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User Interaction Monitoring and Analysis Framework

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ABSTRACT

An overview is given of a user interaction monitoring and analysis framework called BaranC. Monitoring and analysing human-digital interaction is an essential part of developing a user model as the basis for investigating user experience. The primary human-digital interaction, such as on a laptop or smartphone, is best understood and modelled in the wider context of the user and their environment. The BaranC framework provides monitoring and analysis capabilities that not only records all user interaction with a digital device (e.g. smartphone), but also collects all available context data (such as from sensors in the digital device itself, a fitness band or a smart appliances). The data collected by BaranC is recorded as a User Digital Imprint (UDI) which is, in effect, the user model and provides the basis for data analysis. BaranC provides functionality that is useful for user experience studies, user interface design evaluation, and providing user assistance services. An important concern for personal data is privacy, and the framework gives the user full control over the monitoring, storing and sharing of their data.

CCS Concepts

•**Human-centered computing** → **User models;**

1. INTRODUCTION

Human-computer interaction (HCI) research ranges from cognitive science to designing and evaluating graphical user interfaces (GUIs). Current methodologies in HCI, including Activity Theory, User-Centred Design (UCD) [5], and Value Sensitive Design (VSD), aim to improve user quality of experience (QoE) by understanding users and determining their design needs. It is essential for these methodologies to understand users through building a user model based on monitoring HCI activities and thus learn about their design needs. Users interact with a variety of internet-enabled digital devices such as smartphones, smart appliances, ATM machines, cameras, coffee-makers, heating systems, etc. Most users are unaware of the variety and number of connected digital systems they interact with, and, in addition, users have little control over the bits of personal data that are collected and stored by various entities. The collection and modelling of personal digital interactions can, however, be beneficial as it can, for example, provide the basis for useful pro-active assistance services.

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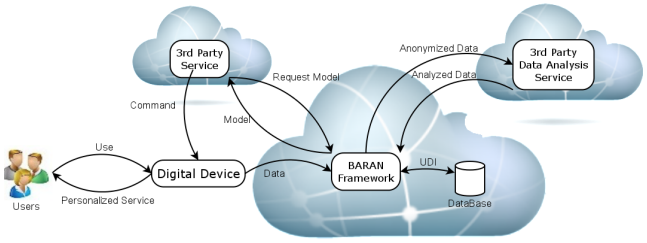

Figure 1: The Overview of the BaranC Framework

Some similar work is the Lifelogging user monitoring activity [2], in which a user's life activities (mostly physical activities) are tracked using wearable sensors and devices. This monitoring system tries to capture life moments, events, and activities. Using the framework, researchers proposed some ideas such as identifying people with dementia [6]. The privacy issue of Lifelogging is studied in [1].

BaranC has a similar but different focus to existing work. It is a user monitoring, modelling, and analysis framework that addresses similar challenges to existing studies but focuses only on the digital activities. It monitors and records the digital life of a user, in order to build a model of the user digital behaviour which can then be exploited in various ways. The users can gain insight into their own habits; application and interface designers can learn about the use of existing artefacts and get ideas for future designs.

2. BARANC FRAMEWORK

The original Baran [3, 4] has been re-engineered and reimplemented as a cloud-based, service-oriented, user monitoring and data analysis framework, BaranC. The framework is implemented in the Amazon cloud AWS and also supports IBM BlueMix, OpenStack, Azure and can be extended to support other cloud software. It transparently, efficiently, and implicitly records a user's activities and context data. It analyses the collected data, extracts information and knowledge from the raw data, and enables other IT systems to use the information in order to provide a better (e.g. personalized) services to users. The framework is built on the the data collection services that gather not only the user in-

teraction but also the data from sensors on the interaction device, sensors in the environment, smart watches, activity bands, and smart appliances. Different operating systems are supported - currently Android and Windows versions of the data collection service are provided. The data collection service records all data as User Digital Imprint (UDI) packages. The UDI is the important underlying data stucture and user model of the framework.

