An Approach to Evaluating Quality of Context Parameters in an Ambient Assisted Living Environment

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Abstract—This paper provides an approach to evaluating Quality of Context (QoC) parameters in a ubiquitous Ambient Assisted Living (AAL) environment. The study presents the proposed context management architecture, which is then verified with the Siafu simulator in an ALL scenario where the user’s health is monitored with information about blood pressure, heart rate and body temperature. Considering some parameters, the proposed QoC assessment shall allow verifying the extent to which the context information is up-to-date, valid, accurate, complete and significant. The implementation of this proposal can mean a big social impact and a technological innovation applied to AAL, at the disposal and support of a significant number of individuals such as elderly or sick people, and with a more precise technology.

Keywords—Context, Quality of Context, Ambient Assisted Living, Ubiquitous Computing, Health.

I. INTRODUCTION

In ubiquitous environments, one of the many important factors is context-awareness. But context information may not be reliable or useful, becoming a problem in terms of quality. Consequently, an important point about context-awareness is that such context information must be reliable and quality must be ensured.

Quality of Context (QoC) is any information that describes the quality of information that is used as context information. So QoC refers to the information itself, not the process or the hardware component that provides the information [1].

This study demonstrates the use of QoC in an Ambient Assisted Living (AAL) environment, evaluating some QoC parameters.

Assisted Living is the term given to the provision of care to people either in their own homes or in supported housing, underpinned by technology. The provision of care, augmented by assisted living technologies, is growing because of the increasing demand and also due to the maturing of many of the underlying technologies that make assisted living possible [2].

The paper is organized as follows: Section II describes the context management architecture adopted, and presents the Ambient Assisted Living scenario selected. Section III describes the case study implemented and the results. Section IV presents our conclusions and future work.

II. CONTEXT MANAGEMENT ARCHITECTURE AND THE AAL SCENARIO

QoC can be used to improve context management, assisting in decision making as regards its applications. The context management architecture described below is proposed and detailed in study [3].

The bottom layer represents the context providers, which may be room sensors such as of temperature, light; health monitoring sensors such as of heart rate, blood pressure; mobile device sensors such as of location, time, and preferences; or actuators that can be used in intelligent automation.

The middle layer represents the context processing, where acquisition of context information, processing and distribution of such information will take place. In order to follow these steps, some modules will be used:

1. Context Collector: collects context data from the sensors;
2. QoC Quantifier: performs quantification (calculations) of QoC parameters and QoC overall value considering the context, for instance space, time, user, etc.;
3. QoC Evaluator: verifies the QoC associated with the context information by means of ontologies;
4. Security Policy: checks the security policies adopted for the distribution of context knowledge and QoC among context consumers;

The top layer represents context knowledge and QoC consumers, such as healthcare applications, home or intelligent environments, in addition to other services where the context is considered.

The present study focuses on the context processing layer. In order to verify this proposal, an Ambient Assisted Living (AAL) scenario was selected.

The proposed AAL scenario is a house consisting of a kitchen, a laundry, a bathroom, a TV room, a bedroom and a studio/office.

The house is occupied by an old person (henceforth referred to as resident). The resident takes daily medication for health control. Some of his/her daily activities are: waking up around 8:00 a.m.; having breakfast; walking the dogs; taking medicines; doing health monitoring (blood pressure, heart rate, body temperature); having lunch at home or at a nearby restaurant; doing some housework and...
III. CASE STUDY AND RESULTS

This study used the context simulator Siafu [4] to simulate both context provider and context processing. A graphic scenario was created with Siafu, with an agent representing the resident. The simulated sensors are those related to the monitoring of the resident’s health: blood pressure, heart rate and body temperature, in the bottom layer of the proposed architecture: context provider.

The first step of the context processing is data acquisition. The data are obtained from the sensors through a context collector module implemented in the simulation.

The proposed QoC assessment will be made through the quantification of some QoC parameters using the QoC Quantifier module. At this point, an algorithm will quantify the following QoC parameters:

- **Coverage**: defines the set of all possible values for a context attribute [5];
- **Up-to-dateness**: indicates how old the context information is by using a timestamp [1];
- **Precision**: describes exactly how the context information provided reflects reality [1];
- **Completeness**: is the extent to which the context information is available, sufficient and not absent [6];
- **Significance**: indicates the importance of the context information - its value is particularly important in life-threatening situations for humans [7];

A. Results

As a result of the implementation, the graphic display shows the simulation with real-time QoC and context information.

