CAPSIL

International Support of a Common Awareness and Knowledge Platform for Studying and Enabling Independent Living

CAPSIL Project Periodic Report Two
Grant Agreement: 215639
July 2008 – December 2008

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Project Objectives for Period

2.22	Body Sensor Network Wiki Entries	2	R	PU	Month 9

Please provide an overview of the project objectives related to your work package for the reporting period in question, as included in Annex I of the Grant Agreement. These objectives are required so that this report is a stand-alone document.

The following are the objectives for the Body Sensor Network Work Package Wiki Entries:

- Data processing – Identify the best approaches to sensor data processing i.e. on board data process versus streaming to a centralised processing node.
- Compile and review existing sensors and platforms which are currently being used or can be adapted for body worn sensor applications.
- Examine the Design aspects to allow them to be pervasive and to operate unobtrusively without significant human intervention.
  - Design aesthetics – utilisation of design techniques which make the wearing sensor acceptable or even desirable.
  - Design for function – the practical aspects of body worn wear sensors
- Communications – Detail the most appropriate wireless communications solutions and protocols for BSN applications.
- Development Environments – Detail software development for both firmware and high level application development.

Work Progress and Achievements during the Period

July

- Michael McGrath, Terry Dishongh and Prof Guang Zhong Yang attended the CAPSIL Workshop meeting in Tokyo Japan.
    - BSN status update presentation delivered to the CAPSIL partners.
    - Intel assigned joint ownership with Queens of the Congestive Heart Failure CAPSIL and sole ownership of the Falls CAPSIL

August

- Draft Circulation of sample CAPSIL (Congestive Heart Failure). This CAPSIL reviewed the current approaches to the in-home measurement of the following:
    - Weight (Device: Weight Scales)
    - Blood Pressure (Device: BP Monitor)
    - Peak Expiratory Flow Rate (Device: Peak Flow Meter)
    - Blood oxygen saturation (Device: Pulse Oximeter)

The topics were also addressed in the CAPSIL as they pertain to CHF management in a home environment:

- Technical Issues:
- Actuation Issues:
- Sensing Issues:
- Environmental:
- Compliance issues

- Work Package Coordination Meeting with Imperial College
- Attendance at the EMBS Conference, Vancouver, Canada where CAPSIL was highlighted at a workshop event

September

- Work Package Coordination Meeting with Imperial College
    - Review of Intel and Imperial Wiki Updates
    - Assignment of the new topics areas for research and documentation.
- Population of Wiki content

October

- Content created by Imperial College on the following subject areas:
    - On-node Data Processing
    - Sensor Fusion
    - Context Aware and Autonomic Sensing
    - Data Mining and Trend Analysis
- New content created by Intel on wireless sensor nodes.
- Work Package Coordination Meeting with Imperial College
    - Review of Data Processing and Analysis Twiki updates by Imperial.
    - Review of sensor node and hardware component updates by Intel
- Background research into Gait and Falls Prevention CAPSIL

