Self-monitoring of Emotions: a novel Personal Informatics Solution for an Enhanced Self-Reporting

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Abstract. Personal Informatics systems help people to collect personally relevant information for the purpose of self-reflection and self-knowledge. Moods and emotions are ones of the most complex data to gather, since a complete automation is impossible due to the need for a cognitive interpretation by the person. The goal of this paper is to present a novel Personal Informatics solution which overcomes some limitations in tracking emotions. To this aim, we propose a complex PI solution based on tangible interface and automatic tracking which support users in tracking their emotions with a limited cognitive load. Our initial efforts on these key directions will be described.

Keywords: Emotion tracking, Personal Informatics, Self-tracking, Tangible Interface

1 Introduction

"How do you feel?" can be a very difficult question to answer. Emotions represent fundamental components of human beings, encompassing physiological, affective, behavioral, and cognitive elements. Differently from moods, emotions are intentional, i.e. imply and involve a relationship with a certain object, and tend to be relatively short lived, while moods are experienced as more diffuse, general and long-term: while moods usually influence which emotions are experienced, emotions often cause or contribute to moods [15]. However, emotions are often contradictory and it is possible to feel different emotions, of different type and intensity, at the same time. Moreover, people tend to report about their emotions on the basis of their belief about them rather than experiences of them [1].

It can be useful to collect emotions for several reasons. Therapists often ask patients to keep track of their changing emotional states (together with other aspects of their daily lives), in order to help with depression and other mood disorders. Recording data helps doctors and patients better understand why symptoms occur, and whether the treatments are working or not. Moreover, people may desire to collect their emotions in order to simply know themselves better, or in order to find correlations among data that suggest a change of their behavior in a particular direction.

Now, new Personal Informatics (PI) tools [2] are making possible to track the ups and downs of people emotional states, and then to aggregate data through some forms of reasoning, feeding them back to user through meaningful visualizations. PI tools

track data on different aspects of the daily lives of people (e.g., heart rate, amount of calories burnt, skin temperature, kilometer run, sleeping hours). The data can be gathered automatically in a transparent way with respect to the user or can be self-reported by the user herself, depending of the types of data. It is simple to automatically track physical states (such as glucose level in the blood) or indicators of performance (such as the kilometers run) with the appropriate sensors, while it is almost impossible to collect other data (such as food or dreams). Emotions fall in this second category, since for their nature they are not suited to be automatically detected. In fact, they have a *physical* part (e.g. the arousal, i.e. the physiological reaction to stimuli, which causes changes in physical parameters such as blood pressure, heart rate, temperature), and a *cognitive* part, which interprets the physiological changes and classifies them in a specific emotion [1]. Even if there is a large amount of work trying to infer the emotions from the arousal measured by means of physical parameters, such as heart rate, skin temperatures, eye movements, etc. (see for example Affdex [3] and Emotient [4]), they can only track the physical component of the emotions, but not the cognitive one. Moreover, with the currently available technologies, automatic detection of emotions is very cumbersome for the user, since she must be equipped with a set of invasive devices (such as sensors or wearable devices, like bracelets, helmets, belts, etc.) that make the experience of collecting not natural and not easily applicable to everyday life.

For these reasons, and following psychological literature (e.g. [5]), users' *self-reporting* is necessary to track emotional states, capturing what the user has subjectively experienced. From this perspective, Personal Informatics technologies can be exploited for supporting the self-reporting process, even if they show some practical issues [6].

First, common users may not be so compliant in tracking their own emotions. This issue is also present in clinical settings, where the therapist compels the patient to track her emotions, as Li et al. [7] highlighted. Users can fail to self-monitor themselves due to lack of motivation and time or to forgetfulness.

Second, usually users tend to self-report data after the event to be recorded has occurred. In fact, often it is not feasible for the user to interrupt her activity in order to record what she feels. However, when user reminds of reporting the data, it is often too late to recollect the exact emotional states experienced. This is the case when beliefs trump feelings in self-reporting of emotions [1]. For example, beliefs about the influence of a particular situation (e.g., birthdays are happy), or generalized beliefs about the self (e.g., derived by trait measures of extraversion or neuroticism) or social stereotypes related, for example, to gender (e.g., women are more emotional than men) appear only when the actual experience is relatively inaccessible (later in the time). In fact, memory is reconstructive [8]: with the passage of time, a shift from relatively veridical memories to relatively schematic or stereotypical ones can be observed.

The goal of this work is to find a solution for tracking emotions which addresses these two issues.

First, we aim at *finding new ways for reducing the burden of self-monitoring*. A way for reducing these barriers is to make self-monitoring more fun and enjoyable. We propose to use *tangible interaction* to involve people in self-reporting their emotional states. Tangible User Interfaces (TUIs) leverage physical representation for

connecting the digital and physical worlds [9]. TUIs can remind people, by sheer presence, to insert data, motivating users in doing tasks usually perceived as repetitive and burdensome. In fact TUIs showed to be more involving than Graphical User Interfaces when a task is not appealing enough on its own [10], providing a more engaging experience, that can increase the number of repeated activities accomplished by the user [11]. Using TUIs, self-report can become a form of "physical activity", in which objects are manipulated playfully by individuals and contextually gather information about their emotional states.

