SenseSeer Mobile-Cloud-Based Lifelogging framework

Rami Albatal, Cathal Gurrin
Jiang Zhou, Yang Yang, Denise Carthy, Na Li
CLARITY - Dublin City University
Email: rami.albatal@dcu.ie

***Abstract*—Smart-phones are becoming our constant companions, they are with us all of the time, being used for calling, web surfing, apps, music listening, TV viewing, social networking, buying, gaming, and a myriad of other uses. Smart-phones are a technology that knows us much better than most of us could imagine. Based on our usage and the fact that we are never far away from our smart phones, they know where we go, who we interact with, what information we consume, and with a little clever software, they can know what we are doing and even why we are doing it. They are beginning to know us better than we know ourselves. In this work we present SenseSeer a generic mobile-cloud-based mobile Lifelogging framework. This framework supports customisable analytic services for sensing the person, understanding the semantics of life activities and the easy deployment of analytic tools and novel interfaces. At present, SenseSeer supports services in many domains, such as personal health monitoring, location tracking, lifestyle analysis and tourism focused applications. This work demonstrate the design principles of SenseSeer and three of its services: My Health, My Location and My Social Activity.**

I. INTRODUCTION

Nowadays, standard smartphones contains multiple sensors and data capture devices that are becoming lighter, cheaper, more accurate and less power consuming. This integration of multiple sensing technologies leads us to believe that the mobile phone will become the de-facto Lifelogging device. In addition, the availability of free storage space in the cloud allows everyone to capture and store any kind of data to create his/her own data store or lifelog. In 2007, Sellen et. al. claimed that:*”Now, as never before, technology offers the possibility of capturing data from everyday life both continuously and unobtrusively”*[1], and this is indeed becoming a reality where new services allowing people log their own lives are now appearing. Many individuals are interested in self-tracking for better understanding their lives and for storing their experiences and their ”existence” for next generations. Associations and organisations are increasingly interested in understanding people behaviours, tendencies and lifestyles in order to improve the quality of life (like in the health care domain), or to discover and extract information that wasn’t available using the classical data collection methods (like in market research domain), or to propose advanced and customised services (like applications based on lifelong user modelling).

Our work presented in this paper addresses the challenge of building extendible and customisable cloud-based semantic analytic service for Lifelogging. We hope in the near future that all the efforts in Lifelogging domain will lead into a standardisation of Lifelogging frameworks architecture.

II. RELATED WORKS

Lifelogging applications can be viewed as context-aware applications. From this point of view we can find numerous mobile phone context aware data collection and aggregation applications that sample user context.

Among the first mobile-based Lifelogging applications was the Nokia Lifeblog project[2], this tool was a multimedia diary that collects all multimedia content and organise it on a Timeline and supports user querying.

The release of Nokia Lifeblog has inspired several applications, and new generation of mobile applications started to emerge and to integrate more sensing and logging functionalities. For a more complete survey about mobile phone Lifelogging applications please refer to[3]. Reality Mining[4] recored the location and social proximity using bluetooth sensors, as well as text message and calls in order to recognise social patterns and learn the social behaviour of people.

Some applications are designed for memory and reminiscence support, such as iRemember[5] and Pensive[6]. Mobile Lifelogger[7] and CenceMe[8] are based on a similar system design using multiple sensors to capture raw data and analyse it on a server back-end in order to extract the user’s physical activities and selected life patterns.

UbiqLog[3] is a generic mobile phone based Lifelogging framework that focuses on the collection stage and does not explore semantic analysis point-of-view in much depth. UbiqLog work is novel as it constitutes a step toward the standardisation and the adoption of unified principles of Lifelog data collection. SenseSeer and UbiqLog both are concerned with describing the design principles of Lifelogging mobile application and we will extend some principles to cover the back-end side and the data semantic analytic tools.

Among the major efforts toward a standard open-source sensor management tool is the ”Funf Open Sensing Framework”[9]. Funf provides an open source, reusable set of functionalities enabling the collection, uploading, and configuration of data signals accessible via mobile phones. SenseSeer mobile application is inspired from the Funf Framework and adopt its principles of sensor access and management.