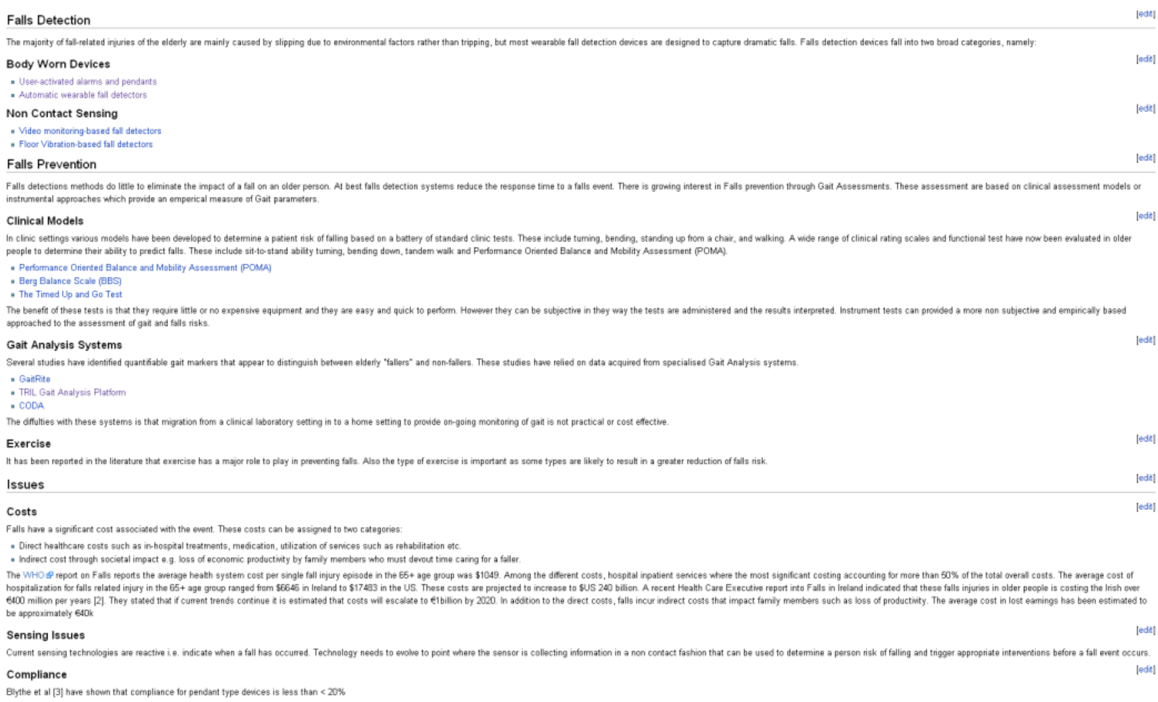
November

- Initial Gait and Falls Prevention CAPSIL created which included the following content:
    - Falls Detection
        - Body Worn Devices

        - Non Contact Sensing
    - Falls Prevention
        - Clinical Models
        - Gait Analysis Systems
        - Exercise
    - Issues
    - Costs
    - Sensing Issues
    - Compliance
    - Justification
    - Research
    - Projects
    - References
- Additional resource secured by Intel.
- Work Package Coordination Meeting with Imperial College
- Imperial College Updates to Falls Prevention and Gait Analysis CAPSIL finalised.
- Second resource secured by Intel work on CAPSIL project.
- 24th – 29th Contact of 10 EU related projects to CAPSIL to inform them of CAPSIL and its goals.
- 24th November - Circulation of Falls Prevention and Gait Analysis CAPSIL to extended team
- November 28th – 29th Attendance at the CAPSIL meeting, Lyon
    - Refactoring of CAPSIL documents into Wiki Pages

December

- 2nd – 9th December – Migration of Twiki pages to Wiki
- 1st – 3rd December – completion of publicly available Falls Prevention and Gait Analysis Wiki.



Falls Detection [edit]

The majority of fall-related injuries of the elderly are mainly caused by slipping due to environmental factors rather than tripping, but most wearable fall detection devices are designed to capture dramatic falls. Falls detection devices fall into two broad categories, namely:

Body Worn Devices [edit]

- User-activated alarms and pendants
- Automatic wearable fall detectors

Non Contact Sensing [edit]

- Video monitoring-based fall detectors
- Floor Vibration-based fall detectors

Falls Prevention [edit]

Falls detections methods do little to eliminate the impact of a fall on an older person. At best falls detection systems reduce the response time to a falls event. There is growing interest in Falls prevention through Gait Assessments. These assessment are based on clinical assessment models or instrumental approaches which provide an emperical measure of Gait parameters.

Clinical Models [edit]

In clinic settings various models have been developed to determine a patient risk of falling based on a battery of standard clinic tests. These include turning, bending, standing up from a chair, and walking. A wide range of clinical rating scales and functional test have now been evaluated in older people to determine their ability to predict falls. These include sit-to-stand ability turning, bending down, tandem walk and Performance Oriented Balance and Mobility Assessment (POMA).

- Performance Oriented Balance and Mobility Assessment (POMA)
- Berg Balance Scale (BBS)
- The Timed Up and Go Test

The benefit of these tests is that they require little or no expensive equipment and they are easy and quick to perform. However they can be subjective in they way the tests are administered and the results interpreted. Instrument tests can provided a more non subjective and empirically based approached to the assessment of gait and falls risks.

Gait Analysis Systems [edit]

Several studies have identified quantifiable gait markers that appear to distinguish between elderly "fallers" and non-fallers. These studies have relied on data acquired from specialised Gait Analysis systems.

- GaitRite
- TRIL Gait Analysis Platform
- CODA

The diffulties with these systems is that migration from a clinical laboratory setting in to a home setting to provide on-going monitoring of gait is not practical or cost effective.