Second, we aim at *supporting users in the retrospective reconstruction of emotions*. Since people's reports of their emotions reflect whatever information is accessible at the time [1], we aim at providing people with some hints in order to recall the experience where the emotions arose. We will provide user with some other contextual data automatically detected by sensors during the day (time, place, people), in order to recall her the situation in which she experienced an emotion. This would allows her to connect her emotional states to the places visited, the people met and the task accomplished, and, through them, remember what happened to her during the day and report more faithfully her emotions, in a way as much similar as possible to how it actually happened.

In this paper we present a *novel solution for tracking emotions* which reaches these goals. To this aim, we propose a complex PI solution based on tangible interfaces, enhanced with data automatically detected by sensors which support users in tracking their emotions, without a too much cognitive load in the tracking process. Moreover, the solution will be able to integrate all these data and, on the one side, provide users with a meaningful picture of them and, on the other side, find correlations among them. Moreover, we want to enhance the User Model with these correlations that can be used to provide user recommendations about her daily habits in a logic that tries to support her wellness and happiness.

The paper is structured as follows. It first presents a theoretical background of emotion self-reporting in psychology and a brief review on the related work dealing with tool for emotion tracking. Then, our proposed solution is presented and the work in progress is described.

2 Theoretical background

Clinical and experimental psychology has a long tradition in tracking people's emotions. However, emotional experience, defined as the conscious representation of changes in the states of the functional subsystems of the organism, represented by evaluation of an antecedent situation, physiological change, motor expression, motivational effects with prepared action tendencies and subjective feeling state, can only be studied via the introspective report of the subject [5]. In fact, even if it can be possible to obtain physiological measurements and objective measures of the behaviors expressed by the emotions, it is not possible to measure the way in which the subject experiences the physiological and behavioral changes other than through self-report [5]. In psychology several techniques are available for measuring emotions

through self-report. A common approach presents participants a checklist of adjectives asking them how well they describe their emotional states [12]: such lists can comprehend terms such as calm, nervous, bored. Another approach relies on dimensional theories of emotion and mood, asking people to rate one or more dimensions of their emotional states, such as arousal (activation) and valence (pleasant/unpleasant) [13]. Sometimes the instructions ask for reports of immediate feelings, sometimes for feelings experienced in a recent period, sometimes for feelings experienced over long periods [14]. However, questions about emotions and mood often refer to past emotional states relying on imperfect and biased memory; otherwise, asking a subject to self-report her emotions when they occur inevitably interrupts the experience [15]. In addition, questionnaires and more in general self-reporting activities commonly employed in psychology are burdensome and time-consuming, making difficult to imagine their usage in the everyday life of people that want to keep trace of their emotional states without having therapeutic motivations or impellent needs.

3 Related works on Emotion tracking

There are a number of applications, research works and technological tools for the emotion tracking, either self-reported or automatic.

Regarding *self-reporting*, a lot of systems collect user's emotions for therapeutic and rehabilitation purposes, such as Mobile Mood Diary [16], a mobile and online symptom tracking tool for adolescents with mental problems.

Commercial applications and devices (e.g., T2 Mood Tracker [17]) (see [18] for an overview) mainly aim at promoting a deeper self-knowledge through a visual exploration of the gathered data. Moreover, they are able to suggest patterns, trends and correlations between emotions changes and habits or occurred events. Other apps, like Mood Panda [19], have an additional social component: users can share their mood with friends and support one another. All these apps force the user to suspend her current task to interact with the phone and this makes tracking burdensome and annoying and the risk exists that in the long term the user gives up.

Many other systems *automatically* track users emotions, such as PSYCHE [20], a personal monitoring system based on textile platforms and portable sensing devices; Fractal [21], which is composed of some gem-like structures and detects wearer's muscle tension and movements, as well as the presence of near people, and adjusts the integrated LED lights pulsing accordingly and the Textile Mirror [22], which is a wall panel made of felt that changes its textural structure according to emotional signals coming from its viewer. An alternative way to detect user's emotions is to interpret facial changes. This is the approach adopted by Affdex [3] and Emotient [4] which is about to release a Google Glass app that analyses subtle pattern changes in a person's face.

Our solution supports users in self-collecting emotions by providing contextual information as hints for remembering emotions. This is different from other systems which are able to automatically collect contextual information and to suggest a relationship between them and the tracked emotions, such as the above mentioned

Mooditoode, which automatically detects position, and Emotion Sense [23], which correlates user's emotions with other factors such as time of day, location, physical activities, phone calls and SMS patterns. Anyway, they do not make the self-reporting activity easier since the user still need to interact with the app to explicitly declare her emotions. Our aim is to facilitate this task for the user, by making it straightforward with a tangible interface.

