AN ARCHITECTURE TO SUPPORT WEARABLES IN EDUCATION AND WELLBEING

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ABSTRACT

Technological devices help extending a person's sensory experience of the environment. From sensors to cameras, devices currently use embedded systems that can be used for the main goal they were designed but they can also be used for other objectives without additional costs of material or service subscription. Emotional assessment is a useful tool for students' assessment of motivation and engagement on learning activities while it is also a valuable tool to evaluate elder mental status. On the other hand, the same devices are useful to monitor health risks in young and older individuals. The present work aims at tackling students' dropout, by emotional reasons, and emotional problems of elderly people, both considered serious cases as the dropout in South America and ageing worldwide. Considering the identified needs, it is proposed an architecture that aims at supporting people in the learning process while providing advice and ensuring support in case of permanent or temporary cognitive disabilities. The present research work is in merged fields of education within the scope of ACACIA project and elderly support within the scope of CARELINK project. It is proposed a technological solution, based on a wearable, that covers a wide range of ages and different cognitive stages.

KEYWORDS

Emotions, ECG, Wearables, Healthcare, Safety, Ageing

1. INTRODUCTION

The emerging field of internet of things is growing at a fast pace as it is expected that by 25 billion Internet-connected things by 2020 (Gartner 2015). Wearables are user centric devices that follow that line with an increasing adoption, with a rise in shipped devices from about 13 million in 2013 to 130 million in 2018 (Wei 2014). Those devices can be used for diverse purposes as in the case of fitness bracelets that can track a person's movement, sleep and infer burned calories and stress level. There are different configurations for wearable devices, like bracelets, clothing and even the smartwatches can provide wearable functionalities since the accelerometers measure physical activity and some use cameras to measure a person's heartbeat with a high degree of accuracy (Pelegris et al. 2010). Heartrate and skin conductance are both used to assess a person's emotional state (Luis-Ferreira 2015) (Lee et al. 2005). But there is also strong evidence that heartrate (HR) and heartrate variability (HRV) are related with a person's emotional states and may, per se, constitute a source of information about the person's emotion psychophysiology (Anttonen & Surakka 2005).

Emotions play a relevant role in humans' lives. Its importance relates with success and failure and augment or reduce cognitive capacities. Damasio states that 'We feel therefore we learn' to highlight the importance of affective and social neurosciences in education (Immordino-Yang & Damasio 2007). Diverse technics can be used to identify emotional status in a classroom and by informing the teacher or trainer about the class affective state while learning thus providing tools to actively promote the quality of the teaching environment (Sarraipa et al. 2016). With this in mind, it is possible to envisage that emotional evaluation can have a strong impact in preparing classes and managing the ongoing of a class, promoting the quality of the learning environment and preventing students dropout, a serious problem in many developing countries (Gutiérrez y Restrepo et al. 2016). On the other hand, it is possible, and desirable, to stimulate fitness practices and health monitoring. That is precisely the aim of most of fitness device and it became an area with multiple solutions but most of the times restricted to physical exercise. The balance can arrive while using the same devices explore other regions like the above mentioned, students' emotional status and collective affective reactions towards teaching environment. Beyond that, considering lifelong learning and elderly engagement in classes that aspect becomes also sensitive since demotivation plays an important role in elder disengagement from learning and other stimulating cognitive activities. It is possible to reason about physiological measurements in order to infer about a person's emotional state (Mauss & Robinson 2009). Those measurements, provided by the above-mentioned wearables and, in the same process, ensure the person's safety, in cases related with Alzheimer or other dementia cases as a surplus of the wearables in use. That is a path towards a rational use of all the data collected, by applying that to different purposes while using the same device and thus maximizing its utility and reducing expenses. In overall, the assessment behind the current work is that data generated by wearable devices is used for a main purpose, established by manufacturers, but it can be used for many other purposes. Among those purposes the present work elects emotional engagement to the learning process, in young and lifelong learners while providing health safety in case of impairments like those related to aging. The paper is divided in three main sections, this introduction presented the case to be addressed and the motivation, the second section presents an architecture that addresses those objectives and finally section 3 debates the results and prospects for future work.

2. AN ARCHITECTURE FOR TEACHING AND HEALTH

The architecture presented in this section has multiple finalities from coaching students and assisting the learning environment to assisting elder people while learning, in a lifelong learning strategy but also ensuring health safety and security. Those objectives are achievable without adding hardware and result from the exploitation of the flexibility of the architecture presented next in **Figure 1**.

The research question that motivated such architecture can be instantiated as; If we can use smartphones for emotional evaluation, helping students to outperform, supporting older people to perform daily routines while being cognitively stimulated, why not developing a system that does it all?

