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Developing Intelligent Systems' Patterns for AAL Based on the Context Extraction

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Abstract

The AAL (Ambient Assisted Living) is a promising area of research as the field is novel and demand efforts for its evolution. Developing intelligent systems that fall within the scope of responding to the needs of the elderly is becoming demanding in the matter of software design and in model references. AAL systems are sensitive in a matter of time and performance as they deal with special targeted groups of users. The stakeholders in the field need to be embedded in an environment that is capable of sensing their presence and acting according to their needs without the interference of the users. The contribution of this paper falls within the scope of providing a reusable solution for developing patterns in AAL systems based on the extracted context based on the collected data from the different resources of the system. This solution will accelerate the time of response and enhance the quality of the actions triggered by the actuators according to the needs of each user and taking into consideration its profile and preferences.

Keywords

AAL, Pattern, Context-Extraction, Intelligent Systems

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1. Introduction

AAL is a new area of research that has been evolving rapidly. Developing promising systems that play vital roles in the stakeholders' everyday life is a challenging mission for designers as well as the manufacturers [1]. The industry of AAL has evolved due to the evolution known in IoT (Internet of Things), AmI (Ambient Intelligence) and many other fields [2-4]. In software engineering, designing reliable sensing and actuating environments has to be based over RM (Reference Models) and RA (Reference Architectures) which gives solid background for developers and a powerful infrastructure for the systems to survive through the gigantic changes of technology [5].

Many efforts have been considered in designing distributed AAL systems under the umbrella of the same RM to give empowerments for integration and clearing the process for updates [6-8]. AAL systems are sensitive in a matter of time and performance as they deal with elderly people and people with special disabilities. The possibility of achieving coherent decision in time and raising the performance of the system gives it the acceptance and the support from the stakeholders' side as well as the manufacturers' one. Real-time-decision-making is the most vulnerable elements in such systems as they rely on acting towards the users' environments in appropriate timing keeping in consideration the selection of the best decision in real time mode [9].

In our vision, we consider developing patterns in AAL systems to enhance the quality of response of these systems as well as the timing of reaction as they deal with multiple actuators embedded in an AAL environment. Patterns has the ability to present repeated and regular actions that happen in the same way for several times. Patterns will represent a regularity in each of the stakeholders' space as they will be

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adjusted to each one's needs and will take into consideration each users' preferences. They will offer a predictable manner for the actions of the user according to his profile and as a result speed up the reactions of the system.

In this paper, we describe a general, reusable solution for AAL systems to be able to develop patterns within the context extracted from the user's environment. It can be used as an original model for developing patterns in systems sensitive to time related reactions in multi-agent environments. To be able to develop these patterns we suggest starting by reasoning the commonly accrued situations. Secondly, we suggest orienting the system's actions according to the goals. Dividing the systems' responses according to the needs and objectives is the third step. Finally, we provide a set of steps from the data aggregation to the pattern's development to be considered in designing AAL systems with a powerful mechanism of response, which we believe enhances the timing and the quality of response in these systems.

This paper is divided into five sections. In the second one, we describe the mechanism of the situation reasoning we suggest to achieve a good understanding of the commonly accruing situations in each of the users' spaces. In the third section, we illustrated the drive toward the goals while building the actions, which will lighten the functionalities of the systems. The fourth section was devoted to the response planning process and the last one illustrated the steps from the data extraction to the details of the developments of the associated patterns.

2. The Situation Reasoning

In AAL systems, many features are used to identify the context, whether by individual sensors or networks, by smaller devices, mobile objects or from distributed sources [6, 10]. The flow of context extracted from the space's devices has to merge into a reasoner where the extracted information might be managed in order to determine the situation taxonomy. This flow has to take in consideration the context history manager to achieve convenient results. The events triggered by the system sets the services on to execute a service or to provide a series of functionalities that might affect the environment and the user. These events are based on the extraction of the context and the determination of the situation taxonomy as illustrated in Figure 1.

