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Integrating the Single Assessment Process into a lifestyle-monitoring system

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Abstract: Lifestyle-monitoring systems are being researched to determine if they can predict long-term deterioration in well-being and allow carers to anticipate and address emerging problems. The Single Assessment Process (SAP) aims to make sure that older people's care needs are assessed thoroughly and accurately. In the traditional assessment process, technology is chosen to address only a limited number of primary issues. The integration of an electronic SAP tool with a technology-mapping database would allow the selection of a minimum set of sensors capable of monitoring not only the immediately demanding conditions, but also those requiring discreet surveillance. Moreover, the use of the same SAP tool as the means of presenting and visualizing the output of the installed lifestyle-monitoring system would allow the relevant well-being issues to be automatically re-assessed on a regular basis, thus permitting the timely detection of emerging problems. This paper presents a discussion of lifestyle monitoring and its integration with the SAP, then introduces the prototype of an integrated system.

Keywords: Lifestyle monitoring, Single Assessment Process, SAP, well-being, older people, disability, independent living, pervasive computing.

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1. Lifestyle monitoring: activities, analysis, and sensors

1.1. Activities

Telecare systems can be divided into three main categories, according to their complexity. So-called first-generation systems merely enable their clients to summon help in the event of illness or accident. In turn, second-generation systems provide automatic detection of emergencies: they use sensors to ensure continuous monitoring and can trigger an alarm without any human intervention, if an emergency condition is detected. A further category of systems is being researched to determine if it is possible to predict long-term deterioration in well-being, which would allow carers to anticipate and address emerging problems. When served by an appropriate array of sensors, these intelligent response systems should be able to compare current data with historic data, in order to detect the sort of changes that might be associated with imminent illness or accident [1]. The latter are often referred to as third-generation systems, or lifestyle-monitoring systems, and rely on the constant monitoring of activities. References [5] to [18] address work in this field.

Activities can be defined in multiple levels of detail. In practice, this classification can become very extensive and, for some activities, it may also be useful to distinguish between the different locations where they can take place, or detail whether they are carried out in private or in the presence of others. For example, the person may be eating either in the kitchen or in the dining room, as they may be cooking either alone or in company. The left-hand side of Figure 1 shows a simplified categorisation of some activities.

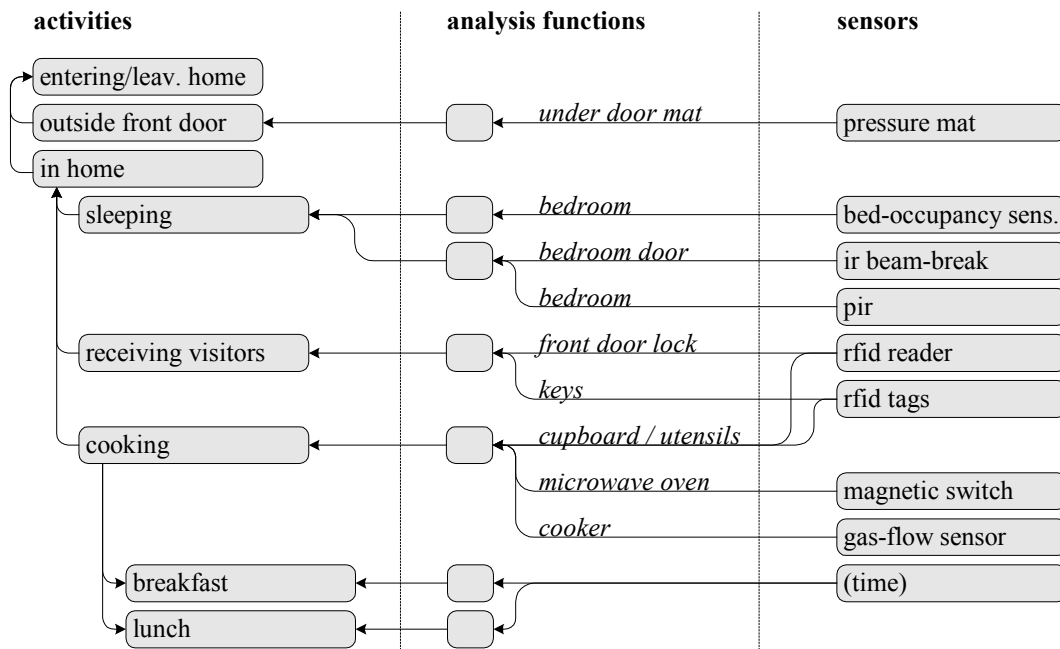


Figure 1 – Example of categorisation of activities and their mapping to technology

1.2. Analysis and technology

Lifestyle-monitoring systems analyse primarily the duration, frequency, and patterns of activities. For example, changes in the time periods that the person spends out of the home, as well as the frequency of leaving the home, can be relevant to the assessment of the quality of their social life. Similarly, changes in the pattern of the person's sleep periods can help assess the healthiness of their lifestyle.

