Studying Media Usage in the Living Room by Measuring Infrared Signals

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ABSTRACT
While HCI field studies are traditionally undertaken by using tools from social sciences, this paper describes a complementary method for studying media usage in the living room. It provides a first step for blurring the boundary between lab and field-test studies for media usage in living room.

We constructed a device that measures and records the distinct infrared (IR) patterns of the remote controls used in the living room to interact with media devices. These recordings are later used to deduct usage patterns across media devices.

Author Keywords
User behavior, media usage, living room, Infrared recording.

ACM Classification Keywords
H.5.m Information interfaces and presentation: Miscellaneous

INTRODUCTION
Traditionally, HCI field studies are conducted by using a set of tools from a large repository of social sciences. These tools allow insights into a user's daily life and often include cultural probing or a variation like playful probing (Bernhaupt et al. [1]).

For a finer temporal description of user experiences, methods like the experience sampling method (ESM) and the day reconstruction method (DRM) are getting more and more common.

ESM was originally referring to a technique involving random signaling of users during their daily lives (Larson and Csikszentmihalyi [5]). Today, the term ESM is used more broadly, and describes procedures that assess in-situ experiences at the time (or near the time) they are occurring (Christensen et. al [2]). Experience Samples can be taken in response to a random signal, at predetermined times, or following a particular event (or events).

While ESM requires the user to report nearly in real-time, DRM (Kahneman et al. [4]) is designed to provide detailed descriptions of daily activities and experiences by the mental reconstruction of a day – Participants provide demographic information and rate items on satisfaction and mood, then divide the day into episodes starting at arising and ending with retiring in the evening. Each episode is marked for activity, location, and social contact, and rated on positive and negative affective states.

However, for studying the behavior of users in the living room we needed a complementary measurement, providing objective and quantitative data as well and allowing us to monitor users behavior with an even finer temporal resolution. We need a tool that would allow us to observe users at home, with minimal interference of the users daily life and without intrusion into their privacy. Essentially, we want to have lab-like measurements in the field, to eliminate lab-based influences on the user's behavior.

Lab-based studies have the advantage of a higher degree control, and the use of techniques such as video monitoring of user interaction, eye-tracking as well as other physiological measurements, while field studies have the advantage of being closer to the way users are likely to interact with technology.

The approach described in this paper should be a first step for blurring the boundary between lab and field-test studies for media usage in living room.

APPROACH
Since a majority of interaction in the living room is performed via a remote control (or as we can find in most households an accumulation of remote controls), we can achieve lab-like measurements of user interactions and therefore usage behavior through measuring and recording infrared (IR) signals.

Figure 1. IR measuring dongle with USB cable.

Each remote control is producing a distinct IR pattern for each key pressed, and this is what we are measuring and recording. We record the raw demodulated IR signal for post-processing in the lab. This eliminates the need to update the device for each new remote control, and keeps the hardware and its firmware as simple as possible. For being able to find out when exactly a button is pressed we are also storing a timestamp derived from built-in real time clock, allowing us temporal reconstruction of the remote control usage as recorded in the living room. But placing a device into the users home usually requires some extra issues to be considered: The device has to seamlessly blend into the users' already installed infrastructure. Users are usually reluctant if a device has to replace one of their own devices, or the researcher needs to rewire the whole home theatre equipment. This rewiring would take quite some amount of time, is error prone and even less likely to be welcome by a user. So the only viable approach, which we have chosen, is the "side-car" approach, to have a device sitting next to the users own devices.

IMPLEMENTATION

Figure 2 depicts the block diagram of the IR measurement hardware, which is placed in the households to record IR frames sent by all remote controls present in a room.

Most used IR protocols that are based on carrier-modulated pulses, exhibit a carrier frequency of 35-39kHz or 56-58kHz respectively.

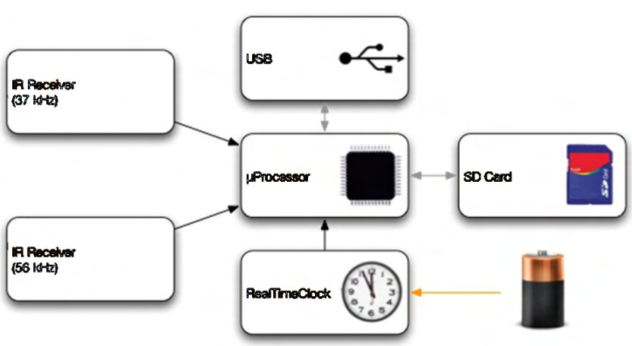

Figure 2. Block Diagram of the IR recording hardware.

IR receiver modules are available in a wide variety of carrier frequencies, although the passband of the bandwidth filters is usually big enough to successfully receive IR frames of carrier frequencies deviating from the center frequency.