Exercise [edit]

It has been reported in the literature that exercise has a major role to play in preventing falls. Also the type of exercise is important as some types are likely to result in a greater reduction of falls risk.

Issues [edit]

Costs [edit]

Falls have a significant cost associated with the event. These costs can be assigned to two categories:

- Direct healthcare costs such as in-hospital treatments, medication, utilization of services such as rehabilitation etc.
- Indirect cost through societal impact e.g. loss of economic productivity by family members who must devout time caring for a faller.

The WHO report on Falls reports the average health system cost per single fall injury episode in the 65+ age group was $1049. Among the different costs, hospital inpatient services where the most significant costing accounting for more than 50% of the total overall costs. The average cost of hospitalization for falls related injury in the 65+ age group ranged from $6646 in Ireland to $17483 in the US. These costs are projected to increase to $US 240 billion. A recent Health Care Executive report into Falls in Ireland indicated that these falls injuries in older people is costing the Irish over €400 million per years [2]. They stated that if current trends continue it is estimated that costs will escalate to €1billion by 2020. In addition to the direct costs, falls incur indirect costs that impact family members such as loss of productivity. The average cost in lost earnings has been estimated to be approximately €40k

Sensing Issues [edit]

Current sensing technologies are reactive i.e. indicate when a fall has occurred. Technology needs to evolve to point where the sensor is collecting information in a non contact fashion that can be used to determine a person risk of falling and trigger appropriate interventions before a fall event occurs.

Compliance [edit]

Blythe et al [3] have shown that compliance for pendant type devices is less than < 20%

Figure 1 Falls CAPSIL documented in Wiki

- December 4th – 11th Finalise BSN Wiki entries for publicly available versions.

Overview [edit]

A key capability of any assisted living technology system is the ability to sense. This can take the form of direct measurement of biometric parameters e.g. ECG (electro cardiograph) or indirectly through tracking a person's interaction with their physical environment e.g. movement using [accelerometers]. Research in recent years has presented the concept of the body sensor network BSN which individual sensors connected together normally via wireless network such as 802.15.4 are used to deliver a comprehensive view of a person's state of wellbeing. The majority of wireless sensor platforms share a common set of system components:

- Microcontroller - Provides the computational capabilities to the platform.
- Communications - Provides low power wireless communications
- Sensor interfaces - hardware interfaces to external sensor boards
- Memory - External memory e.g. mirco SD card
- Power Supply - e.g. Lithium ion battery.
- Sensing e.g. acceleration
- Development Environments

Key Features [edit]

Ren et al described the key features of WBSN's for medical applications as follows:

Reliability	Biocompatibility
Portability	Privacy and security
Light weight protocols	Retrievability
Energy aware communication	Prioritized traffic
RF radiation safety	

Sensor Nodes [edit]

Academic

- Ambient Systems
- BEAN project
- Cortex Project
- DSYS25
- eyesIFXv1
- eyesIFXv2
- FireFly
- Fleck
- Glacsweb
- Hoarder Board
- Kmote
- Marsian
- Particles
- SensAction-AAL
- ScatterWeb
- SquidBee
- TinyNode 584
- Tmote mini
- Tyndall Mote
- T-Node
- Wireless Integrated Network Sensors (WINS)
- WiseNet

Commercial

- Accsense
- ANT
- Atlas
- BTnode rev3
- CRICKET
- Ember
- EnOcean
- IMOTE2
- IRIS
- L-Node
- MICA2
- MICAz
- MicroStrain Sensors
- Newtrax Wireless Mesh Nodes
- PicoCricket
- SHIMMER
- SmartMesh
- Sun Spot
- Tip Mote (MTM-CM5000-MSP)
- TMote Invent
- TELOSB/TMote Sky
- WeBee
- WSN430 sensor node

Figure 2 46 commercial and academic wireless sensors nodes identified in the Wiki.

SHIMMER Wireless Sensor Platform [e

SHIMMER is a small sensor platform designed for wearable applications by Intel's Digital Health Group. The platform features an integrated 3-axis accelerometer, large storage (micro SD card), and low-power standards based communication capabilities on the based board. It supports standalone application as such as motion capture. Additional sensing capabilities can be added via extension boards which connect to the base platform via Hirose 20 position connector. The platform is fundamentally a radio agnostic platform supporting both the 802.15.4 and Bluetooth standards in a low-power system architecture.