The analysis functions performed by the system delineate the types of sensing devices that should be installed in the person's home, as well as their locations. In other words, analysis functions implicitly define a mapping between (monitored) activities and technology, which is illustrated also in Figure 1. For example, monitoring the duration, frequency, and patterns of visits received by the person can be achieved by analysing raw data about who enters and leaves the home. In turn, these data can be obtained from a radio-frequency identification (RFID) reader installed next to the main door lock, provided that the monitored visitors hold RFID-tagged door keys.

Since the monitored activities can represent very different levels of detail and abstraction, their mapping to technology is not always direct. In other words, some activities can be analysed by monitoring groups or even sequences of other activities. For example, leaving the home will typically mean a short period of increased movement inside the home, followed by some activity inside then outside the front door, and finally complete inactivity in the home.

It may be impossible to achieve a precise mapping between certain activities and technology. In such cases, the system should still be able to monitor less-detailed activities, based on the data provided by the available sensors. For example, if no technology is being used to monitor specific actions inside the kitchen, the time spent in cooking must be approximated by an upper limit: it cannot exceed the periods that the person spends in the kitchen. In other cases, the analysis may have to be based on exclusion. For example, should the installation of a bed-occupancy sensor raise ethical issues, the time spent in sleeping could be approximated by the periods during which the person is known to be in their bedroom but is not active.

As would be expected, the same types of sensors can be associated with different activities. For example, RFID technology can be used for identifying who enters and leaves the home, and for monitoring the usage of kitchen utensils, among many other applications. The variety of relationships that can be established between technology and activities, and between activities themselves, suggests that a relational database is an appropriate way of storing all the mapping information discussed here.

2. Integration of the Single Assessment Process

2.1. Well-being issues

The previous section addressed the technological side of lifestyle monitoring, that is, the mapping between monitored activities and types of sensors. In turn, on the human side, activities are mapped to issues considered relevant to the assessment of the person's well-being. It now becomes clear that measurable activities work as an abstraction layer between technology and particular groups of well-being issues. In other words, if a sufficiently vast set of activities are addressed (mapped to technology), that set can then be mapped to different arrangements of well-being issues. Figure 2 illustrates the mapping of some of the activities discussed earlier to possible well-being issues.