Therefore, two IR receiver modules have been selected for the IR measurement dongle that exhibit a center frequency of 37kHz and 56kHz. These modules allow the detection of all carrier based IR protocols using these two frequency bands.

Protocols that are not carrier based cannot be detected by the IR dongle, but these protocols sum up to less than 5% of all still used IR protocols.

The IR modules filter the carrier frequency of the modulated IR signal and output a demodulated signal (see Figure 3). A microprocessor measures the timing for high and low states of the IR signal and stores those on a flash based memory card along with a timestamp of microsecond resolution.

Since we are very interested in the correct timestamp – which is configured once when the device is set-up – we wanted to make sure that under no circumstances this valuable datum is lost. Therefore, an external real time clock and calendar (RTCC) chip is used, that is additionally backed up by a large capacitor (SuperCap) and is able to keep the time and date for up to two weeks without external power supply by the USB interface.

For a rapid deployment of the IR dongle, we have developed software, which allows us to set the clock and read the contents of the memory card via USB.

This software further offers learning of the IR remote controls to match the IR pattern to the key pressed on remote control (Figure 4).

This information is used in a post-processing step after the IR dongles return from the households. The files with the recorded IR patterns are decoded using the data retrieved during deployment. This allows the analysis of multiple IR protocols without prior knowledge of the type of remotes used in a household.

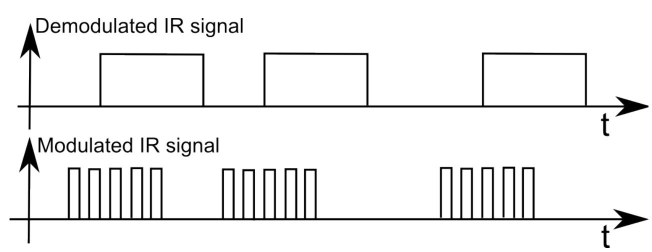

Figure 3. Modulated IR signal as received by the IR dongle. Demodulated signal as measured after the IR modules.

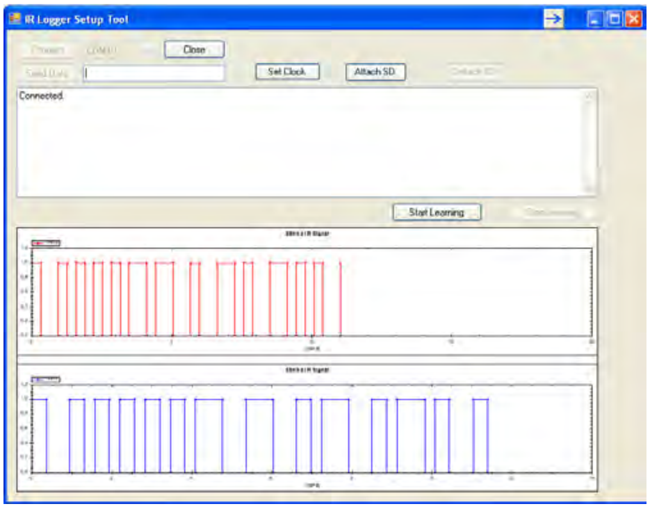

Figure 4. IR Logger Setup Tool used to set the current time on the IR dongle, as well as use it in USB mode to send the received signal to the computer for displaying it.

CONCLUSIONS

With this small recording device we can reveal media usage patterns within a household, as well as general patterns common to all the households in a region.

We can find out if a user belongs to the group of Zappers, Loyals and Casuals (as characterized by Jenkins [3]) Zappers constantly shift channels and essentially only watch snippets of shows. For them the fast transition from one channel to another or from one type of content to another is essential. Loyals cherry pick content and spend more time socializing about their shows. They are the series watchers and are more likely to record shows on DVRs. Hence, the capability to easily record and navigate through recorded content may have high value. The Casuals have elements of both: they wander away from boring shows and will have a tendency to multitask until they find a show that attracts their attention.

This IR recorder enables us to optimize remote controls, since most of them are just there to fulfill one or two functions. Imagine a typical system with TV set, Hi-Fi system and set top box (STB): usually all tree devices are powered on, but then only the volume is changed with the Hi-Fi remote control, while the TV channel is switched with the STB remote.

FUTURE WORK

The first field study using this IR recorder is currently conducted, but we have already identified some optional enhancements to the current recorder.

For future field studies we plan on recording additional signals and optionally add sensors. These sensors can measure bio-physiological values like heart rate or skin conductance.

Another improvement is to identify users interacting in the living room, by adding a camera and storing a video stream. But placing a camera into a living room causes privacy concerns, and so another approach is inevitable. A possible solution would integrate in the already working system: users can wear simple IR badges, which are repeatedly sending a unique pattern, which in turn can be recorded by the existing IR measuring device, and users within a household can be distinguished, while still guaranteeing anonymity.

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