Nodobo Capture: Mobile Data Recording for Analysing User Interactions in Context

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ABSTRACT

As part of our on-going research into analysing user experiences, the authors present Nodobo Capture: a tool for recording interaction sessions on mobile devices. Software running on the device records a user's interactions, the screen state before and after these interactions, and context information gathered from available sensors. The gathered data can then be synchronised to a PC to be analysed in a complementary playback application, Nodobo Replay.

To test the tool's ability to generate suitable data, the authors conducted a study of touchscreen target selection accuracy. We found that users require more attempts to select targets smaller than a finger-width. Making the target any larger than finger-width has negligible effect on the user's ability to select it. A small increase in the mean time taken to select targets while walking was observed. By comparing methodologies with previous studies, we found that usability studies can be conducted with Nodobo Capture more easily.

Author Keywords

usability evaluation, in-the-field, interaction recording

ACM Classification Keywords

H.5.2 Information Systems: User Interfaces—*Evaluation/ methodology, Graphical user interfaces (GUI), Prototyping, Theory and methods.*

INTRODUCTION

Usability testing is an important aspect of product research and development. It can be used to verify a proposed new interaction method, evaluate an individual application or test the quality of a near-market device as a whole. For handheld device testing, we categorise these studies into three groups: laboratory testing, user-recorded interactions, and third-party monitoring.

Laboratory testing is the traditional approach used in usability studies. A user is introduced to a controlled environment, given a device to use, and asked to perform a set of tasks. Video cameras can be used to study exactly how the user interacts with the device during the test, and in the case of think-aloud testing, an examiner accompanies the test subject discussing the interface. While such an approach may yield excellent data, it is not always representative of real-world usage of these devices[9, 14].

Field testing of devices can give a more realistic insight into their practical performance. Commonly, a third party is used to record the user's behaviour [11, 2] which can affect the user's normal environment, in turn affecting the validity of the results. Field testing with an observer also does not scale to large numbers of test subjects and is an expensive option.

An alternative field testing approach requires the test subject to wear monitoring equipment to record how they interact with the device under test[5]. Similarly, the device may be augmented with cameras mounted on sleds to record the screen contents[7, 13, 11]. While the device is being used in a dynamic context, the presence of the monitoring equipment may modify the user's behaviour significantly.

Handheld devices are becoming more powerful, with increased processing power, memory, and mass storage capacity. This technological progress has led to the emergence of a new approach: using the device itself to record its usage. Such an approach removes the requirement for field observation by either examiners or user-attached observation devices.

Software running behind-the-scenes records a user's interactions with their device, often including this with context information. Modern devices are rich with context sensors, including GPS receivers, tri-axis accelerometers, and ambient light-level readers. These sensor readings, along with other software sensors, allow researchers to recreate the user's actual conditions.

Recording user interaction sessions and context in the field can generate large volumes of data. Analysis tools will be required to process the context information and associate it with the user interactions. These analysis tools must also present this data appropriately if it is to be useful.

RELATED WORK

Nodobo Social is an ongoing study into the social interactions of a group of senior high school students[1]. Social context is collected from the phone logs, synchronised regularly with a web services data store, and can be examined and studied to determine how the students use their devices

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to foster and maintain social links among their peers. The Nodobo Social architecture is described in Figure 1 and is similar to the architecture used in the capture tool. With a combination of Nodobo Capture and Social, it would be possible to record both a user's interactions with their device, and their social interactions with others.

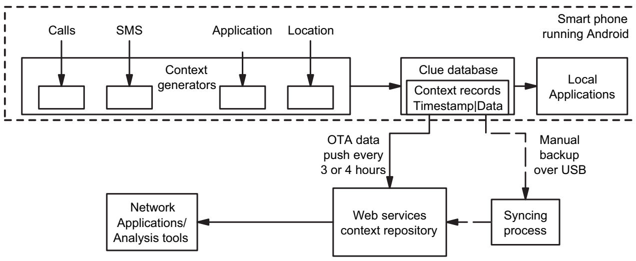


Figure 1: Nodobo Social architecture

The RECON system is a tool for automating the capture of application-specific interactions, general device usage, and device context[6]. The application under test is first augmented with the RECON Log dynamic-link library (DLL), allowing application-level log messages to be recorded. A *RECON Client* captures device context and synchronises the log messages and context information with an external server. An analysis tool called GREATDANE is currently under development which pulls data from the server for analysis.

For an application to be tested, it must be compiled with the DLL. A simpler approach would be to have RECON built into the operating system of the device, catching everything. The researcher could then filter the captured data to only that which they were interested in.