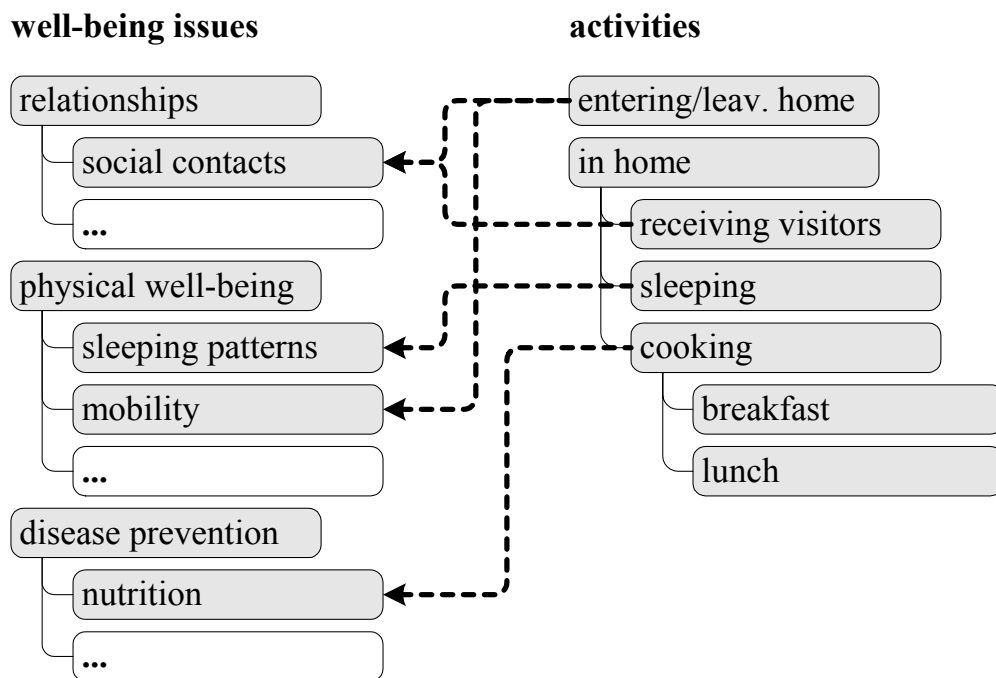


Figure 2 – Example of mapping of activities to well-being issues

It is apparent that, like activities, well-being issues can be divided into categories, and that many-to-many relationships can be established between activities and issues. For example, when the actions of entering and leaving the home are associated with visits, they become relevant to the assessment of the person’s social life. Alternatively, when the same actions are associated with the person alone, they can help assess their mobility. This type of mapping information is again suitable for storage in a relational database.

2.2. The Single Assessment Process

Specific arrangements of relevant well-being issues are the basis for the various existing tools compliant with the Single Assessment Process (SAP). The SAP, introduced in the UK’s National Service Framework for older people, aims to make sure that older people’s care needs are assessed thoroughly and accurately, but without procedures being needlessly duplicated by different agencies [2]. The Department of Health (DH) has accredited a number of off-the-shelf assessment tools that have been developed by independent bodies for national use in the overview assessment of older people’s needs under the SAP for older people.

These tools are fully compliant with SAP guidance and include CAT (Cambridgeshire Assessment Tool) Electronic Version; EASYcare Version 2004; FACE (Functional Assessment of the Care Environment) for Older People V.3; MDS (Minimum Data Set) for Home Care Version 2.3; NOAT (Northamptonshire Overview Assessment Tool); and STEP (Standardised Assessment of Elderly People in Primary Care in Europe) [3]. Each of these SAP tools is a collection of scales, questions and checklists that have been brought together for specific assessment purposes [4 (*Annex E*)]. Many of these tools are paper-based, and even those provided in electronic form are never integrated with the technology they may help to choose.

It is thought that it would be advantageous to integrate an electronic version of a SAP tool with a technology-mapping database, and (most importantly) to use that same tool as the means of presenting and visualising the output of a lifestyle-monitoring system. When compared with the traditional (manual) assessment process, such a solution would permit a better choice and employment of the technology installed in the homes, as well as a better management of the gathered information.

In the traditional assessment process, the manually gathered data raises a limited number of primary issues, and technology is then chosen to address specifically those issues. As a result, even when the system in place is adequate to continuously monitor the detected problems, it is likely to overlook other conditions that were not considered serious when the assessment took place, but which may nevertheless be declining over time. Thus, a new assessment is likely to be carried out only when a non-monitored, critical situation occurs.

The integration of an electronic SAP tool with a database storing the type of mapping information discussed previously (activity-technology and activity-issue mappings) would result in a decision-support system for the choice of appropriate technology. The information manually gathered about issues relevant to the person's well-being could be used to query the database in order to obtain a minimum set of sensors capable of monitoring not only the immediately demanding conditions, but also those requiring discreet surveillance.

Moreover, the integration of the installed lifestyle monitoring system with the same SAP tool would make it possible for the analysis functions to drive the automatic update of the information contained in the SAP tool about the person's well-being. In other words, after a first manual assessment, the highlighted issues would be automatically re-assessed on a regular basis, thus permitting the timely detection of emerging problems (before the occurrence of any critical events). This approach would convert episodic care into continuous care.

Figure 3 illustrates the characteristic layout of a paper SAP form (on the left), as compared with the on-screen layout of an electronic form (on the right).

