Chapter XV
Context–Aware Task Redistribution for Enhanced M–Health Application Performance

Hailiang Mei
University of Twente, The Netherlands

Bert-Jan van Beijnum
University of Twente, The Netherlands

Ing Widya
University of Twente, The Netherlands

Val Jones
University of Twente, The Netherlands

Hermie Hermens
University of Twente, The Netherlands

ABSTRACT

Building context–aware mobile healthcare systems has become increasingly important with the emergence of new medical sensor technologies, the fast adoption of advanced mobile systems, and improved quality of care required by today’s patients. A unique feature of our mobile healthcare system is a distributed processing paradigm whereby a set of bio–signal processing tasks is spread across a heterogeneous network. As well as applying the traditional adaptation methods such as protocol adaptation and data prioritization, the authors investigate the possibility of adaptation based on dynamic task redistribution. In this chapter, the authors propose an adaptation middleware that consists of a task assignment decision mechanism and a task redistribution infrastructure. The decision mechanism represents task
assignment as a graph mapping problem and searches for the optimal assignment given the latest context information. Once a new assignment is identified, the member tasks are distributed accordingly by the distribution infrastructure. A prototype implementation based on the OSGi framework is reported to validate the task redistribution infrastructure.

1. INTRODUCTION

Telemedicine has been receiving more and more attention due to its potential amongst others to tackle the resource challenges to the healthcare system posed by the aging society, by improving the quality of diagnosis and treatment and by reducing the costs of delivering healthcare (TelemedicineAlliance, 2004). Being part of telemedicine, mobile healthcare (m-health) is emerging along with the fast adoption of advanced mobile technology into daily life. Several m-health systems have been developed for mobile network environments (Halteren, Bults, Wac, Konstantas, & Widya, 2004; Hung & Yuan-Ting, 2003; Rasid & Woodward, 2005; Yuan-Hsiang et al., 2004), in which an m-health platform is introduced comprising a patient Body Area Network and some back-end healthcare service facilities linked by wireless communications links. On top of the platform, multiple applications, such as tele-monitoring and tele-treatment services, can be operated to provide continuous (24/7) mobile services to patients.

However, like other applications in a mobile environment, the performance of m-health systems can be seriously affected by context changes and scarcity of the platform resources, e.g. network bandwidth, battery power and computational power of handhelds (Halteren, Bults, Wac, Konstantas, & Widya, 2004; Jones, Incardona, Tristram, Virtuoso, & Lymeris, 2006). From a technical point of view, to solve this mismatch between application demand and resources, an appropriate context-aware adaptation mechanism should be embedded into the system. Satyanarayanan (Satyanarayanan, 2001) identifies three approaches to building such adaptation mechanisms: (1) task adjustment - this is to automatically change task behavior to use less of a scarce resource, e.g. scalable video transmission over wireless network; (2) resource reservation - this is to ask the environment to guarantee a certain level of a resource, e.g. QoS (Quality of Service) management and reservation techniques; (3) user notification - this is to suggest a corrective action to the user. The second approach assumes that it is possible to reserve sufficient resources for the task, which is sometimes unrealistic, e.g. the drop of network bandwidth could be so significant that the required data transmission quality just cannot be met. The third approach could avoid the mismatch by giving the patient suggestions or warnings, e.g. “Please stay near to a charging point to reduce the risk caused by draining battery power”. However, restricting users’ mobility in this way is a far from satisfactory solution. Therefore, we focus on the first “adjusting task demand” approach to tackle the problem in m-health of mismatch between demand and resources.

Previously, adjusting tasks was often performed within an isolated device, e.g. by a local application-specific adaptor (Badrinath et al., 2000). Methods applied in the past include data compression, discarding less important information and handover to a better network connection. The fundamental model common to remote monitoring systems consists of a set of bio-signal data processing tasks distributed across a set of networked devices. Therefore, one possible adaptation scenario is to exploit the distributed processing paradigm and adjust the assignment of tasks across available devices at run-time.
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