An Integrated Smart System for Ambient-Assisted Living

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1. Introduction

The paper was **motivated** by a need to take advantage of the new developments currently underway in TV Digitalisation Programme in South Africa [From Analogue] – to be rolled out by the end of 2013.

Important Themes include:

- Digital TV as a gateway to internet access, wireless mesh networks, motes and smart phones
- TV whitespaces [freed up TV & Radio frequencies] – (i) to provide needed broadband to boost internet penetration and (ii) to support AAL.
- This paper is on a low-cost technology customised to the South African environment to support ambient assisted living.
- *Increasing life expectancy leading to increase in population of the elderly – Hence the need to carry out R&D around Ambient Assisted Living* - AAL

2. Problem Statement

The need to extend the time that the elderly can live in their home environment by increasing their autonomy, security and to assist them carryout their daily activities calls for appropriate low-cost technologies to support ambience. There are many such systems in place, but each of these plays a limited role. Therefore we are moving towards designing an integrated system that incorporates features of a number of such systems. The architecture takes advantage of South Africa's TV digitalisation programme which is set to be in full swing by the end of 2013 when analog switch-off occurs. **The aim of this research is to come up with the design of an architecture to support AAL to both urban and remote areas of South Africa.**

Problem Statement

The question that this papers answers is:

- “what architecture of an AAL system that incorporates the features of a number of such systems can we come up with that would take cognisance of South Africa’s digitalisation programme?’

The approach

- The identification of AAL systems through a literature survey
- Analysis of the systems to identify features that would benefit our architecture
- Design of an architecture based on the identified features

3. Ambient-Assisted Living

Goals of AAL solutions are:

1. Improve the quality of life of the elderly
2. Reduce the need for external assistance
3. Reduce health care costs for the individuals and society

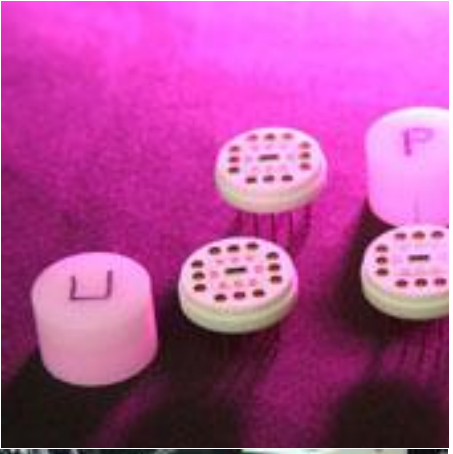
AAL covers a hybrid product [German AAL Standardisation Roadmap, 2012]:

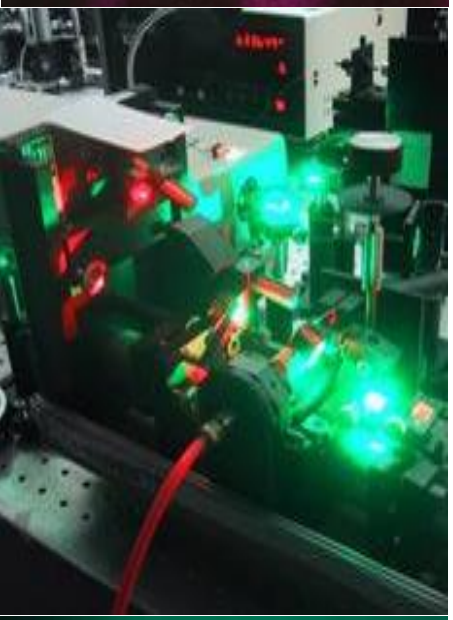
1. A basic technical infrastructure in the home environment (sensors, actuators, communication devices) and
2. services provided by third parties with the aim of independent living at home with assistance in the areas of communication, mobility, self-sufficiency and life at home.

Ambient-Assisted Living

The technical components of an AAL system are:

1. Fitting the user's home with ambient sensors and actuators,
2. Mobile components carried by the user (sensors on/near the body, mobile terminal devices)
3. The service providers' computing centre that performs external computing jobs and offers services such as remote maintenance, remote configuration, back-up or also an app-store with rechargeable software module on AAL systems, and
4. Third parties, i.e., those offering electronic services or services used by the AAL system without actually being part of the AAL system.