Making a decision in real-time scenarios is the success element of the AAL systems [11]. Considering a high performance in the data position, the process and the adequate selection of services in the environment will be a great achievement for the field. The reactive action service is driven by the situation model with the assistance of the predictive situation model. The proactive plan is launched by the request of the predictive situation model. By choosing the context of interest, the final step is to implement the application.

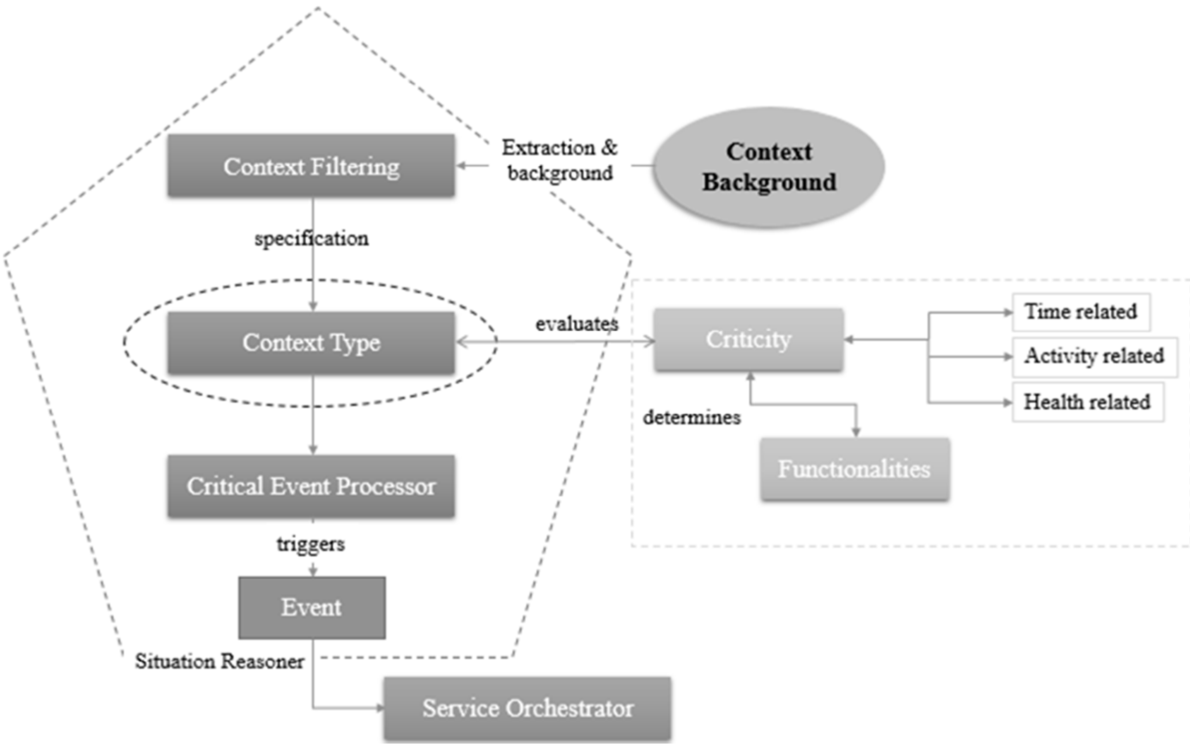

Figure 1. The Situation Reasoner depth process.

Context-awareness gives the system the ability of adjustment to the needs of stakeholders as all the actions of the system are based on the knowledge based on the characteristics of the environment, the needs of the users and the overall situation taxonomy, which makes the system highly personalizable.

Our vision bases the extraction of context on the homogeneity between the context background concepts from where a scenario can effectively project the situation taxonomy in the stakeholder's environment.

3. From Goals to Actions

The AAL field is a multi-disciplinary domain where the objectives of the systems might differ thus, they keep the same overall goal, which is enhancing the elderly everyday life tasks and managing emergencies.