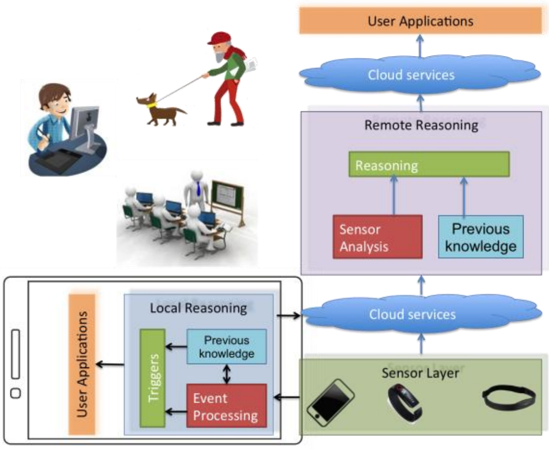

Figure 1. Architecture based on a smartphone for education, teaching and safety

In the proposed architecture, two approaches are considered; one that is a local system, contained in a smartphone, that is permanently monitoring the person and as a main function is ready to respond to health threats. The other is a system that uploads data to the cloud and can use data analysis and reasoning to feed more complex applications.

The Local System (LS) captures data from sensors being those of the smartphone supporting also others wirelessly connected (e.g. by Bluetooth, Wi-Fi). It relies on real-time measurements of heartrate for local assessment of vital signals so that emergency situations can be tackled immediately. It also uses known algorithms over heartrate measurements in order to provide clues about a persons' emotional state. The goal is not to characterize to detail a person's emotional state but rather tell if the person is unresponsive or with low response to external stimuli. As in what regards to students it can report their state of alertness or boredom thus providing clues to the teacher's system about the behavior of the class. These local applications are also able to provide feedback to web-services in a cloud where a more complete analysis is made and that will not condition the need for network access as data can be uploaded asynchronously. That is of particular importance as the system remains autonomous but while possible it uploads anonymized data. Services in the cloud will be used to improve algorithms and perform analysis of the classroom students' performance, or reason about a person's health status providing valuable feedback.

The Remote Reasoning System (RRS) is accessed by web services supported by the cloud and thus providing powerful tools that cannot be supported on a smartphone. The RRS also depends on connectivity that may not be accessible all the time due to location or strategy to preserve smartphone energy. The services on the cloud will perform analysis over the available sensors, with strategies of data mining, data extraction and sensory fusion. While the smartphone easily obtains HR measurements and performs HR, HRV analysis, other measurements can be executed (e.g. Galvanic Skin Response, Blood Pressure). Reasoning will be performed using previous knowledge that may include teachers' instructions or clinical guidance but also background knowledge on cognitive issues or clinical aspects. The analysis to be executed over the cloud can become available for diverse types of applications from health to education.

The sensors within a flexible sensor layer can be of diverse type; while in the local system they should be restricted those of the smartphone, in the remote system they can be of any type according to the objective to be achieved.

In overall, the system aims at using the available sensory capacity already embedded in smartphones, to diverse goals supported by the proposed architecture. The architecture is based on results already achieved in the scope of the ACACIA project (https://acacia.digital/en/) and the starting CARELINK project. While ACACIA supports education and prevents dropout in south America, CARELINK helps elder to perform their tasks safely by monitoring health and avoiding losing track due to dementia associated projects. The proposed architecture aims at providing a holistic solution both for young and old population, learning or just doing daily routines and preventing hazardous behaviors while monitoring health in older or young at risk.

3. CONCLUSION

The usage of wearable devices is becoming a reality that can be adopted in diverse societal domains including health, wellbeing and learning. The work hereby presented aims to address those mentioned areas, empowering the student's performance and the citizens health track while centered on the individual. The proposed architecture was partially implemented with results that encourage the continuation. It is also to mention that the pilot experiments made with students in the scope of this research work, correlate physiological measurements with emotions and are suitable to be integrated in the proposed framework (Kadar et al. 2016). As for the real impact of the work hereby described, it has been tested in pilot studies in universities of South American countries, in the scope of ACACIA project, with results that encourage its adoption tackling heavy numbers of students' dropout from university. Aiming at a broader utility, the present work is to prove that solutions can be of large spectrum on the opposite of the traditional reductionist approach focused on limited solutions. The present technological solution can be deployed for the student and grandparents supporting teaching or daily activities. It can be useful for young and old with physical or cognitive impairments while using devices as common as smartphones or not that common as fitness bands or smartwatches.

The results achieved so far are encourage the usage of emotional assessment to prevent dropout and stimulate students' learning activities. Future research will aim at designing nonobtrusive devices that can be used daily without minimum impact along with new methods, including data mining and machine learning, for determining emotional and behavioral changes and its impact on people's lives. Those objectives will be pursued in the scope of the CARELINK project and ACACIA project using cloud services and local deployments in the case that online services are not available.

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