MyExperience is a system for capturing objective and subjective data in-the-field[3]. A three-tier architecture of sensors, triggers, and actions is used. Sensors model the device state, any user interactions, and the state of the environment while triggers execute on user-defined sensor conditions. Researchers are able to define actions that run when certain triggers fire, such as capturing a screenshot when a user interaction occurs, or synchronising the local database with the external server when network connectivity becomes available. The researcher also has the option of presenting a survey to the user to obtain subjective feedback.

Kawalek et al. have created a tool for analysing user interactions with mobile devices[8]. When a user interaction occurs, the system takes a screenshot as well as storing some environmental context. A log file recording tool captures clicks with timestamp and screen position and item selection in data lists. When the user manipulates data in a dialog, the time and action are recorded. Screenshots are taken at each interaction to allow the user experience to be recreated in an analysis tool, which presents all recorded data to the evaluator. The screenshot sequence is displayed, allowing the evaluator to watch what happened, and the sequence of interaction events is also presented to the evaluator.

The log system presented by Kawalek only captures screenshots at the time of an interaction giving no indication of the screen contents before or after the interaction. If the user is interacting with an application that is dependant on network traffic, the user may experience a delay due to limited connectivity that will not be visualised when the evaluator studies the screen captures later. With the system proposed by Kawalek, there is no way to show the evaluator what the user sees when they are looking at the screen, but not interacting with it.

CAPTURING USER INTERACTIONS

Nodobo Capture records a number of data enabling the recreation of user interaction sessions: the screen state preceding the interaction, the interaction itself, and the screen state after the interaction. In doing so, we are able to later reconstruct a replay of the user interaction, showing the trigger for the interaction, displaying the user's input, and the result of the input on the screen.

To capture screen contents before an interaction occurs, a ring buffer is used. When a user interaction event is detected, the event is recorded and the contents of the buffer are moved to mass storage. The ring buffer is then allowed to refill completely, at which point it is again stored to disk. This results in the recording of the events leading up to a user interaction, the interaction event itself, and the moments after the user interaction occurs.

Interaction events will often occur in quick succession. If a second user interaction event occurs before the ring buffer has refilled completely, the partially-full buffer is stored. The ring buffer is then allowed to refill as normal, unless interrupted again. In this way, a normal sequence of user inputs will result in a reconstructed continuous replay of preconditions, inputs, and results, without any overlaps.

A study by Roto and Oulasvirta found that users operating a web browser in a mobile context would first glance away from the screen between 4 to 8 seconds after a page request is issued[11]. This means that the user interacts with some element, 4 seconds later the web page hasn't finished loading, and the user focusses their attention elsewhere. As the capture tool is intended to be used in mobile contexts, this factor must be taken into consideration. Therefore, the tool maintains a copy of the last 10 seconds of screen state to capture interaction patterns such as these.

To trigger the capture utility to write a sequence of frames to disk, the user must interact with the device. Three types of interaction cause a write: interaction with the hardware buttons, the soft buttons underneath the screen, and touch interactions with the screen itself. For touch interactions, the software records the location of the touch in pixels, as well as the "pressure" value associated with the touch (the deployed device, a rooted Google Nexus One, has a capacitive display, so the "pressure" value is a function of touch area).

As well as capturing the screen contents and user interactions, Nodobo Capture also gathers device context from any available sensors. The current implementation captures context data such as battery level, orientation and screen state, as well as information from on-board sensors such as the proximity sensor and acceleration sensor.

EXAMPLE STUDY: SELECTING WHILE WALKING

To verify that Nodobo Capture is capable of generating data relevant to usability studies, the authors have conducted an experiment investigating the touchscreen interaction accuracy in different contexts. When a user is interacting with a device in a mobile context they must divide their attention between the device and their environment. This task concurrency can lead to conflicts, where one task is neglected in favour of the other[4]. The experiment aimed to quantify how detrimental walking while interacting was to touchscreen effectiveness.

Schedlbauer et al. investigated users' ability to select with a stylus on a tablet computer while walking[12]. This experiment was recreated with Nodobo Capture on a capacitive touchscreen device to determine if finger accuracy was comparable to stylus accuracy. The experiment would also determine whether Nodobo Capture could be used as a platform for rapid-deployment usability studies.

Methodology

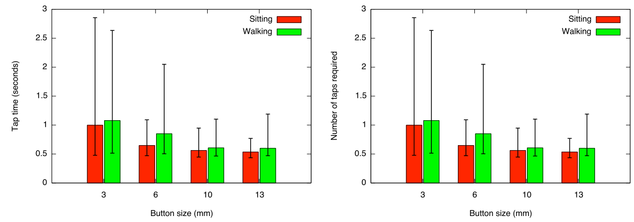
Twelve subjects were required to select randomly-located square targets appearing consecutively on the screen. A sequence of 80 targets was presented to the user; twenty each of four target sizes (3, 6, 10, and 13mm), in a random sequence. Target generation was achieved by deploying a small test application onto a device running the capture software. The test application recorded the target location and the time that the targets were drawn. The test was conducted both sitting and walking at a fixed pace along the corridor. Schedlbauer noted in the discussion of his results that subjects slowed down while attempting to select smaller targets. To counter this, subjects were asked to walk to the beat of a metronome to maintain consistency in their walking speed.