By definition, a goal is an objective achieved by using the composites of the system, it demands a set of desired behaviors of the system's elements [12]. Elaborating the goal requirements needs, the determination of the actions and decisions that the system has to make during its lifecycle. Defining the goal helps structuring the links between the needs and the functionalities of the system. The goal elaboration process consists of defining the goals and relating them through clarification links in a combination of top-down and bottom-up sub-processes. The objective of this elaboration is to achieve coherence between the goals and the actions required to satisfy the needs of the stakeholders.

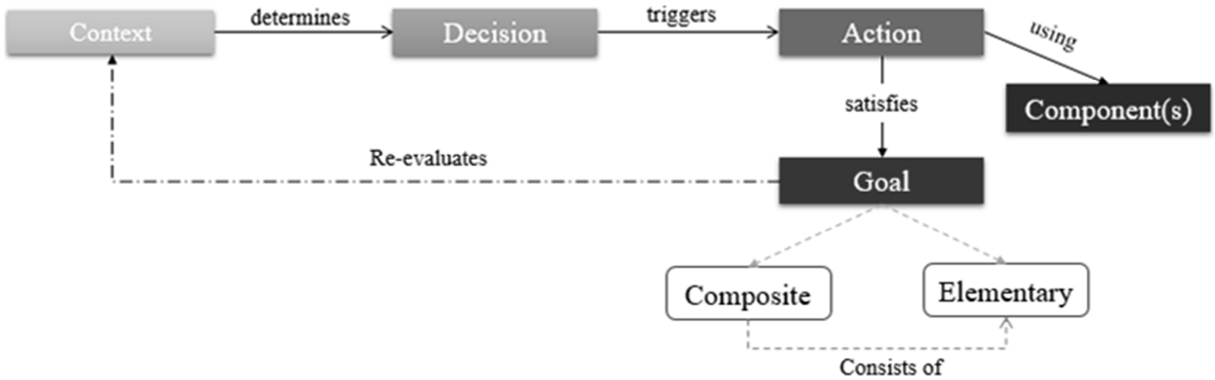

Figure 2. Process of achieving the goals.

The goals determines the usability of the tasks that should be presented in the system. In addition, they offer the luxury of building systems that are adaptive to a number of situation taxonomies.

We aim for the system to trigger the actions from the decisions, which are determined by the context. We propose to decompose the goals in order to achieve more coherence and prevent redundancy. The actions use the different components to satisfy the goals as illustrated in Figure 2. The goals might also be used to re-evaluate the context to avoid future miss judgements of the different situations.

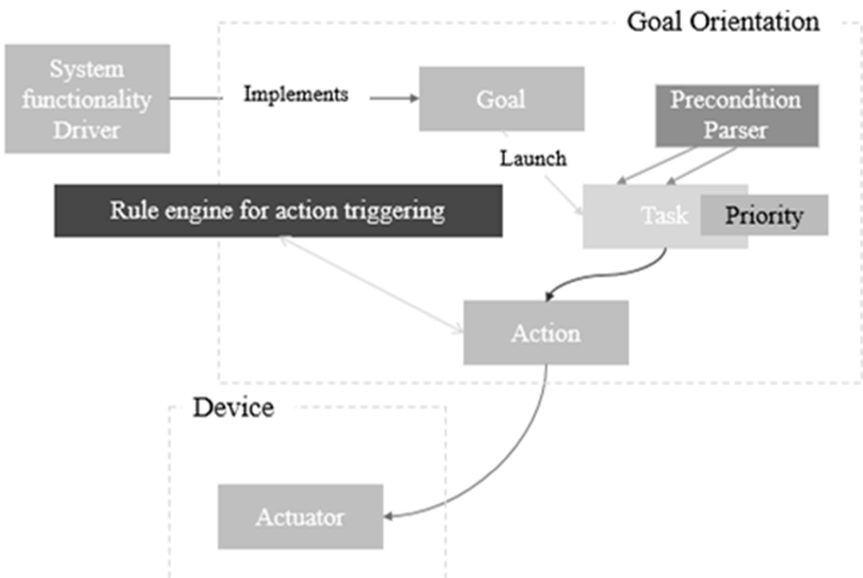

Figure 3. Goal orientation to trigger the actuator's actions.