Ambient-Assisted Living

Support applications (Hiroko, 2004) e.g. healthcare service entails providing

1. Emergency treatment services
2. Autonomy enhancement service – independent living
3. Comfort services.

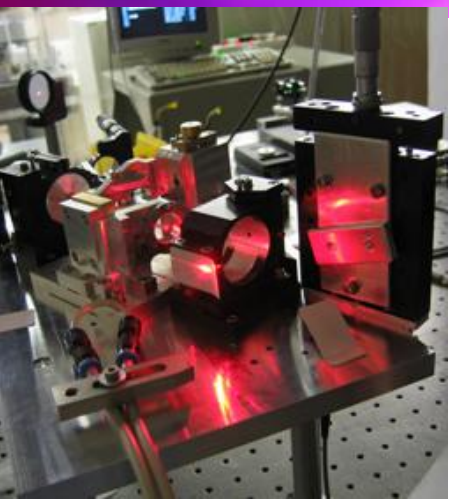
Enabling technologies (Pitta, 2006)

1. Sensing – anything, anywhere, in-body or on-body
2. Reasoning – collecting, aggregating, processing and data analysis, transforming them into knowledge
3. Acting – automatic control through actuators and feedback
4. Communication – sensors and actuators are connected to one or more reasoning systems which in turn might be connected to other reasoning systems or actuators and
5. Interaction – intelligent interaction of people within systems and services

4. Smart Systems in Ambient-Assisted Living

Definition:

"Smart objects are autonomous physical/digital objects augmented with sensing, processing and network capabilities. They carry chunks of application logic that let them make sense of their local situation and interact with human users. They sense, log and interpret what's occurring within themselves and the world, act on their own, intercommunicate with each other and exchange information with people" [Kortuem et al, 2010] .



Smart systems in ambient-assisted living

Examples of Intelligent environments

- **SenseWear armband** is a wearable body monitor and allows capturing body movement and energy expenditure Vitaphone is a mobile phone with integrated heart monitoring functions
- **Dr. FeelGood** is a combination of a PDA and mobile phone which measures various physiological functions
- S**martPillow** is an electronic monitoring device in the form of a traditional pillow: it checks user's basic vital parameters e.g. respiration, pulse, body temperature and in the case of an emergency or illness immediately and notifies medical personnel
- The **SmartVest** is a wearable physiological monitoring system that monitors various physiological parameters such as ECG, heart rate, blood pressure, body temperature and transmits the captured data along with geo-location of its wearer to remote monitoring stations

5. Components of the Architecture

- **Sensors** for information acquisition and dissemination. These sensors should be wearable. E.g. of such sensors are motes, RFID tags and QR codes;
- **Wireless communications** for connected environments. These include Bluetooth, near field communication (NFC), Zigbee, WiFi, 3G, 6LowPan
- Mobile technology for remote monitoring, emergency detection, activity logging and remote control of smart devices
- Predictive and decision-making capabilities (intelligence) to interpret the data acquired
- Intelligent devices to support intelligent actions, e.g. smartphones
- Notification of medical personnel, caregivers and relatives, e.g. sms, mms, RSS, Twitter
- Geographic location of patient via GPS
- Interactive TV with set-top-box as a gateway to the interne

Components of the Architecture

Broadband through Digital TV

- Broadband internet access is a high rate connection to the internet.

Wireless Mesh Networks

- A mesh is connectivity between two or more nodes in a network.

Motes

- A sensor node, also known as a mote, is a node in a wireless network that is capable of performing some processing, gathering sensory information and communicating with other connected nodes in the network. Motes are low power wireless sensor network devices.

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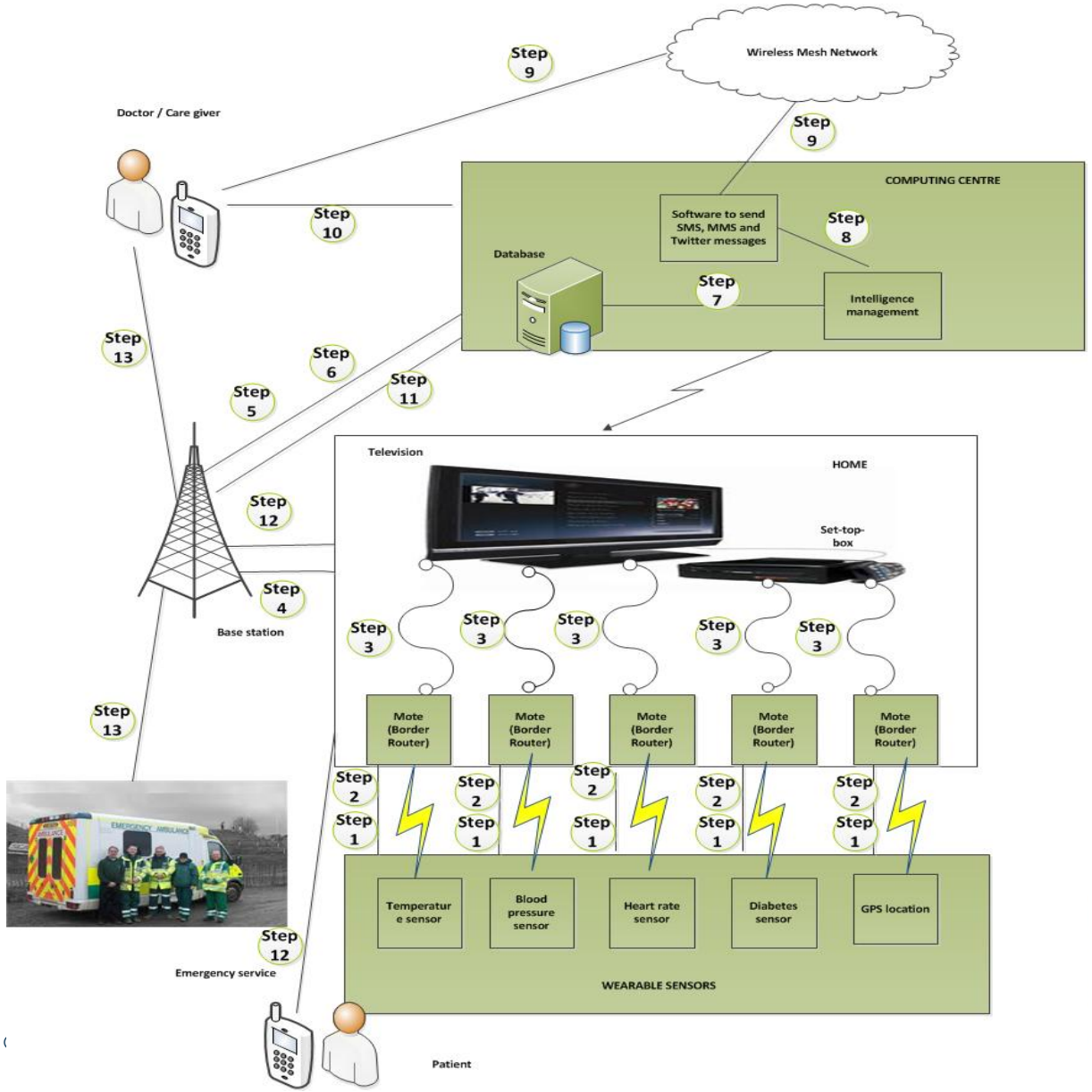
6. Architecture of the System

