Prosthetic Memory: Object Memories and Security for Children

Juan Antonio Álvarez García
University of Seville
jaalvarez@us.es

Luis Miguel Soria Morillo
University of Seville
lsoria@us.es

Juan Antonio Ortega Ramírez
University of Seville
jortega@us.es

Ismael Cuadrado Cordero
University of Seville
icuadrado@cica.es

ABSTRACT

Children younger than 3 years old are very special humans, their psychomotor and social development is very fast and parents and relatives would like to know every new detail (when, who, where, what, how and why) in real time. These news are difficult to remember and some kind of diary is needed. Here we propose a "prosthetic memory" based on Digital Object Memories applied to Web of Things using hidden NFC tags in children's clothes, mobile applications for smartphones and a central server to store the ontologized information.

Keywords WoT, object memories, NFC, prosthetic memory.

INTRODUCTION

Ubicomp deployments have the potential to monitor almost every person using sensors or mobile phones who wants or need to be monitored. However this technology is hard to introduce in babies or very young children who are healthier. Furthermore parents and relatives of children from 1 to 3 years would like to know every little detail on psychomotor and social development and health state. Due to our rush live, the interactions with our children are non-continuous and we trust on kindergarten teachers and relatives, implying the need to ask to third persons about the child activity during this time.

To overcome the difficulty to access to the memory of a child from 1 to 3 years and the retard and lose of information that verbal interactions with another produces and to exploit the monitoring and supervision capabilities that technology offers in this sector of the population, a hybrid model has been created. This model, halfway between "Internet of Things" and "Internet of Persons", will introduce the child in a technological environment in a bit intrusive way. This immersion will make parents, families and educators to establish a communication and a prosthetic memory about the individual.

In other words, the child will become an element of the paradigm of "Web of Things", on which all information concerning their education, behaviour and even positioning can be managed.

After conducting market research to capture the needs of parents, families and caregivers of infants, a model to collect and apply information on children indifferent areas has been designed.

The remainder of this paper is organized as follows. In next section, related work is introduced. Aims and scenario Section describes the objectives and illustrates them. Then infrastructure and profiles are shown. In next section security system is explained in depth. Finally, applications of the developed system and conclusions are drawn.

RELATED WORK

Our proposal is related to child monitoring and Life logging.

Monitoring healthy children has two main objectives: mobility surveillance [4] and activity monitoring [1,2]. In the first one, sensors such as GPS [7] are used to locate children typically between home and school transitions. In the latter, pedometers or accelerometers are employed to support physical activity and supervise obesity and sedentary lifestyles in youth [6]. Both research lines are focused on children from 6 years old in advance that travel to school largely independently, either on foot, by bicycle, or by bus. The devices used in these works are usually passive, designed to automatically record data without the need for user effort or intervention.

Life logging systems record passively almost every moment of our live, storing visual, spatial and/or verbal [7, 9, 9] information that can be queried in the future as a prosthetic memory. These solutions are focused in Alzheimer's patients.

Our approach differs from previous works both in user age: from 1 to 3 years old, recording type events: active, and objectives: creating a prosthetic memory very related to digital object memories in the Internet of things [5]. Technology employed is similar to Ervasti et al. work [3] where NFC cards are used to supervise school attendance. In this case most of the pupils said they kept their cards in their backpacks but in our case the tag is camouflaged in the child clothes. NFC passive tags are not intrusive and

according Ervasti work, parents seem enthusiastic and saw benefits in the increased availability of information that can be gained through these technologies.

AIMS AND SCENARIO

The aim of this work is to create a prosthetic memory for the child that takes into account all the major aspects of their environment, from education to health. Parents, caregivers and relatives will add the information to it through mobile interactions with a physic element in the child clothes: a NFC tag. Thanks to this system, it will be possible, among many other things, query about allergies or diseases, check the last location interaction with the child and the interactions with their social environment, detect cognitive abnormalities or behaviour at an early age or check the activities that students perform in the kindergarten.

When	Who	Where	What	How and why
24 May 2012 9:01	Mum	Kindergarten	Personal	Crying :(seems tired
24 May 2012 11:10	Rocío (Caregiver)	Kindergarten	Educational	Learning colours song
24 May 2012 11:10	Rocío (Caregiver)	Kindergarten	Health	Seems ill, 37.9ºC
24 May 2012 13:03	Unknown (trusted location)	Kindergarten	Health	Doesn't want to eat and vomits some of the food
24 May 2012 14:30	Dad	Home	Health	38.8ºC, 2.5ml antipyretic
24 May 2012 17:19	Pilar Grandma	See map link	Health	Query about last week health events
24 May 2012 17:24	Pilar Grandma	See map link	Health	Doctor sais it seems a 48 hour virus