When using the goal-orientation in the AAL architecture, we aim to produce systems capable of triggering the action of their embedded actuators based on a chain of rules and priorities. The functionalities of the system might be gathered in a form of drivers where each of them drive the implementation of a specified goal. Achieving these goal relays on launching a number of tasks. The precondition parser illustrated in Figure 3 verifies the presence of the vital preconditions of each task (such as the alimentation of a device or the connection of an actuator with the body of the stakeholder in case of testing blood pressure) (Massacci et al., 2009). The priority of each task is associated to the process through which a goal can be achieved. Finally, launching the actions might influence other processes and that is the reason why the rule engines have to be checked every time an action is ready to be launched.

4. The System Response Planning

The estimation of events related to the overall situation of the stakeholder is also to be considered while developing the patterns [13-14]. Associating a value for each data type would ameliorate the reactions of the system. Furthermore, it gave us the possibility to decompose the system into Reactive, Proactive and Extensible parts each of them are connected to specified features. This organizational view facilitates the extensibility and the scalability of the system.

The Reactive Planning of the system is based on the modality of the functionalities proposed for the system as presented in Figure 4. Determining a period for each collected data to be combined into one sense is a mandatory step while constructing the system. For example, people suffering from Alzheimer might need shorter periods than other disable persons might. The reactive action plan is triggered to react to the situation.

The hypothetical predictor is the one that lies at the core of the proactive planning. The anticipated situations have to form a database of reference to be consulted. The proactive planes are launched according to many indicators. Finally, the system should prepare to the situation. On the other hand, the scheduled plans might take in consideration some predefined indicators. The system has to be equipped by the temporal intervals of launching the actions.

Fusing the new situations and decisions associated with them with the situation patterns provides the system with enough data to learn for future incident. The exceptional element of the decision-making is relying on the situation patterns, which gave the capacity to the system to embrace or ignore unusual values collected by the sensors.

Alternative solutions for complicated situations must be prepared and integrated in the system. The AAL system should always converge toward the optimal solutions even if they are not convenient for a selected situation. Moderating should be taken into consideration while waiting for further assistance.

