PROFILED STUDENT IOT ASSISTANT

Jordan Todorov, Vladimir Valkanov
Plovdiv University
Ivan Popchev
Bulgarian Academy of Sciences

Abstract: *The purpose of the publications is to introduce the multi-agent system LISSA[1] and the changes that has been made to the original idea and the first prototype. The simple agent has grown from a single agent in VES[2] to multi agent system with a major part in the space and has become capable of working with outside network of sensors. The latest revision of the systems takes into considerations people with different health problems and disabilities.*

Key words: *LISSA, VES, sensor networks.*

1. INTRODUCTION

In the last couple of years eLearning appears more and more appealing. Besides well-known open source systems, some universities develop their own eLearning systems. In line with this trend the Faculty of Mathematics and Informatics at the University of Plovdiv implemented its own Distributed eLearning Centre (DeLC) which aims to create dynamic learning infrastructure for both students and teachers.

DeLC however, despite creating exceptional virtual environment, does not account to the physical domain, where the learning process is active. We hope to build an infrastructure where the virtual world integrates naturally within the physical environment. That’s why we started a transformation of DeLC in a new, cyber-physical infrastructure known as VES (Virtual Education Space). Developed as an Internet of Things ecosystem, it consist of autonomous components that display context-aware „intelligent” behavior.

The following paper is dedicated to the creation of a personal assistant (LISSA). Her role is to greatly assist students with their work.

2. RELATED WORKS

The concept of using personal assistants for aiding people in their everyday lives was first introduced in the 90s and is being developed to this day. AI technologies give us the opportunity to build intelligent machines, which perform tasks on the user's behalf. The application of agents is generally divided in two main groups, the first one being distributed system, while the second one is personal software assistants, where agents play the role of proactive assistants for their users. Personal assistants (or PA for short) help the users with both their everyday tasks and in long-term management (planning a trip, making reservations, online shopping, payment tracking etc.) Today, PA are usually installed on smartphones, and everybody uses their services. They often use the resources and information obtained through social media so they can offer more personal services. The expanding domains of personal assistants is demonstrated by two useful interviews. The first one is for the use of PA in the context of IoT and the second one is for Intelligent Pedagogical Agents (IPA) for personalized learning and increasing students' motivation [3].

There are several big projects, which stimulate the research in specific area and outline the prospects of it. Personalized Assistant that Learns (PAL) [4] is one of the first broad-range programs to scientifically explore the field of cognitive systems. Its goal is to improve the way computers interact with people. A bright example of a system developed within PAL is CALO (Cognitive Assistant that Learns and Organizes) [5]. CALO is helping the user reach a decision and is used mainly in military situations. It is capable of self-educating. User's interface and database are of great interest, since they are built as a semantic application frame that also includes a platform for military education as well. The frame offers different services to the users such as views, context navigation, calendar, web- and file browser, e-mail client, instant user messages etc. Another example of a project for creating intelligent assistants is COMPANIONS [6]. It aims towards changing the generally acknowledged way of interaction between human and computer. A „Companion" is an agent that „co-exists" with the user for long periods of time, during which it studies the owner's preferences. Communication between users and the agent is mainly established by understanding of speech, or using sensor displays and detectors. Project PAL (Personal Assistant for healthy Lifestyle) [7] is a system that uses common database and conclusion mechanisms, to help and guide the users into healthier lifestyle. Thanks to Project PAL, field specialists are able to set goals and monitor patients' progress. That way PAL can be of great help to those patients.

Personal assistants are ease everyday activities. There are several bright examples (Siri [8], Google Now[9]) of personal assistants interacting with their users in a natural language to make the communication more user-friendly. The first major corporation that used such an assistant was Apple, which introduced Siri with its Iphone 4S back in 2010. Nowadays versions of Siri support a variety of techniques suitable for self-education. The healthcare field also offers different personal assistants, for example – HealthPal[10].

Some universities conduct occasional researches regarding the creation of personal assistants. They combine researches on the Internet of Things, machine learning, as well as robotics. The Center for Cognitive Ubiquitous 111 Computing (CUbiC) at Arizona State University devoted its time to developing multimedia technologies for disabled people. One of their greatest projects consists of planning and developing a social interactions assistant, designed to help those with ocular disabilities. Its main goal is the improvement of social non-verbal signals for blind people. It works by analyzing computer algorithms in a video stream, coming from special „camera glasses". That way the information is delivered through the user directly.

For the last couple of years, there have been many attempts to create robots for aiding the elderly. Despite facing some significant difficulties, they manage to provide personalized care for the user. Since the elderly constantly have various needs, personal assistants often face different issues, despite being self-learners. This service often consists of three main components – Virtual Care Personalizer, Virtual caretaker and Template Care.

As technology keeps growing, there is an increase of educational environments with intelligent components with better developed PA. Nowadays PAs offer instant messaging, which allows the user to connect to other users online and exchange information through messages. The following research [11] describes a platform (type of personal assistant) being developed. It specializes in helping students with both their academic and everyday tasks. It provides useful functionalities to manage the school schedule. This assistant is reliable due to the simplicity in its interface.