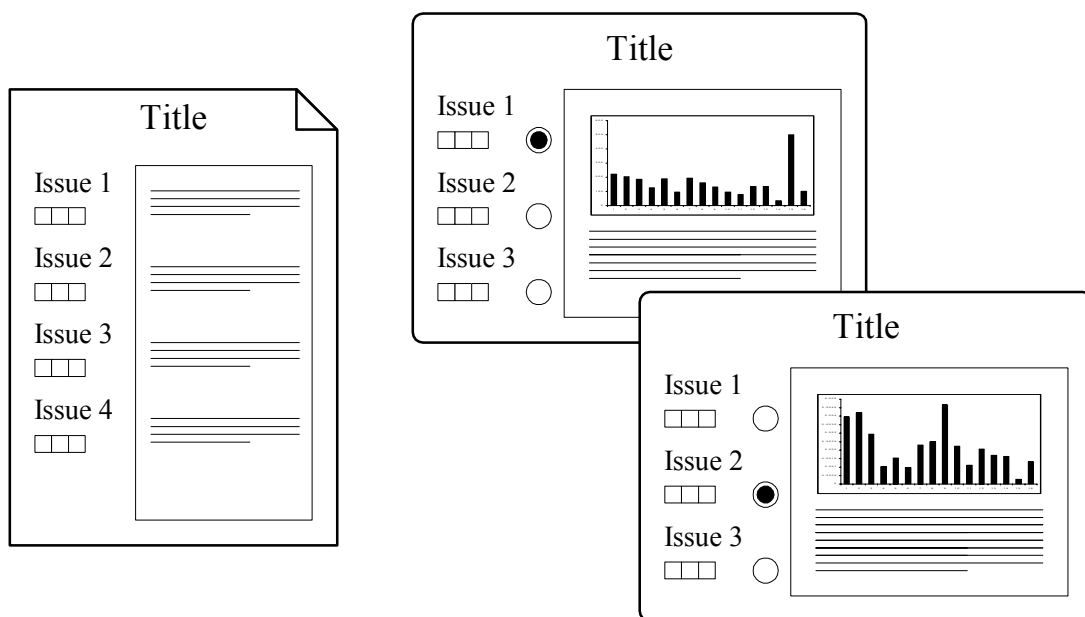


Figure 3 – Layouts of paper and electronic SAP forms

A page from a paper SAP form typically presents a list of issues that can be rated in discrete scales, as well as an area for comments. Notes about any of the covered issues must be written in this (relatively limited) area. In contrast, an electronic version of the same page could provide (e.g.) a radio button to select each issue individually, so that the whole comments' area would be available for typing notes about only the selected issue. Moreover, after the manual assessment, the same area would be used to display all the information generated automatically by the analysis functions, which might consist of graphs and text. Selecting a different issue would simply cause the comments' area to display different information. Whenever necessary, the ratings of specific issues would be updated automatically as well, to reflect the results from the analysis.

This approach would not only be more user-friendly than the traditional assessment process, but also encourage the centralisation (in electronic format) of all the gathered information. A social care professional could easily use an electronic SAP tool to carry out the manual assessment process, e.g. via a tablet-PC, and afterwards upload the gathered information to a central database.

3. Prototype of an integrated system

A test site has been equipped with a variety of sensors that allow continuously gathering lifestyle data, which in turn is being used to test the prototype of a system featuring an activity-analysis module and a front-end based on SAP. The installed technology includes passive-infrared (PIR) sensors, infrared beam-breaks, pressure mats, magnetic door switches, and RFID.

Figure 4 illustrates a part of the system's front-end interface, in this instance addressing some of the sub-domains of the *Personal care and physical well-being* SAP domain [4 (*Annex F*)]. This interface is implemented in HTML and JavaScript, so that it can be executed on a web browser.

The form's fields are implemented simply by drop-down lists, which contain the appropriate sets of options for each question. Once the first manual assessment is done, and the chosen monitoring technology is installed in the person's home, the system itself will update the status of the various form fields over time. Colours can be used to make easier the detection of significant issues. In this example, a five-item scale is coloured between green (for total independence / maximum well-being) and red (total dependence / minimum well-being).

Each field can be individually selected via a radio-button. The area below the form fields is then used to convey more detailed information about the selected field, such as a graphical representation of the trends of changes in the person's well-being or health condition over time, and an elaboration on how the automatic assessment was achieved. This elaboration can describe, for example, which activities were monitored to draw conclusions about the issue in question and, if necessary, which sensors were used to monitor those activities (in other words, details are provided about the adopted mappings).

In the illustrated example, a variation in the daily sleeping periods of one of the occupants is estimated over a period of 15 days. This is done through a linear regression of the inverse counts of firings of the PIR sensor installed in the person's bedroom, restricted to periods between 9 pm and 9 am. Given that a significant variation is detected in the trend of inactivity overnight (a 64% decrease), the assessment of *Sleeping patterns* is automatically updated from *Medium* to *Low*.