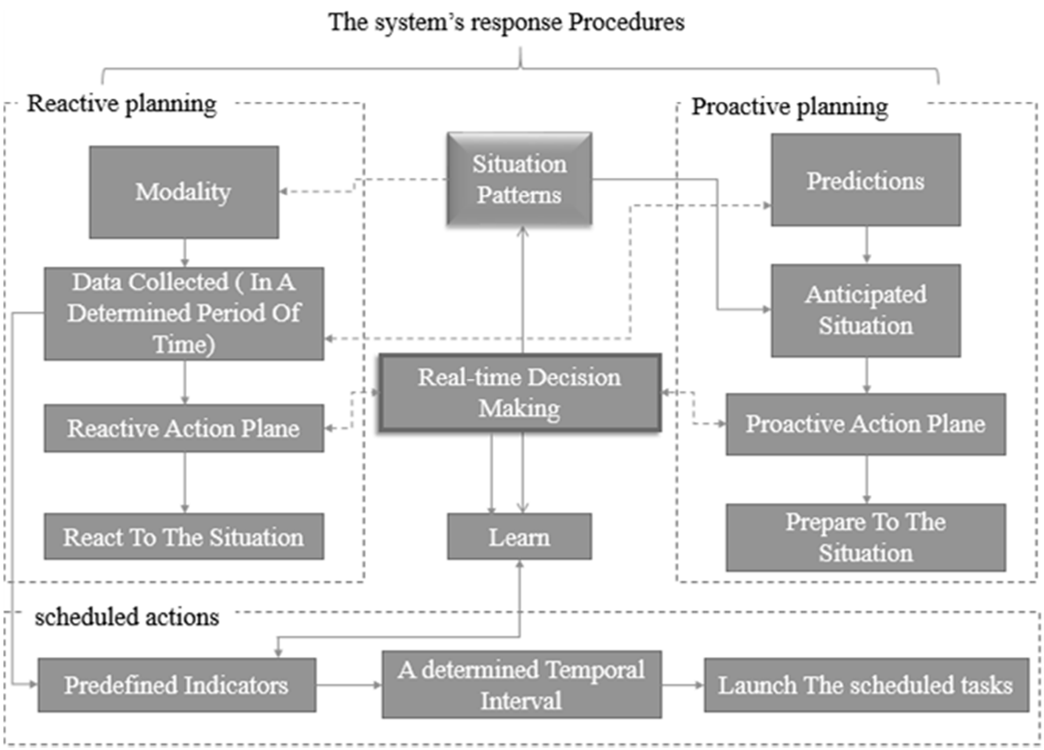

Figure 4. The system's response procedures.

5. Data Filtering & Data Flow

The data collected from the sensors and from other resources connected to the system is uncertain [15-16]. Dealing with the volume and the value of the collected information are a dilemma for designers. The system has to embrace multiple functionalities that reduce the volume of the undesirable data collected by the devices. These processes have to be triggered and applied frequently to enhance the storing capacity. Learning from this data has to be a core functionality of the system to develop reliable patterns of incidence or situations.

The data flow in the AAL systems is exceptional [16]. The collected values from the embedded sensors combined with the data aggregated from other resources made the filtering a complicated process. Our fusion models rely on cleaning the data by ignoring the storage of invaluable values. This process would simplify the processing and made it optimal in a matter of time and cost. The approximated information extracted from it makes the assumptions more close to reality. Using several filters all across the processing will approve the validity of the decisions taken by the system. A recursive learning process is a mandatory one to keep the system up to date according to the changes that may appear in the stakeholder space.

For achieving meaningful values from the data collected many methods have to be adopted. The underestimation of some factors may cause a delay of the system response to some urgent situations. The covariance of values might also detect a miss lead of parameters in the processing chain. Solving the integration problem facilitates the maintainability and the scalability issue [17].

We illustrates in Figure 5, the process from Data Aggregation to the pattern Development. We assume that patterns are a mandatory element in AAL system as they rely on them while dealing with critical situations.

After the data aggregation, all the collected values should be filtered. Unnecessary data are neglected and the other one is checked in matter of Relevance, Redundancy and Overlap.

a) Value filtering: sensors collect data 24/7. The room temperature for example is not a valuable data unless there is a major shift in its value. Everyday values are not considered important. Thus, the system has to get rid of them once they are selected as inappropriate for determining any decision.

b) Relevance: while making real time decision some data may show irrelevance to the situation context. To accelerate the process these data have to be ignored. Relevance should take in consideration action patterns and functionality goals.

c) Redundancy: it may result from the same data collected from two different devices (for example if the system contained a temperature sensor and an air conditioner the air conditioner has the capability of detecting the temperature as well which may cause an overlap)

d) The overlap: the data presenting some vital measurements for AAL users such as blood pressure etc. might appear in several sources such as the hospital data centers and the laboratory servers, which may cause an overlap. The system has to figure out some factors to eliminate the undesirable ones and keep the more useful one according to the user's condition, the parameters defined specially for him and the preferences accorded to his medical history.

When resulting with the filtered data we ask for using first choice storage to facilitate the processing chain. After cleaning and normalizing, the data has to be compressed and transformed. We assume that relating data to criteria would provide more clear vision of the situations as they ease the edge analytics before delivering the data to the context layer. In the end of this chain, we choose to associate a quality indicator to the resulted process based on the data quality model offered while creating the system based on the stakeholder medical history and demands.