Most of the presented state-of-the-art work focuses more on the data collection step or provides an ad-hoc data analytic and semantic extraction methods. As a result, data analytics is often considered a second priority activity. In this work we focus more on the data analytics and semantic extraction from lifelog data; within SenseSeer, we consider both to be inseparable

components of any Lifelogging framework. It is true that the data collection is the first and the major step in Lifelogging, but raw data and low level metadata can not constitute A sufficient source for indexing and exploring the life-logs by themselves. In addition, not all of the raw data is meaningful, and a relevant data analytic step can extract additional semantic information that could allow for more meaningful and advanced querying and exploration of the life-log.
In the next section we will introduce SenseSeer Lifelogging framework, then we present three among its services: ”My Health”, ”My Location” and ”My Social Activity”

III. SENSESEER LIFELOGGING FRAMEWORK

SenseSeer is a mobile-cloud-based Lifelogging framework, i.e. it is uses mobile phones to collect Lifelogging data and it stores much of this data on a cloud server. It comprises three engines:

1) Collection Engine: a mobile application (currently available for Android mobile phones), responsible for the collection of multi-sensor data and upload it to the cloud. The architecture of SenseSeer collection engine is similar to the one of UbiqLog framework [3] and uses the same sensors running strategy of Funf Open Sensing Framework [9].
2) Capture Engine: A web service installed in a cloud server, in charge of receiving the collected data from the mobile phones and save it in an appropriate format and organisation.
3) Semantic Engine: A web service installed in a cloud server, responsible for data analysis and semantic extraction, it uses several reasoning, machine learning and statistical analysis algorithms.

Figure 1 shows the architecture of SenseSeer framework.

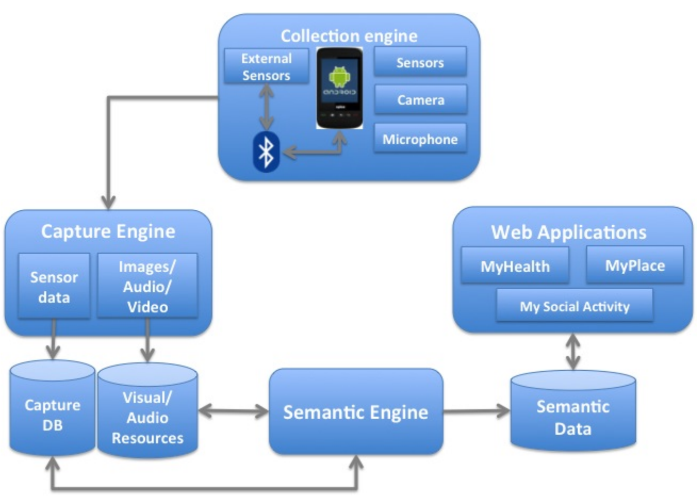

Fig. 1. SenseSeer architecture overview (without authentication modules)

IV. DEMONSTRATOR: SENSESEER USE CASES

A. My Health

”My Health” is a personal healthcare-oriented web application. It allows the user to track his physical activities and visualise them on a user friendly interface. It uses accelerometer sensor data as primary input resource, My Health analyses and classifies these raw sensor data in to human recognizable physical activities. The interface is displayed to end users through a mixture of visualizations consist of number grids, pie charts, and timelines. In addition, a calorific burn identifier is also developed for the platform. Users are able to interact with the interface to find out more information about their data. The key semantic outcome of this work is the activity recogniser for physical activities, the calorific expenditure calculation and the personal wellness score calculation, all of which were developed to address the needs of the Quantified Self users.
The Lifelogging perspective on the healthcare-oriented applications provide a much finer and more precise view on the user healthy or unhealthy activities, which allows to allows to identify the week points and the health challenges more clearly, then to propose more effective solutions.
Other than the personal point-of-view on this kind of application, taking a view of the data of many users can lead to population-wide epidemiological studies. Global goals can be set to address the obesity problems for example, and exploring such kind of continuous daily data for many people can give a better understanding of the problem and lead to propose advanced solutions.
In addition, the fact that the semantic data are hosted in a cloud server allows users to share this information with other parties, such as his doctor. Alarms can be set to be triggered when the caloric expenditure or the heart rate or the blood pressure[1] of the user reach certain threshold; and when the alarm is trigged an intervention from the doctor could occur. In other cases, the consulting might not be necessary if the records of the users seems to be fine.