In addition to the graphic display, a history of information recorded at every instant is shown below in Table 1, for time (Tm). The column type (T) includes Temperature (T), Diastolic Pressure (DP), Systolic Pressure (SP) and Pulse (P). The columns show actual values (Ac), read values (R), and the last read value (LR). Subsequently, QoC information includes Up-to-dateness (U), Coverage (C), Precision (P), Completeness (Cm), Significance (S) and the overall QoC value (QoC).

<table>
<thead>
<tr>
<th>Tm</th>
<th>Tp</th>
<th>Ac</th>
<th>R</th>
<th>LR</th>
<th>U</th>
<th>C</th>
<th>P</th>
<th>Cm</th>
<th>S</th>
<th>QoC</th>
</tr>
</thead>
<tbody>
<tr>
<td>56</td>
<td>T</td>
<td>37.5</td>
<td>-</td>
<td>34.5</td>
<td>0</td>
<td>1</td>
<td>0.93</td>
<td>0</td>
<td>1</td>
<td>0.48</td>
</tr>
<tr>
<td>57</td>
<td>T</td>
<td>37.6</td>
<td>36.0</td>
<td>36.6</td>
<td>1</td>
<td>1</td>
<td>0.97</td>
<td>1</td>
<td>0</td>
<td>0.99</td>
</tr>
<tr>
<td>101</td>
<td>T</td>
<td>38.7</td>
<td>37.9</td>
<td>37.9</td>
<td>1</td>
<td>1</td>
<td>0.98</td>
<td>1</td>
<td>1</td>
<td>0.99</td>
</tr>
<tr>
<td>105</td>
<td>P</td>
<td>120</td>
<td>104</td>
<td>104</td>
<td>1</td>
<td>1</td>
<td>0.87</td>
<td>1</td>
<td>0</td>
<td>0.97</td>
</tr>
<tr>
<td>138</td>
<td>DP</td>
<td>90</td>
<td>86</td>
<td>86</td>
<td>1</td>
<td>1</td>
<td>0.95</td>
<td>1</td>
<td>0</td>
<td>0.99</td>
</tr>
<tr>
<td>138</td>
<td>SP</td>
<td>136</td>
<td>129</td>
<td>129</td>
<td>1</td>
<td>1</td>
<td>0.95</td>
<td>1</td>
<td>0</td>
<td>0.99</td>
</tr>
<tr>
<td>150</td>
<td>DP</td>
<td>76</td>
<td>48</td>
<td>48</td>
<td>1</td>
<td>0</td>
<td>0.63</td>
<td>1</td>
<td>0</td>
<td>0.66</td>
</tr>
<tr>
<td>150</td>
<td>SP</td>
<td>114</td>
<td>72</td>
<td>72</td>
<td>1</td>
<td>0</td>
<td>0.63</td>
<td>1</td>
<td>0</td>
<td>0.66</td>
</tr>
</tbody>
</table>

Several tests can be performed with the output data of the simulation. Table 1 above illustrates some situations.

The first line shows that at time 56 the temperature has low QoC. There is a big difference between the last reading and the true value, moreover the information is outdated. Next, time 57 shows good QoC, the reading is updated, the values are valid and accurate, and S equals zero indicates that the values are within the expected range. At time 101, S changed to 1, indicating that the temperature is higher than expected; QoC remained adequate but it is a situation that deserves attention. Time 105 illustrates the pulse reading, with good QoC. The subsequent times concern pressure readings. At time 138, the QoC value is appropriate as well as other parameters, with S equals zero, indicating that the values are in line with the expectations. At time 150, in turn, the QoC value is low and so is the precision value, and the value of C is zero (outside the expected value range). These values indicate a possible problem with the pressure gauge.

IV. CONCLUSIONS AND FURTHER RESEARCH

This study stands out for its approach to evaluating QoC information in a ubiquitous assisted environment, supporting the care of people with special needs (elderly or with health problems), thus improving their quality of life.

The study of QoC can help achieve the following objectives: detect anomalies or inconsistencies in sensors, generate alerts, activate backup sensors, discard data with insufficient QoC, choose appropriate providers, and other actions.

In future works, we intend to include environment sensors and mobile devices, evaluate other QoC parameters, and use ontology in the development of the QoC Evaluator module to help identify potential QoC problems.

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REFERENCES