For the pattern development we encourage consulting the situation accuracy as well as the repeated samples that the system contemplate while a period of operation. The functionality driver has to be consulted and the risk score accorded to each scenario is mandatory to be checked. Finally, we believe that the classification and the assembled knowledge are satisfactory elements in building the patterns.

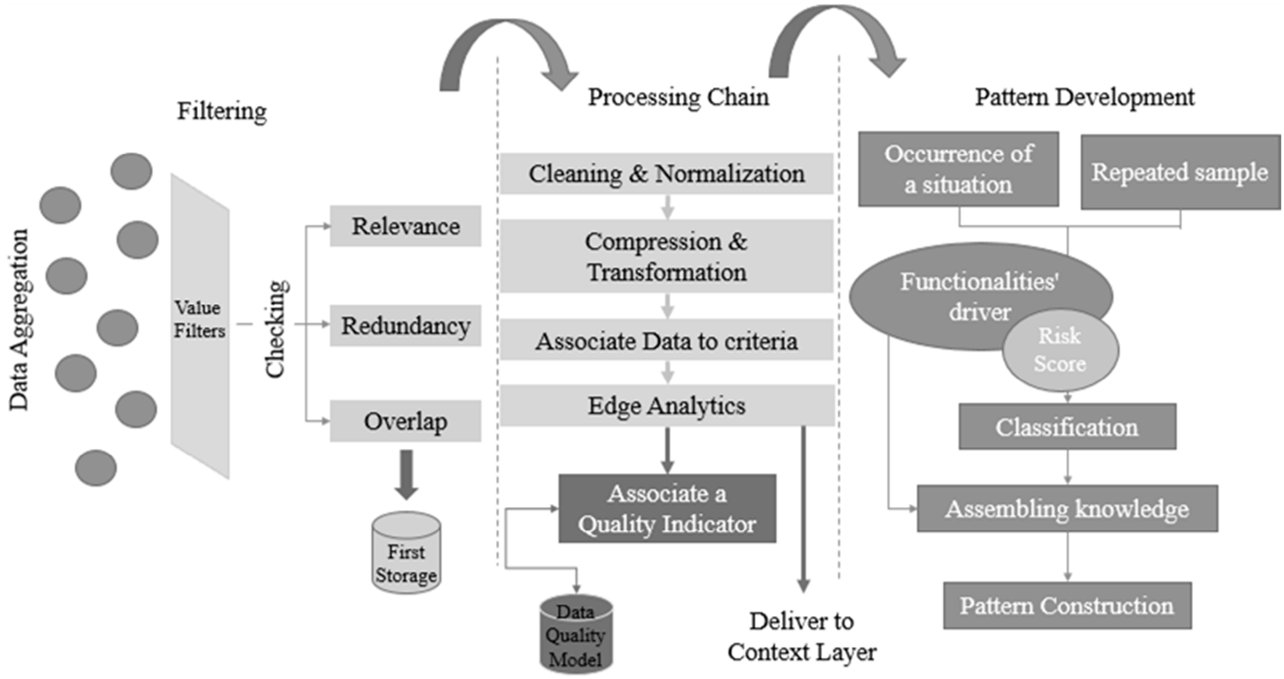

Figure 5. From data Aggregation to Pattern Construction.

6. Conclusion

In this paper, we presented a process for developing patterns in AAL systems. We believe that it is a reusable solution for different Ambient Intelligence systems to use in order to enhance the quality of response in real time decision making. We aim to construct the system's patterns relaying on the assembled knowledge from the data extracted and aggregated by the different resources of the environment. Using the occurrence of situations with the consideration of the repeated samples of the different events presented in the user's space. Dividing the procedures of response is also a mandatory element in the raise of the quality of the reactions oriented for the different actuators of the system. We believe that our next step will consider adopting this process in a case study to highlight the loopholes of the process.

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