Results

Target selection times were generated from the test application output file. We found that target selection time for larger button sizes was near-constant, implying that making a target larger does not make it easier to select (Figure 2a). The minimum time required to select the target is near-fixed across all button sizes, and both stationary and walking. This appears to be the time taken to react to the target and positioning the finger in the correct place ready for a tap.

Touch attempts were associated with their intended target using data produced by Nodobo Capture. Subjects had difficulty in selecting the smallest box (Figure 2b), possibly because the target is completely obscured by the subject's finger. The 1 %ile woman's finger is approximately 4 times the size of the smallest box[15]. A stylus is potentially more accurate than a finger because the point does not obscure the target.

Average selection performance for target sizes of 10mm and 13mm suggests that users can accurately select these targets



(a) Selection Speed (b) Number of Attempts

Figure 2: Results, varying button size and movement

on the first attempt. This result is consistent with the findings of Parhi et al. who found that around 1cm target sizes should be sufficient for thumb interaction[10].

FUTURE WORK

The authors have also been working on Nodobo Replay, a tool that allows the recorded application sessions to be played back as a video on a computer (Figure 3). This allows interaction sessions spanning multiple contexts and from different users to be compared. Filtering of the recorded data for areas of interest will also be possible with the tool, giving a complete end-to-end solution for performing usability studies without the need for an in-situ examiner. The complete process of recording a user's interactions, playing them back for analysis by an expert, and identification of usability problems will be presented in future work.

Lastly, processor cycles and battery power are used up when user interactions and especially screen content is captured. The first step in the development of the capture system was a feasibility study, to see if the devices were capable of recording the data that needed to be recorded. The next step will be to study the effect of such a capture system on the responsiveness of the user interface, and optimising the capture system if required. These experiments will be conducted in future work.

CONCLUSIONS

The authors have presented Nodobo Capture, a tool for recording user interaction sessions and their context. The system can be used to gather data for use in mobile device usability evaluation studies, removing the potential for observation interference in traditional in-the-field methods. The capture system runs independently of the higher-layer software, and so works with all applications without modifications.

The capture tool was used to perform a small usability study to test that the data generated was valid and can be used in usability studies. Touch screen interaction events were compared when users were walking at a fixed pace and while they were stationary. We looked at the accuracy of finger presses, and the time taken to locate and select targets. The methodology used in the experiment was simplified with the use of Nodobo Capture.

Finally, the data that Nodobo Capture is capable of capturing can be applied to other areas than in-the-field observation

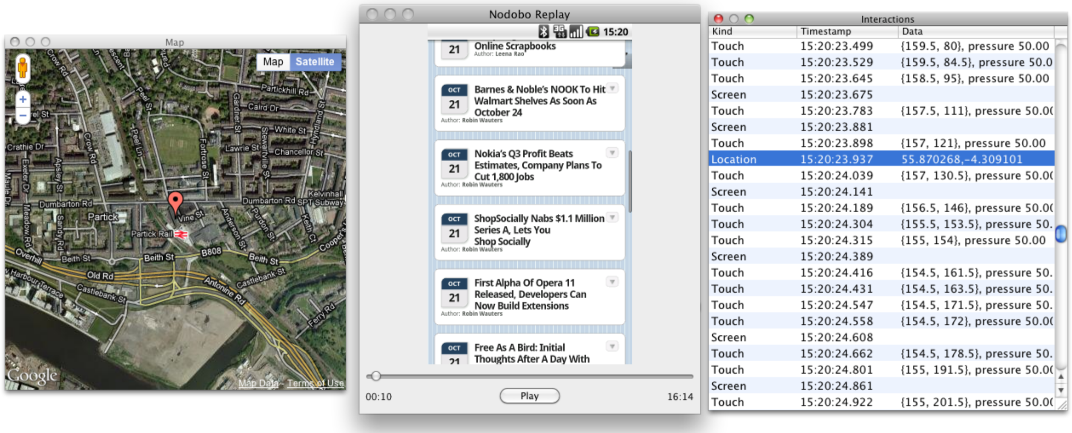


Figure 3: Nodobo Replay Screenshot

studies. Nodobo can detect applications in use, estimate the user's social network, and understand context of communications. This wealth of user experience data could be used to support future mobile applications.

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