4. A proposal for a personal informatics system for tracking and remembering emotions

We propose a Personal Informatics system able to support users in self-reporting of emotions. The solution will have the following features:

- it will allow the self-reporting of emotions in an amusing, simple and appealing way by means of a tangible interface
- it will allow to automatically collect contextual aspects related to the emotions: location, time and people in the surrounding when the emotion occurs that will help users in recalling the emotion
- it will provide these contextual information to users to help them in live again emotions in a way as more similar as it actually happened
- it will be able to feed back to users a complex aggregated picture of the emotions of a period of time or of an experience, and correlations among data.

The idea is to create a portable, entertaining and, above all, not burdensome platform that will be composed by several parts: a mobile application on the user smartphone to automatically gather contextual data and some TUIs, i.e. a set of physical objects that the user can manipulate in order to communicate with the system. The TUIs, built on an Arduino board, are used by users to provide her emotions and the moment of the day. It has been decided to monitor 8 different emotions selected as primal emotional states. When user is going to report her emotions, she manually selects in the TUI the time in which the emotion is occurred and the system automatically recollects the context (place and people) in which that emotional state happened, inferring it by e.g. the GPS sensor of user's smartphone, users' social networks (Facebook, Twitter, WhatsApp, Google +), shared calendars (Google calendar, Facebook), etc. Moreover, the platform will be able to receive further information from other devices able to automatically detect physiological indicators (such as heart rate, body temperature, etc.). Data collected will be kept on the server and the user can browse her emotional history, having a representation of her emotional states through different points of view, and inspecting correlations among data.

Fig 1 shows the system architecture. It is composed of two TUI hardware components: the time module and the emotion module. The last one is the core of the system and one of its tasks is to manage the context information. To this aim, the context manager gets the time information that the user sets on the time TUI and infers the context taking into account information coming from different sources such as user's smartphone, social networks, PI tools, etc. Then, the emotion chosen by the user on the dedicated TUIs is collected by the data manager and sent to a remote server with the corresponding context for elaboration.

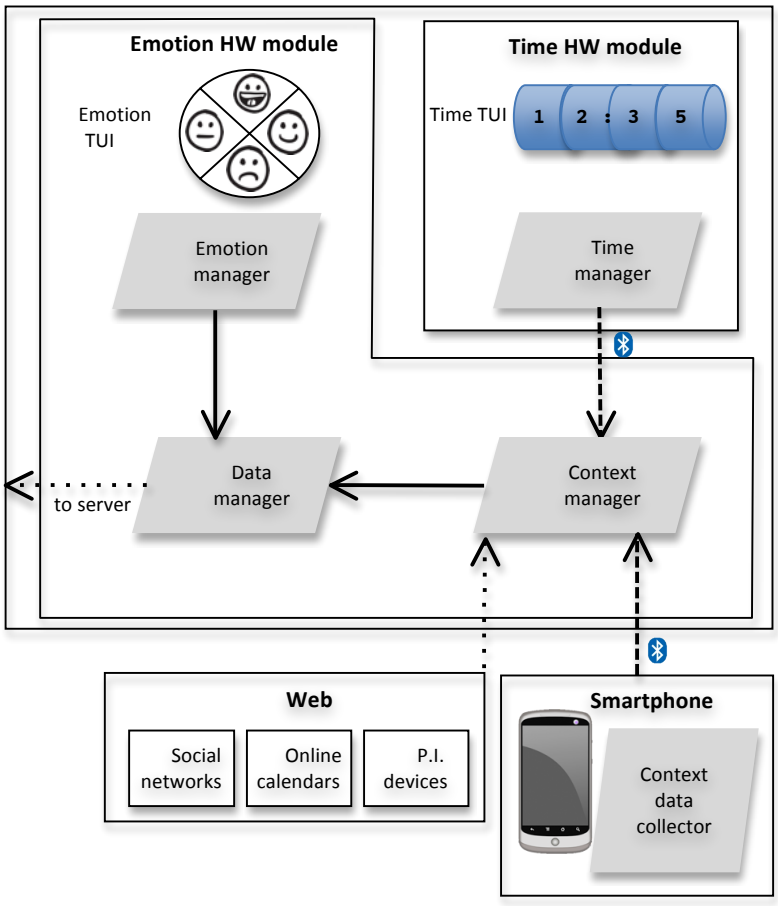

Fig 1. The system architecture

The emotion hardware module communicates via Bluetooth with the smartphone and the time hardware module and via WiFi/Ethernet with the remote server and the data sources exploited to infer the context (social networks, online calendars, personal information tools, etc.).

The final goal of the work will be the design of an enhanced *User Model* to be used for promoting behavior change in some directions (e.g. more healthy lifestyle): i) gathering heterogeneous types of user data (emotions from the prototype but also other data from sensors, from social web activities); ii) reasoning on the data in order to find aggregations and correlations, iii) providing users with personalized *recommendations* in accordance on the UM and meaningful *visualization of data* for rising awareness and motivating people in changing their behavior.

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