of usability and quality.

This paper aims to present a framework to support the development of Ecological Systems. For this reason, we are proposing the use of an Observation Method to evaluate and validate the software usability. This framework will consist, mainly, in the use of two evaluation approaches: (1) ErgoMonitor: Tool that collect data done directly from the user´s interaction and stored at the server log files; and (2) ErgoSV: this software supports usability evaluation using face and speech recognition (Coleti et al., 2012). Both of these tools are presented in further sections. These two applications when used together become a framework to be used during HCI design and evaluation phases to perform an iterative development.

We are proposing that the use of ErgoMonitor + ErgoSV can help to evaluate ecological systems usability identifying good features to be used as a guideline in developments of this sort of environment. The next section presents the Materials and

Methods used for ErgoMonitor and ErgoSV development and also presents how these environments can be used together for allowing Ecologycal Systems development team achieving their usability design and evaluation goals.

2 Material and Methods

This section presents the resources researched to make this framework that supports the HCI design and evaluation processes of Ecological Environments. Among the studied techniques, we are presenting aspects concerning the Usability Evaluation, and specifically both ErgoSV and ErgoMonitor tools.

2.1 Usability Evaluation

Evaluating is one of the main stages of the design development process and aim to certify if the interface is according with the specification and whether it allows users to perform their task with efficiency, effectiveness and satisfaction, i.e., with high levels of usability. The evaluation activities should be performed in all stages of usability engineering such as analysis, development and evaluation. So, specific techniques that are appropriated for each stage were developed, such as usability inspection and usability tests (Cybis et al., 2010).

Some HCI evaluation techniques are widely used to support usability tests such as filming, verbalization and the monitoring of users activities using log files. Log Files are registers that contain data about what a user has done during their visit on the website such as hour, IP address and electronic address accessed. The data can be processed by specific software and generate relevant information about website usability such as rate and metrics usability (Cybis et al., 2010; Morandini, 2003, Scapin et al, 2001).

The filming is performed using one or several cameras positioned near the user collecting images about face, hands, computer screen, environment and other resources according to evaluator needs and so recording the interaction. The images collected are used by evaluator to analyzing the interaction between user and software and can present exactly what moment a software error happened or when the test participant has difficult to perform any task usability (Cybis et al., 2010; Coleti et al., 2012). The Verbalization is a technique that the participant verbalizes their thought during or after performing the evaluation. This approach is based on the idea that the participant can verbalize what they are thinking about and so verbalizes you opinion about the software allowing evaluator and designer identify usability problems in the interaction design (Morandini, 2003; Coleti et al., 2012).

Monitoring the use by analyzing the log files, is a not-so-intrusive technique, i.e., the evaluation can be performed without boring the participants. This is extremely interesting for Ecological Systems supported by a web site since the users are can participate in the evaluations do not need to be in a specific place at any predefined time. Some tools were development and others have been developing in order to support usability evaluation based on observation method such as ErgoMonitor and ErgoSV. The next section presents details about these applications.

3 Theory / Calculation

This section presents the environments that should be used together to present a framework for helping the development of Ecological Systems based on the web: ErgoMonitor and ErgoSV. The joint utilization of these usability supporting tools may produce a complete guideline for the HCI design and/or evaluation processes and can be a meaningful tool for Ecological Environments development teams and even for their users.

3.1 ErgoMonitor

The ErgoMonitor is defined as a system able to be monitoring *real* interactions performed by *real* users in their *own working environment*. This defines the usability evaluations attention focus: the presence of usability problems without the total knowledgement about the use context involved (Brajnik, 2000).This project was inspired by a need that web site developers and managers deal regularly: continually assuring and improving the web site usability despite the constant updating of actions and informations (Scapin et al., 2001).

In the ErgoMonitor context, the possible tasks that could be performed by the users while interacting with the web site should be the ones considered as "objective" or "closed". These special tasks have a main feature: they present beggining and ending points (ie, urls) clearly well stated. So, the final url that could be accessed by an user while performing a task, and achieving success, must be an specific success-url. And so, for this same reason, an initial url, is probably the Homepage for most of the tasks that are supported by the web site. In this context, if the dilletantes users, that only wish to visit the web site and do not aim to conclude a task, are not considered.

The ErgoMonitor´s evaluator-operator must have an active participation in the environment configuration, since he/she should define a "service" parameter for the achievement of the server log files. Also, he/she should model the tasks and behaviours. This modelling is, basically, the presentation of a set of *urls* that are accessed while a task is being performed. So, the models needed include the success, cancels, desistances, help solicitations, error messages, and others.

3.2 ErgoSV

The ErgoSV Software is an application that is been developing based on observation techniques. The observation is used in usability evaluation in order to register images or sounds by user to create relevant quantitative and qualitative information about software usability (Cybis et al., 2010). To register these data the evaluator usually uses: (1) video cameras in order to film several relevant point of evaluation such as face, hands, keyboards and computers; (2)voice recorders in order to register what the participant/user say during the evaluation.