B. My Location

Uses GPS, and network location sensors data as the primary resource. It records the geolocation information about user’s daily as well as weekly activities. This demonstrator groups and aggregate users data into word cloud based on the ranking of frequency from user’s location log information. The network location data is used in Android phone whenever there are visible WIFI networks, despite that the network location is less precise than the GPS measures it reduces significantly the battery usage of the mobile phone. So we use normally the network location and we adjust it by taking GPS measures every predefined period of time (one minute for example). The usage of GPS or network location depends on the need to be precise or not. The SenseSeer mobile application offers the possibility of adjusting the precision of location measures.
A wide range of services can be based on such services with a big social impact. If the data upload is programmed to be done with high frequency, applications for emergency response can improve the quality and the efficiency of emergency responses and health-care interventions for example.
Again, from a collective point of view, the urban planing and development can take big profit of such applications by exploring the geo-temporal data of people in the cities or on the highways. Better transportation and construction planing and optimisation is possible.

[1] The hear rate or the blood pressure can be logged using external device connected to the phone by Bluetooth.

C. My Social Activities

This is an advanced use case based on multiple sensor data and multiple semantic extraction techniques. It uses all the sensor data collected by the mobile phone and the goal is to extract advanced activities and display it to the user on a dynamic map view where he can control the time frame and filter his activities and retrieve them. Not all the activities or the semantic information can be formally defined, for example: ”Relaxing” is a subjective estimation so we use here a very general definition of relaxing like ”sitting in a quiet environment outside work and outside the average sleeping hours”.

Some activities are straightforward to detect and need one type of sensor data, e.g. ”walking” activity detection is based only on accelerometer data; other activities need more complex analysis and has to be based on several type of data, e.g. ”housework” need first to detect that the user is at home (using GPS data analysis), then need to detect that the user is moving (using accelerometer data analysis) then need to check if the user is in a relatively noisy environment (using audio noise information). Our goal is to be able to detect fifteen out of the sixteen (all except the first one) must frequent life activities mentioned by[10] and displayed in figure 2. These

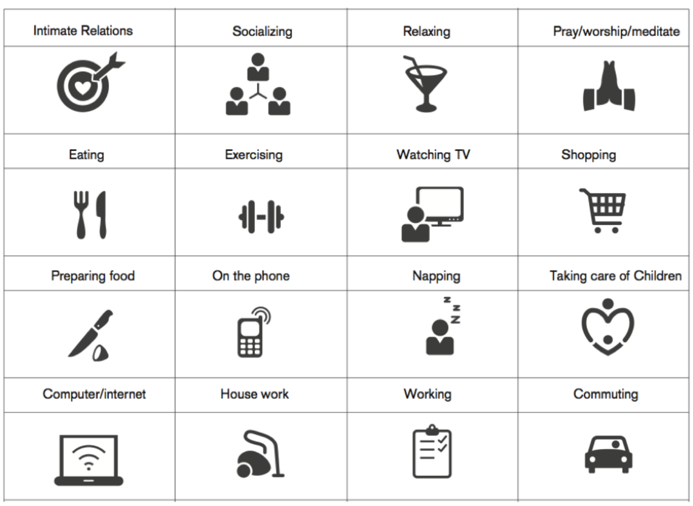

Fig. 2. The sixteen must frequent activities by decreasing order from left to write and from up to down[10]

activities allow the user to discover his lifestyle and to query his social activities and share it and compare it with others. Maybe someone can search for ”People like me” when he is moving to a new city. Some lifestyle pattern can be extracted and used to propose activities to the user or to join him with others. Social event, gatherings, dating can be influenced by the introduction of such automated lifestyle extraction application. From the collective point-of-view, the continuous data collection and activity recognition can lead to a very advanced behavioural analysis. Market research, touristic agencies, governmental and non-governmental organisation can use this source valuable information about the society, the individual and the collective lifestyle and interaction.

V. Future directions

We are planing to increase the number of supported sensors in the collection engine via Bluetooth connection and new activity recognition algorithms based mainly on machine learning for image analysis. We will also go toward providing an API to allow third parties to construct their own services by choosing which activities they want to recognise and how to display it on the front end user interface.

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