Tele-Care Mobile Sensing Systems: Technical and Social Barriers

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INTRODUCTION

The e-Health is the practice of healthcare supported by *Information and Communications Technologies* (*ICT*) (Oh, Rizo, Enkin, Jadad, Powell & Pagliari, 2005). One face of e-Health is Tele-care that helps the physicians to tele-monitor the patients using Web technologies for designing and implementing new and exciting services for citizens with improved 4G wireless access (Kyriacoul, Pattichis, Pattichis, Panayides, Pitsillides, 2007) and smart mobile telephones to use services any time and any place. Modern enriched mobile Web interfaces help to use mobile tele-care (m-tele-care) that was envisioned by Istepaninan and Lacal (Istepanian & Lacal, 2003) and refined by Klasnja and Pratt (Klasnja, Pratt, 2012). Web interfaces have led to many subsequent implementations. An example of rich Web interfaces for m-tele-care demonstrated the applicability of m-tele-care to smoking disease (Macías, Suarez, & Calvo, 2013), which is the first cause of avoidable morbidity and mortality in the developed world diseases (WHO, 2001). The Body Area Network and its key component Wearable Light Device of Complete Ambient Assisted Living Experiment system are in charge to control the mobility of elderly people and their biological variables (Rocha, et. al., 2013).

Mobile sensing is a relatively new technique used to solve cooperatively a sensing problem using Mobile Internet (Lane, Miluzzo, Lu, Peebles, Choudhury, Campbell, 2010). The main element in a mobile sensing system is a smart mobile telephone that behaves as an access point for sensors to Web. Moreover, a smart mobile telephone could be a complex multiple-sensor element. Mobile sensing applies for several domains: weather prediction, environmental degradation, energy saving… However, up to our knowledge it has not applied for m-tele-care in the area of infectious disease early control. Modern m-tele-care systems includes mobile smartphones for sensing (Postolache, Girão, Ribeiro, Guerra, Pincho, Santiago & Pena, 2011). Infectious disease in the developed World outbreaks periodically every 4 to 6 years threaten public Health. The control of this kind of disease is very complicated and jeopardizes not only the public Health system but also the entire social and politic system of countries. It is very important to provide solutions to this complex problem. For this reason, we have applied the mobile sensing theory to m-tele-care to provide novel and initial ideas to achieve the early control of outbreaks.

In this chapter, we first present an overview of mobile sensing systems and its application to the control of infectious diseases domain. We argument the possibility that lay people to implement rapidly open hardware for sensors and applications for mobile smart telephones for a particular (traditional or new) infectious disease. We show that the state of the art in technology allows implementing rapidly a Web server or cloud service to process rapidly the data sensed by people. The main social benefit is that

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rapid detection of outbreaks can be detected and informed to responsible of Health. This allows early controlling the outbreaks and achieving a control official plan. We present our model to develop the mobile sensing system and present technical and social barriers.

The organization of the rest of this chapter is as follows: In Section 2 we present a review of mobile sensing applied to m-tele-care of infectious diseases. In Section 3, we propose a framework for rapid developing of mobile sensing systems applied to infectious diseases and we identify different technical and social barriers. We present further research directions in section 4. Finally, we summarize some conclusions.

MOBILE SENSING SYSTEMS AND INFECTIOUS DISEASES

A mobile sensing system is composed of a mobile smart telephone which is responsible of controlling the sensors (Macias, Suarez & Lloret, 2013); a Web Server that stores the sensed data and makes the fusion and learning processes; and the protocols and services based in modern cloud and social networks.

The objective of personal health mobile sensing (people-centric mobile sensing) is to measure biological variables of runners, fitness, control the daily calories, weight, sleep, nutrition habits (Handel, 2011) (Liu, Zhu, Kenneth, Seng, 2011)… It often consists in a mobile application that optionally publishes information in a social network. Traditionally elderly (Maaser & Ortmann, 2010) and home care (Sashima, Inoue, Ikeda, Yamashita & Kurumatani, 2008) also used sensors to monitor patients using *Java Specification Report* 256 (*JSR 256*) (JSR, 2014) software to control sensors and *Bluetooth* or *Wireless Fidelity* (*WiFi*) technologies to communicate with sensors (Ghose, Bhaumik, Das, & Agrawal, 2012).

The objective of participatory or social mobile sensing is to organize a campaign of sensing to cover the sensing of a geographic area. Collaboration among sensing people is mandatory to accomplish the objective of sensing. For example, Yang et. al. (Yang, Yang, Luo, Gonga, 2009) described the control infectious diseases after an earthquake done by the China Government distributing more than 600 mobile telephones among Health professional. However, the mobile telephones only reported information to a Central of control. We consider participatory mobile sensing system in which people in a determinate geographical area do personal sensing while do their normal live (MIT, 2014). The kind of sensing is discontinuous (for example, every certain amount of time). The Web server will receive health-sensed data, which fuses and learns how to early control the infectious disease. The server would warn Health authorities about an outbreak in a determinate geographic area. The fuse and learning processes demand the formalization of epidemics. Hethcote (Hethcote, 2000) presented a wide study of different models for different diseases. Khöler and Trifa (Köhler, &Trifa, 2007) presented initial ideas for applying mobile smart telephones for sensing infectious diseases data. They reviewed issues such reliability of sensed data, privacy and the minimum size of participating group. We in this chapter present initial ideas about a novel model for m-tele-care presenting a schema for rapid developing of the mobile sensing system. Madan et al. (Madan, Cebrian, Lazer, & Pentland, 2010) developed a study of identification of the behavior changes reflected in mobile phone sensors, when individuals suffer from common colds, influenza, fever, stress and mild depression. Our model is general and it is applied for any infectious disease rapidly implementing sensors and software in the mobile smart telephone and the server.