The face recognition is used in order to identify when the user has some reaction and express it by face. A default image is collected in initial and after test it is

compared with other images collected during the test. The images are collected in an interval time stipulated by evaluator. After collected all images and the participant finish the test, the ErgoSV Software performs an image processing and two informations could be provided: The first one is the moment when the participant´s face is different from the default image. The second is generated when the software don´t recognize any face in image.

The speech recognition is performed in order to support verbalization method also known as Think Aloud. Ericsson and Simon proposed three ways to perform the Think Aloud (Verbalization): (1) the participant don´t need to perform a hard mental load to transforming what he/she is seen to what they will pronounced, for example, whether the participant see a figure containing a number they can pronounce the number easily. (2) in this approach the participant needs to perform more mental load than the last one because he/she needs to transform what he is thinking about in a word to be pronounced; (3) the last approach of verbalization is more complex because the participant needs verbalizing about specific situations of things, moreover, the people could be required verbalizing something from past (Boren e Ramey, 2000). In ErgoSV the participant needs to transform a situation in a word that represents what he is thinking about the software.

To perform an usability evaluation using speech recognition the evaluator needs to choose words to the participant. Some words are initially established such as “good”, “bad”, “regular”. After set the words, the usability test is started and so, when the participant pronounces one of the configurable words, the software performs the recognition, stored it in a database and after speech processing the application presents the word and the confidence (certain recognition rate).

Therefore, the ErgoSV Software is a tool based on observation techniques of usability evaluation that uses an approach improved from the traditional filming and verbalization. Also, this application collects data from voice and face emotion. This evaluation software can support the Ecological Software design in all stages of Usability Engineering. The next section presents an approach to support the analysis, development and evaluation of ecological systems.

4 The Ecological Software Design Development Process Framework

This section proposes an approach based on usability engineering and observation method to analyzing, developing and evaluating ecological websites so that the Human-Computer Interaction can be taken with efficacy, efficiency and user satisfaction.

The framework we are proposing in this work (the use of ErgoMonitor + ErgoSV) involves a series of activities focused on the usability evaluation, starting from analysis process and concluding on the final product evaluation performing, this way, an interactive development process that can allow the evaluator to collect meaningful data about software roles, user satisfaction and interface quality. This framework is strongly based on usability engineering phases: analysis, development and evaluation

processes. The observation techniques are used in the development stages to support the evaluation of existing products, prototypes and final products.

The Interactive Process (Pressman, 2011) which this framework is based allows and guides the development team to repeat the activities with the final user several times in order to improve the concepts and user needs.

The Figure 1 presents the Ecological Software Design Development Process Framework and their activities.

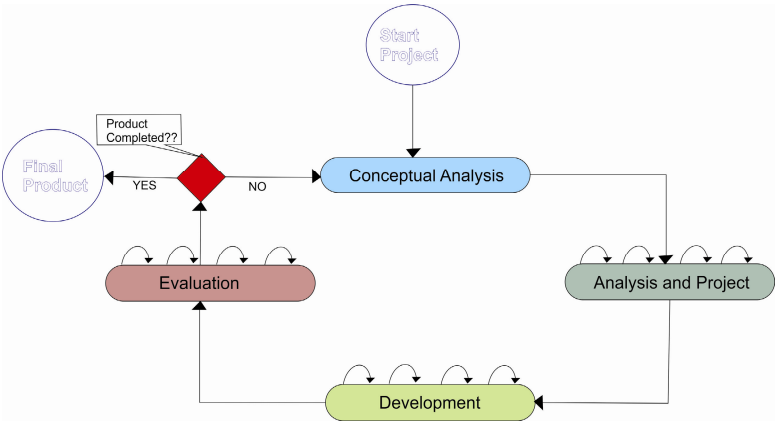

Fig. 1. Framework to Support the Design of Ecological Systems for the Web

The **Conceptual Analysis** is the first framework stage and did not have relevant changes compared to traditional usability engineering. In this stage, the designer should not be concerned about applications of technologies resources to be developed, but the main activities aim to present information about what the user needs in their applications, what problems to solve and what are the important data to be collected to help figuring out how should be the software developed. Mental models, notes, voice recorders and interviews can be used to support this stage (Cybis et al., 2011). Although both ErgoSV and ErgoMonitor are not used in this stage since that application is not the focus of this phase, the test participants chose is also realized in this stage. It should be interesting that a minimum of four or five testers should be selected to achieve a good result in this stage (Cybis et al., 2010; Pressman, 2011).

After performing the Conceptual Analysis, the designers must perform the **Analysis and Project Stage**. In this phase the designer must transform the user needs in interface (software) requirements and verify whether these requirements are in accordance to the concepts collected in previous stages. The number of tests that must be performed in order to support the phase activities can be defined by the development team and can vary according to requirements difficulties, participants´ skills and application tested.

The **Development Stage** aims to perform the development of the ecological websites and can be considered as one of the most important framework stages. In this stage, the development team must transform the user´ requirements, resources,

features and standards established in previous phases into a final product, more exactly, a website for ecological activities. In this stage the use of observation methods supported by ErgoSV and ErgoMonitor must be considered by the development team to perform usability evaluation in prototypes and possible releases.