Figure 1: events controlled by the proposed system and information stored about each one

These objectives are presented in the following scenario:

"Julia wakes up and her mum gives her bottle, dresses and takes her to the kindergarten. She brings her mobile phone closer to the hidden tag and, touching the NFC, includes a text message "Crying ☹ seems tired" in the Julia's system profile. Later her caregiver Rocío teaches a song about colours. She passes her mobile phone close to the 6 tags of their children and includes a message about the activity. Julia seems ill and Rocío puts her the thermometer 37.9ºC and includes this information again trough the hidden tag in Julia's clothes. Another caregiver tries to give her the food but she vomits so she includes the information closing her phone to Julia. Although her mobile phone is not authorized in the access list she is in the kindergarten and this place is a secure place for their parents.

When his father picks Julia up, he knows her symptoms and measures again her temperature: 38.8 ºC, he gives her an antipyretic and closes her mobile. After that, Pilar grandma that has configured an alert with all health information calls the parent to offer herself to go to the paediatrician with the girl.

When Julia arrives to the medical centre, her grandmother queries with her mobile Julia's NFC tag about last health events and shows them to the doctor. After doctor examines her and explains Pilar that it is only a virus, she includes the information. Immediately the mother and the father receive a twitter notification although they are in their work offices.

This scenario shows how the information is stored and how the relatives can configure alerts about some information and determine the media used to communicate (email, twitter, sms, etc.).

INFRAESTRUCTURE

The system enables the collection of information through a NFC tag camouflaged with a tissue motif (such as a flower or a car) in the child's clothes. Through this label, which stores an access point to a web XML descriptor, it is possible to query and insert data to the baby's information profile. Throughout this NFC tag and bringing close a last generation mobile with NFC reader, the app developed can change the state of the child prosthetic memories. This can be done if the user has permissions enough to access this information. By using NFC technology opposite to QR codes, bar codes or RFID, the system turns less intrusive, cheaper and more comfortable. In this regard, as previously mentioned, NFC technology can be hidden into any toy and stick to baby's clothes.

The proposed infrastructure has been conceived for its integration in an "Object memories" eco-system, which further expands the use that can be given to this information. In this way, information descriptor previously commented is stored in an Object Memories server adapted to the application proposed.

Due to this approach integrates object memories concept into a social environment, information stored must be secure. For this purpose, only authorised people by baby's parents can access to the information.

The kind of login is quite different to standard process. To assure that there is not password subtraction, each time a two steps login process is done. In first place, user fills the user and password field with his/her personal information. Once insured the user credentials, system request some information about the child. This information is introduced by the child's parent into the system and is changed each day automatically. This process makes intrusion derived from device or credentials subtraction difficult.

The system infrastructure is shown in *Figure 2*.

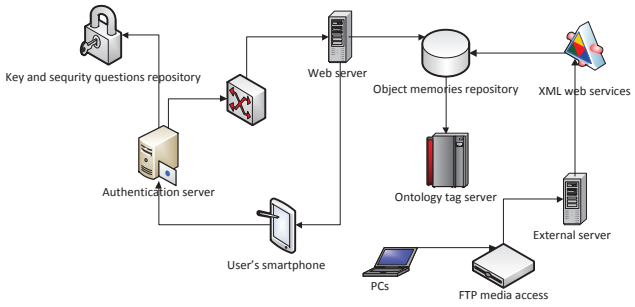

Figure 2: system infrastructure and dataflow information

INFORMATIVE PROFILES

In order to ensure the processing and display stored information about the child, information sections have been identified. These sections are shown in *Figure 3*.

Child's parents, i.e. system admin, could define different security profiles to each section. This is useful due to not all categories store information with the same privacy level. For this reason, some sections could be shared with every person, whereas other information can be presented to parents only.

Furthermore, by using these categories, specific information spaces can be defined. An information space is denoted as any region that has a specific purpose where every person and object inside shares the same kind of information. For instance, the kindergarten could be identified as an information space related to educational section and swing area as an information space associated to entertainment section.

In each section is included certain information taken out from OWL database. This database contains every information label that the system can store. Values of these labels are obtained throughout information provided by the system actors.

Must be noted that same ontology item could be present in various sections. For example, food allergies appear on public information or health information, and parent's name in educational and personal profiles.