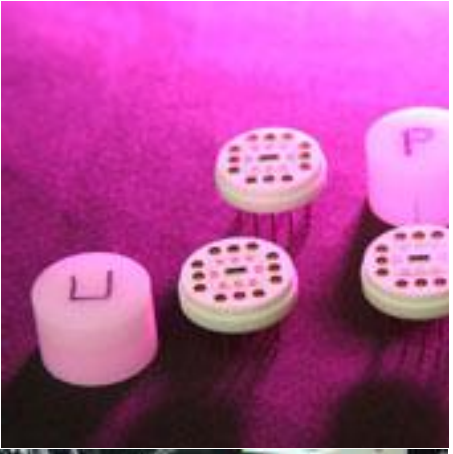
- The wearable sensors (motes) (as shown in Figure 1) detect various body parameters such as the body temperature, blood pressure, diabetes, heart rate, etc. Each of these sensors has a valid internet protocol (IP) address which makes it part of the internet, and also has a GPS location.
- These wearable sensors (motes) communicate with the motes in the house via mote to mote communication. These house motes, known as border routers, are connected by wire to a digital TV, which can read the border router's IP address.

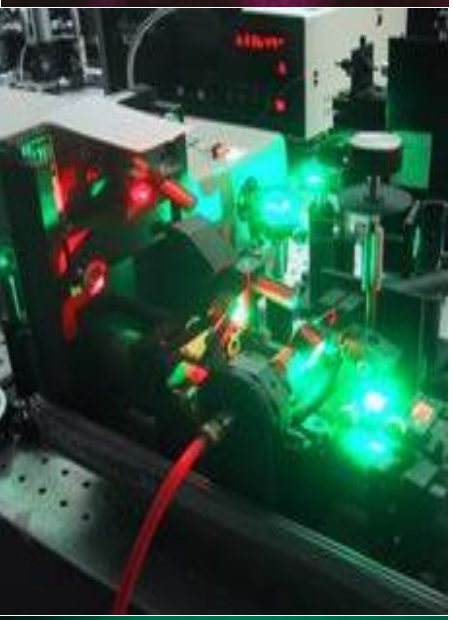
Architecture of the System

- The TV acts a gateway to the internet. The TV gateway's IP address is registered at the doctors', and so are the TV gateways for all the other patients' homes.
- The function of the digital TV can also be controlled via remotely
- The set-top-box (STB) converts analogue signals into digital signals for the older models of the TV.
- In this case, the TV acts as a gateway to the computing centre via a TV base station.
- The computing centre has a database which records data sent to the doctor from the sensors (motes) and doctor's response to the data received.
- The intelligence management software in the computing centre extracts data from the database, analyses it against set rules to determine the state of the patient.

Architecture of the system







7. Conclusion

- **The research was on the design of an architecture to support AAL**. There has been many systems in place to support AAL. Our research is an addition to the body of knowledge on these AAL technologies by trying out a combination of a number of them.
- This has been achieved through an analysis of existing technologies, extracting features that we consider beneficial and designing a new architecture.
- **The shortcomings of this research would be that no single architecture would encompass all the features identified.** It is also true that each of the technologies identified is a whole research on its own, encompassing various research areas, which takes many years of work by multidisciplinary teams.

Thank you

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