4. Conclusion

This paper has discussed the integration of the Single Assessment Process with lifestyle-monitoring and introduced a prototype of an integrated system. Future work will involve the

installation of additional sensors in the existing test site, as well as analysis of data from other test sites. More powerful activity-analysis techniques will be applied to the gathered data, such as state-chart modelling of the occupant's behaviour and pattern recognition applied to the firings of sensors, in order to try to gain further insight and understanding about the occupant's activity.

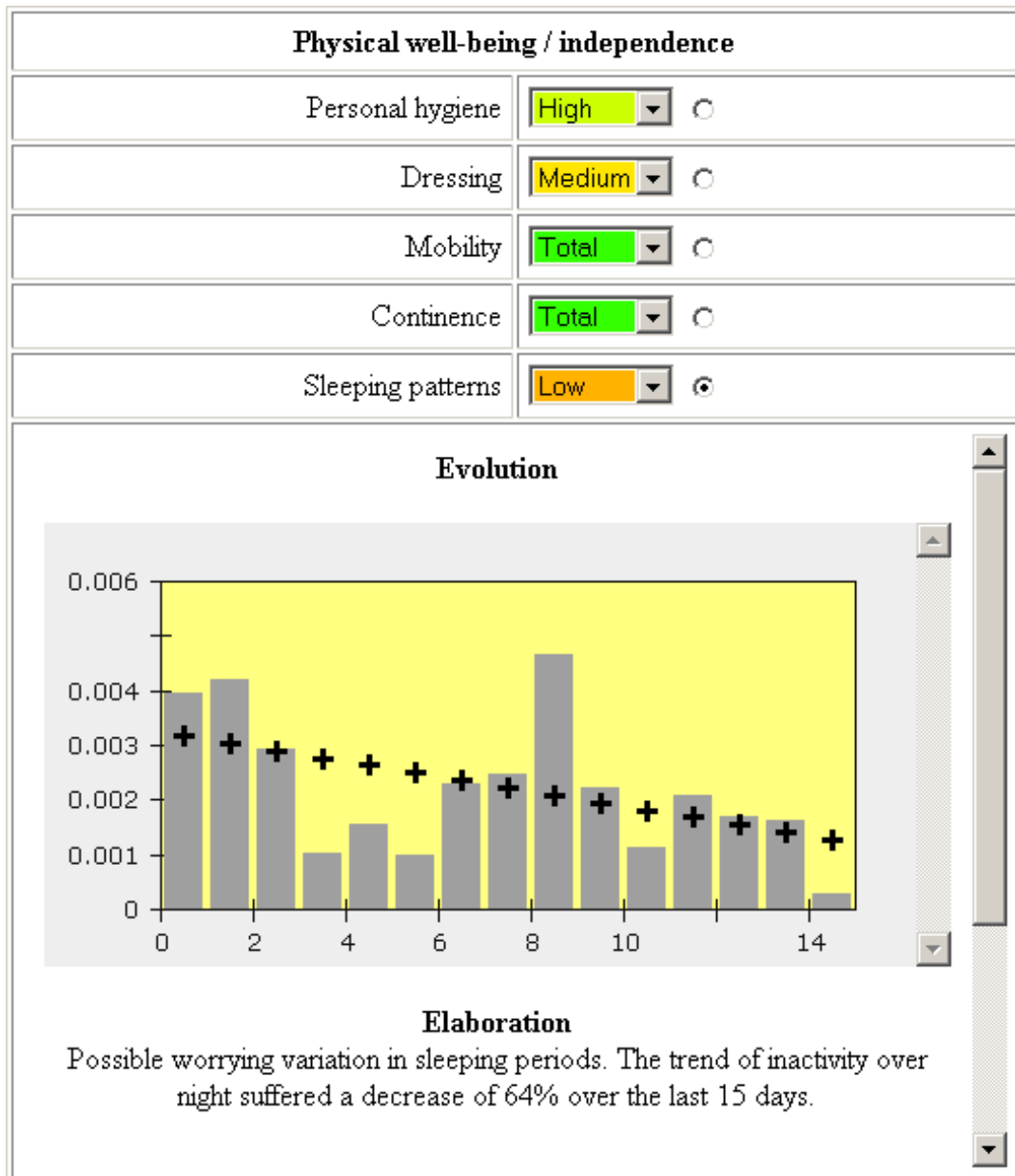


Figure 4 – Prototype of SAP-based interface

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