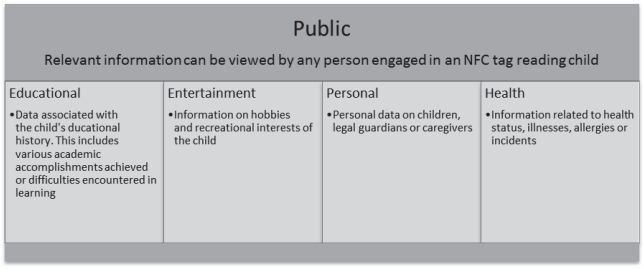

Figure 3: different kind of information that the developed system can store

Depending on the location includes the stored information may be visible to a specific group of devices or those devices that are located in a specific area. This makes it possible, for example, in the hospital to query and insert health information, but not educational information. From the point of view of privileges, access permissions of users to specific types of information profiles will be associated.

At this point, two access types can be defined: access by location or access by privileges. The second one has been presented previously but the first one is a new proposal of this work.

SECURITY

The main problem found when storing personal information on the prosthetic memory is security. While it is relatively easy to secure the information when an adult interact with a system, by using a supervised system of information exchange, in a baby is not possible.

In principle, the system is able to determine what information is possible to share with a particular device when it requires some information. In this sense, the system presents a dynamic behavior based on allocation of privileges by devices or spatial location. In this way, it's possible to share certain types of information with another user, provided the appropriate security conditions.

Here are the different methods of security associated with the information present in the system.

Device-based permission

In order to allow interaction with the prosthetic child memory, an access list composed by mobile devices identifiers and their user name is managed by parents. To manage easily this access list, when a new user reads and interacts with the NFC tag, an email will be sent to the parents asking permission to the prosthetic memory and they can allow query and/or insert information in some (educational, entertainment, personal and health) or none part of it.

Location-based permission

Although device-based policy allows a known device-owner interaction, sometimes parents must trust in places, i.e. home, kindergarten centre, relatives' house, etc. and in their inhabitants. In order to permit all the mobile devices interaction in a trusted location, parents can define some places in their access list. Geo-location is a very common capability in new mobile devices so the application will take this data and send in every interaction. If the device is not in the access list but the interaction is done in an allowed place, the interaction will be trust.

Interaction areas are recognized automatically by making an analysis from each user interaction and its location. When the system is running for a long time, access locations can be grouped in some clusters. Each cluster is defined as an interaction area. Obviously, at the beginning of the execution, interaction areas could be not well-defined, but this problem is solved when the system uses increases.

When there are enough interactions from one place, the system suggests parents to label it and asks if it is a trusted place. This avoids the manual inclusion of latitude and longitude of places and the "Where" data is stored with the label and not with a map link.

APPLICATIONS

Presented work can be applied to a large of fields related to child behaviour such as health tracking, interaction memories or information security. In the first place, results of this work have been applied to an educational pupil monitoring system. In collaboration with the company Kometasoft, some particular gaps and achievements in the

educational progress have been identified. These gaps are reached throughout activities make at classroom and at home. Automatically, child's goals are uploaded to his/her profile in the digital memories architecture. This allows parents to observe the progress of their children in real time and without having to be present at the school. Similarly, the school can use this information to carry out an educational pathway based on the curricular level of their students. Furthermore, developed system is really useful to detect educational problems in an early stage, deviations from the proposed pathway and shortcomings in the catalogue of activities carried out for the development of a specific task.

On the other hand, a social profile that allows parents, relatives and authorized personnel to see a timeline with milestones, incidents or curiosities of the child is being developed. This timeline allows storing all kinds of information relating to the child, and even adding multimedia to such information. Thanks to this application, parents can see when his/her baby said her first word, add a video to the input or determine the date when the first tooth came out with a picture of the event. Derived from this is possible to create an album with the different events that have occurred over the child's life.

In this section two applications that make use of the proposed digital child memories have been exposed. Indeed, a large number of applications are in mind to be developed and to enrich entities managed by the system.

CONCLUSIONS

Although this work is more related to Web of Things than Internet of Things because parents will reject including electronic devices in their small children, there are diverse issues that are interesting at this workshop:

- The proposed infrastructure captures information in a distributed manner (through multiple mobile phones) but organizes, stores, and exploits the kid-related information in a centralized Web Server.
- Memory Content Representation and Modelling: This development uses an ontology for memory content items including health, psychomotor development, places and people that interact with the child, but we are open to discuss standards and best-practice knowledge concerning the representation of object-related knowledge.
- Data Mining: Information stored in a digital object memory can be analysed in order to discover typical usage patterns or anomalies. Our system suggests labelling places when the interaction is enough but due to the large number of interactions stored, much more information can be obtained, such as the kind of interaction patterns, the relatives' personality or the child habits.
- Privacy and Legal Aspects: Health and privacy here are very important concepts. First of all, in Spain mobile phones are allowed to use in a kindergarten. Interactions are tracked using parent authorization and secure spatial location.

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