Chapter 21
Ambient Intelligence and Pervasive Architecture Designed within the EPI-MEDICS Personal ECG Monitor

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ABSTRACT

Recent years have witnessed a growing interest in developing personalized and nonhospital based care systems to improve the management of cardiac care. The EPI-MEDICS project has designed an intelligent, portable Personal ECG Monitor (PEM) embedding an advanced decision making system. We present two of the ambient intelligence models embedded in the PEM: the neural-network based ischemia detection module and the Bayesian-network risk stratification module. Ischemia detection was expanded to take into account the patient ECG, clinical data, and medical history. The neural-network ECG interpretation module and the Bayesian-network risk factors module collaborate through a fuzzy-logic-based layer. We also present two telemedicine solutions that we have designed and in which the PEM is integrated. The first telemedical architecture was created to allow the collection of medical data and their transmission between healthcare providers to get an expert opinion. The second one is intended for improving healthcare in old people's homes.

INTRODUCTION

Recent years have witnessed a growing interest in developing personalized and nonhospital based care systems to improve the management of cardiac care (Axisa, Schmitt, Gehin, Delhomme, McAdams, & Dittmar, 2005; Campbell et al., 2005; Kerkenbush & Lasome, 2003). The reason behind such interest is due to the fact that cardiovascular diseases now represent the leading cause of mortality in Europe and reducing the time before hospitalization is crucial to reducing cardiac morbidity and mortality (McMurray & Rankin, 1994; Task Force Report, 1998).

Event recorders and transtelephonic ECG recorders are thus increasingly used to improve decision making in the prehospital phase. However, such systems are usually unable to capture transient ECG events such as infrequent arrhythmias or ischemic episodes. In addition, all these systems require setting up new information technology infrastructures and medical services and need skilled personnel to interpret the ECG and make decisions for the patient care.

This approach has thus proved to be very impractical for patients with infrequent symptoms such as arrhythmias and ischemia that represent 85% of the cardiac diseased patients, and would be very expensive if adopted for every citizen at risk.

The European project EPI-MEDICS has designed a solution based on the interpretation of ECG derived cardiological syndromes and developed a friendly and easy-to-use, cost-effective intelligent personal ECG monitor (PEM) (Rubel et al, 2004; Rubel et al., 2005). The device (Figure 1) is capable of recording a simplified 4-electrode, professional quality 3-lead ECG, to derive the missing 5 leads (V1, V3… V6) of the standard 12-lead ECG (Atoui, Fayn, & Rubel, 2004), to store the derived 12-lead ECG according to the SCP-ECG standard (EN 1064, 2007), to analyze and interpret the recorded ECG, to detect arrhythmias and ischemia or acute myocardial infarction, and to send an alarm message to the appropriate health care providers.

To develop the PEM software platform, we were confronted to a variety of problems related to the system intelligence and functioning: from recording and storing the ECG according to the

Figure 1. The personal ECG monitor (PEM) device allows for early detection of arrhythmia and ischemia in the pre-hospital phase and thus for better and more adapted treatment