Hardware Specifications [e

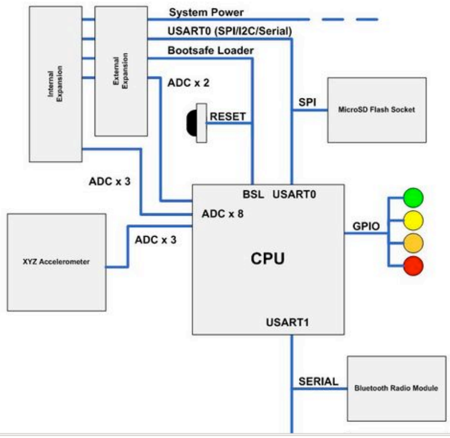


Figure 3 SHIMMER Wireless sensor entry from CAPSIL Wiki

1st – 19th December – Created and added content for the following CAPSILS in the public Wiki:

- Privacy & Security

- Digital Health Records
- Standards
- Connectivity

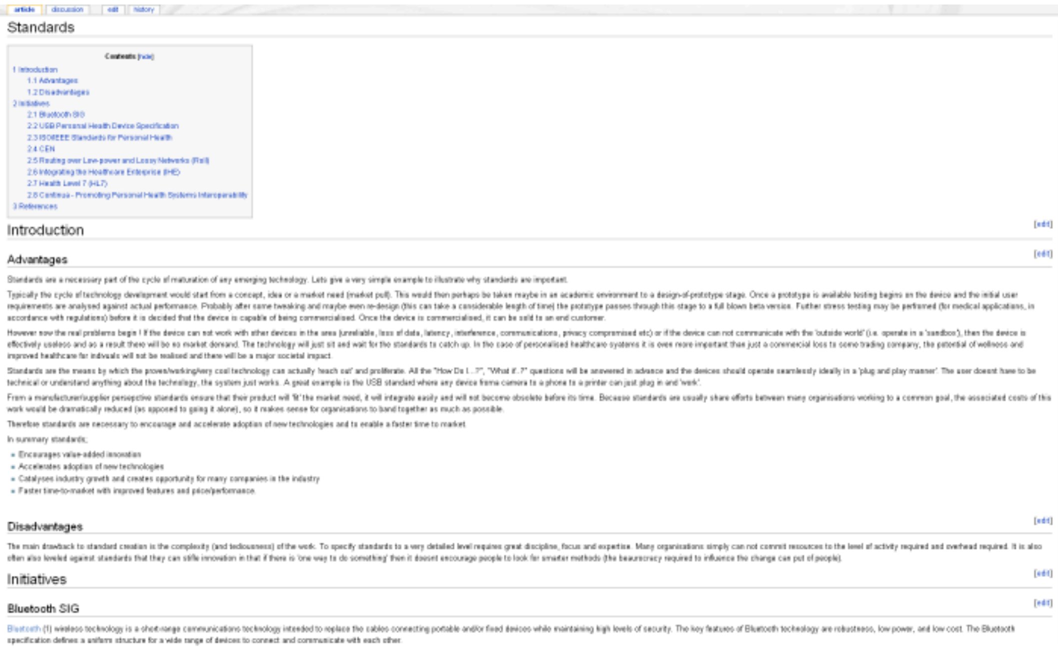


Figure 4 Sample from Standards CAPSIL

Please provide a concise overview of the progress of the work in line with the structure of Annex I of the Grant Agreement. For each work package -- except project management, which will be reported in section 3.5-- please provide the following information. A summary of progress towards objectives and details for each task;

Highlight clearly significant results

- CAPSILs created:
  - Chronic Heart Failure
  - Falls Prevention and Gait Analysis
  - Privacy & Security
  - Digital Health Records
  - Standards
  - Connectivity
- All CAPSILS posted to the CAPSIL Wiki for public access
- Additional content added to the WBSN CAPSIL Wiki Entries

If applicable, explain the reasons for deviations from Annex I and their impact on other tasks as well as on available resources and planning;

- No deviations taken

Deliverables

D2.2: Body Sensor Network WiKi Entries (O, M24)

Milestones

M2.2: Workshop #2 – Initial BSN Roadmap document presented and prototype BSN WiKi entries (M9)
M2.3: Workshop #3 – First draft of BSN roadmap document and initial BSN WiKi entries (M15)