Finally, the **Evaluation Stage** is focused in evaluating the final product. The usability evaluation in final products must be performed by the same participants that realized the other tests and they must use the website completely as had done when the system is ready. The ErgoSV and ErgoMonitor software will support the evaluation activities and so generate relevant information about the interaction between user and the software. The tests can be performed using a list of task compiled by evaluator with help of real users, specialist and regular users, participating or not the previous test. All the tests must be performed in the releases by real users that can submit the application to several situations, including some that could not be identified in previous stages.

As the last framework stage, two possibilities are available: (1) the evaluator can certify that the website is according to all requirements and the interface has all the features to ensure high levels of usability allowing all skilled users performing their task; (2) the evaluation can present problems in the final product such as implementation problems or concept problems leading the project returning to first stage in order to performing a new conceptual analysis and so go through all the phases again. The evaluation is the last stage of the proposed lifecycle and is consider as a delicate phase. This framework also proposes four activities that can be performed in order to optimize the evaluation:

1. **Initial Stages:** The participants are orientated about the Ergonomic Criteria and how they can influence the interface utilization. Also, they are orientated to basically observe the interface according to the eight elementary criteria and the participants are informed that they can be taped and what words they will need to pronounce during the test and in which situations they should do that so.
2. **Configuration Stage** that consists making the configurations in the two applications that will support the evaluation using observation method: ErgoMonitor and ErgoSV. The evaluation software needs that the set of parameters should be defined. Among these parameters are the interval time to collect image faces, words to being pronounced and time to collect screen images. The ErgoSV contains some words predefined such as good, great, bad, regular, but other words can be configured.
3. In **Test performing** the participants perform the usability test and are being observed by ErgoSV and ErgoMonitor. The participants can be monitored by a evaluator in order to solve eventual problems or doubts. A list containing several tasks can be available to participants besides ask them to perform everyday task; and
4. **Test Analysis** is a stage on what the evaluators use the information generated by ErgoSV and ErgoMonitor in order to take decision about usability problems.

The next section presents the conclusions and expectations related to the use for this framework and the results that can be obtained with it.

5 Conclusions

HCI usability design and evaluation must be considered as very important in a product development life cycle and are responsible for providing a better level for its quality. Applying usability evaluation techniques is an activity to achieve better definitions that can be used in the software development (Cybis et al., 2010).

Specifically, when an Ecological Environment is considered, this problem has a special feature that turns it into a special one: the information localization is one of the main important part of its definition. Nowadays, we can consider the Web Ecological Simulation Environment as a reality, as in these web sites the geographic information and the simulation features for specific ecological environments are being disposed in different pages and their manipulation is being supported by the internet. On the other hand, some of these web sites are usually designed and implemented for specific users, such as the biological community and it makes them too specific for being used and analyzed by "regular and traditional" users that can be able to interact with them.

The Web mapping services and the ecological simulation systems are being accessed more regularly and most of them can be available through accessing web sites. But, ecological simulation systems utilization is not always an activity that may be considered as trivial or easy. One of the reasons for that is the great amount of users that may access them and so, due to their differences, achieving usability features for all these users is a challenge that the designers must deal with. And the framework we are proposing in this paper has the intention to be helpful for guiding designers and evaluators achieving their goals.

Therefore, it is really important that the mapping applications should be designed considering usability definitions, such as the Ergonomic Criteria (Cybis et al., 2010) that are strongly accepted and validated by the scientific community. Specifically, the use of questionnaires and checklists was considered as an important, low cost, fast and efficient approach. We plan to focus the use of this framework in the utilization of two initial different ecological web sites and in the using of the environments that can be accessed from them. These web sites (and environments) are:

- **OpenModeller** aims to provide a flexible, user friendly, cross-platform environment where the entire process of conducting a fundamental niche modeling experiment can be carried out. The project is currently being developed by the Centro de Referência em Informação Ambiental, Escola Politécnica da USP, and Instituto Nacional de Pesquisas Espaciais as an open-source initiative (http://openmodeller.sourceforge.net).
- **Knowledge Network for Biocomplexity:** The Knowledge Network for Biocomplexity (KNB) is a national network intended to facilitate ecological and environmental research on biocomplexity. The goal of KNB is to enable the efficient discovery, access, interpretation, integration, and analysis of complex ecological data from a highly distributed set of field stations, laboratories, research sites, and individual researchers (http://knb.ecoinformatics.org/index.jsp).

To conclude, it is important to say that this paper purpose is to have more environments being evaluated or designed using this framework. For this reason this paper was written and submitted: present the Ecological Environments Development Community a framework able to help their design and evaluation activities. When performing the usability evaluations, we do not just aim to collect the evaluators answers for the questionnaires applied, but we also plan to ask to the evaluators to rank the level of importance for each one of the Ergonomic Criterion (Cybis et al., 2010), since each question had, at least, one Ergonomic Criterion associated. So, based on these results, we may have conditions to create a framework for designing web sites for Ecological Simulation applications as we can be able to figure out which information is more relevant and, so, propose strategies for making them more usable.

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