2.1 User Digital Imprint (UDI)

The User Digital Imprint (UDI) is a user model that underlies BaranC. It is a model with a manageable, flexible, and scalable data structure that holds various types of data and information. The main focus of the UDI is to record the user's *digital imprint* and by that we mean to record dynamic user interaction with digital devices. Thus when a user touches the screen when using an application all the information about this event is recorded in the UDI. Other events such as changes in values of sensors that are being monitored or start/stop events from a smart appliance would also be recorded in the UDI.

Beyond the basic collected data, as interpretation and analysis is applied to the data, the additional information is added to the UDI. The UDI model hierarchy therefore contains three levels corresponding to *Data*, *Information*, and *Knowledge*. Consider a scenario where Bob likes to drink a cup of coffee at home on Saturday mornings. In this example, the raw sensor values from a smart coffee machine are at the data level, the fact that this corresponds to making coffee is at the information level, and the pattern that the user, Bob, engages in this activity at home on Saturday mornings is at the knowledge level.

2.2 Service-oriented framework

BaranC is constructed as a service-oriented framework. Figure 1 provides an overview of the framework and how its components work together. In a basic scenario, a user is interacting with a digital device, such as a smartphone, on which the BaranC data collector service is installed (under user control)in order to monitor the user digital interaction and any required contextual digital data. The basic data collection service records all data as UDI packages, encrypts and compresses the data to reduce the communication cost, and then uploads the compressed data to the BaranC cloud-based service. It is important to note that users control the collecting, storing and sharing of their personal data in the UDI. They have full control on how, for how long, and to whom they share their information. The data analysis services of BaranC produce summaries and patterns of use reports which can provide insight to the user. BaranC's security service is another major difference with existing frameworks. This service provides secure data encryption options and allows users to choose a preferred encryption method.

Constructing BaranC as a service-oriented framework has allowed the framework to support its use by 3rd party services (see figure 2). In this scenario a 3rd party service is shown to provide personalized service to the user (e.g. by sending a command to the device) based on his/her model. Once the user permits BaranC to share the information with the 3rd party service, anonymised analysed data or the full user UDI model can be accessed by 3rd party service. For the previous example of Bob who likes coffee at home on Saturday mornings, consider that the coffee maker company would like to offer a personalized service. Analysing a user's data can allow the smart coffee maker to prepare the appropriate coffee drink at the appropriate time for the user. When the smart coffee maker is installed and registered by the user, the company can request the user's data from BaranC. If permission is granted by the user the user's UDI will then be shared with the company's analysis service. The service then analyses the data and the coffee maker can pro-actively provide services for the user based on his/her habits.

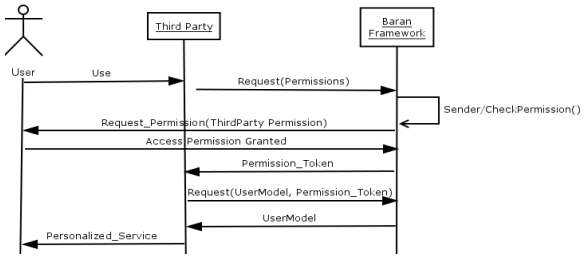

Figure 2: The Sequence Diagram of How a User Permit a 3rd Party Service Accessing the Data

3. CONCLUSION

An interaction-centred, user monitoring and data analysis framework, BaranC, has been presented. A comprehensive and dynamic user model, the User Digital Imprint (UDI) underlies the framework and records all data and derived higher-level information. The UDI provides valuable data that can be used directly by the user or can be shared with services that can be of benefit to the user. The collecting, storing and sharing of the UDI user data is kept directly under the user's control. Implementing the framework as a service-oriented system allows its services to be used in a very simple, direct and transparent way.

4. ACKNOWLEDGEMENTS

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