IRMA [12] covers the topic of personal assistants that help users with mobility. It is developed as SOA/EDA (Service Oriented Architecture / Event Driven Architecture) platform, which uses various sources in order to propose an easy to use modular platform that gathers data from various information sources each of which serve a group of interested users. Having in mind the fact that nowadays everyone is using a smartphone with fast internet connection, it can be put on mobile devices as well. That way the users will stay informed about the immense mobility options in an ever-changing mobile behavior in the big city. Paper [13] conducts research on the importance of introducing learning environment as part of an educational infrastructure. With the information gathered from previous materials, an intelligent interface is proposed for serving various educational necessities, including students with special needs.

3. VIRTUAL EDICATIONAL SPACE

VES is a term that stands for Virtual Education Space and it is intended as Internet of Things ecosystem with characteristics as it follows:

1. **Context-awareness –** Space is able to identify and locate changes when they occur;
2. **Distribution and Autonomy –** Space consists of autonomous components;
3. **Smartness –** Space monitors the processes inside and can reach decisions how to act if needed;
4. **Personalization –** Personal use of resources if needed;
5. **Accessibility –** Accessing any information resources in space is possible only through entry points;
6. **Adaptability –** Space is independent. It adapts to different forms of learning;

3.1. Architecture

VES is IoT ecosystem, so its components are divided in three main levels.

Access level – Some users can access VES through their PA (personal assistant). A copy of PA is automatically generated for every registered user. It is designed specifically for each person, and its purpose is to assist the student with the work in the space. Non-registered user can only access the space trough the educational portal DelC 2.0.

Analytical level (A-Subspace) – The most important level, which indicates the intelligent behavior of space. It sores and analyzes the information gathered by the sensors.

Sensory level – It collects and registers different types of data, which is used for normal operation of space. There are two types of sensors in VES – virtual and physical. The physical world consists of physical sensors, accessible by the guards.

Providing efficient interaction among autonomous intelligent components that operate in space is a serious challenge. Therefore, our approach consists of three steps: **Building a unified integrated technology** – Syntactical and communicational interoperability between different components in space and located on different architectural levels must be ensured. **Providing semantic interoperability** – The proposed integrated technology can not sufficiently provide conditions for intelligent interaction, that’s why it needs to be supplemented. **Proactive and learning assistants** – VES requires intelligent assistants.

3.2. Event Model

For all the components of space to work together, an event is created. In the model the event is defined as *Event = (e_id, e_type, e_pars)*, where *e_id* is event identifier, *e_type* is the type of event and *e_pars* are the different parameters of the event.

In space there four main event types:

- **System events** – events that are bind to changes in space, for example: sending / receiving messages, removing / adding components to space etc;
- **Domain events** – events applicable only with the domain in use (assignments, presentations etc.);
- **Basic events** – events that do not require arguments (date, time, location etc.);
- **Emergency events** – special type of events that correspond directly to emergency situations (earthquake, flood etc.);

Various assistants react differently to certain events (personalized assistants react to basic events and operative agents react to domain events). Depending on the origin of occurrence, events are split on two main categories:

- **Real** – events occurring in real world;
- **Virtual** – events occurring in virtual space;

Various relations may occur between the two types of events.

4. LISSA

Learning Intelligent System for Student Assistance(LISSA) main and only purpose in the beginning of the project was to allow access point for the users to VES trough which they can obtain information about the upcoming exams. With the development of VES itself and the integrations of LISSA in it the things started to change, and the little assistant become more and more complex and with more meaningful services that it can provide to its users. So, from a simple assistant it became multiagent IoT system capable of providing different services depending on the sensor networks it is connected to.

4.1. Introduction to the assistant

The main purpose of the systems stays the same – assisting the user through the educational process and providing additional help when it is needed. Through the iteration of the system we have added several features that were not planned originally but they do help for the system to look more useful and meaningful. At the current iteration the assistant helps by providing information and materials that the user can use to study for upcoming exams. It also warns the student for tests and lectures in the near future that he need to study for. The list of events is constantly updated, and it is based on the score of the exams that the student attends, for example if the student fails an exam the assistant will add to the upcoming events the date of the retake and will warn the students when the time near`s. The agent can also help navigate the student from its current location to the university or the location of a lecture, exam or an event of interest.

4.2. Profiles

To be able to be as useful as possible we introduced several profiles specialized for specific group of people, making it more useful for the user of the selected group. The different profiles come`s with specific hardware sensors that allow the assistant to guide the user.

1. **Regular profile –** as it goes by its name this profile is oriented to regular user and only offers the core functions of the assistant for direct use.

2. **Visually impaired** – this profile is designed for people that have reduced sight. In this case the assistant tries to be as helpful as possible by using OCR libraries to read signs out loud for the user. It can be used to read text books as well. It also provides navigation from place to place by giving directions to the user.
3. **Hearing impaired** – this profile is designed for people that have partially or totally lost their hearing. The agents listen`s all the time to the surroundings and tries to warn the user of incoming danger (for example approaching car) by vibrating and flashing warnings. It also to provides speech to text so the user can understand the surrounding dialogs or understand the lesson in class for example.
4. **Handicap profile –** this is one of the most hardware depended profiles because it comes with the ability to allow the agent to partially or fully control the wheel chair of the user depending on how severe the paralyzes of the user is. When is with this profile the user can give command for the assistant to lead him to or show him the way to specific location and the agent is calculating and showing the directions taking in consideration the terrain and the locations handicap platforms and rams and their operation status. This is done using CCA[14].

4.3 Architecture

LISSA is composed of several agents as it is shown in Fig.1.

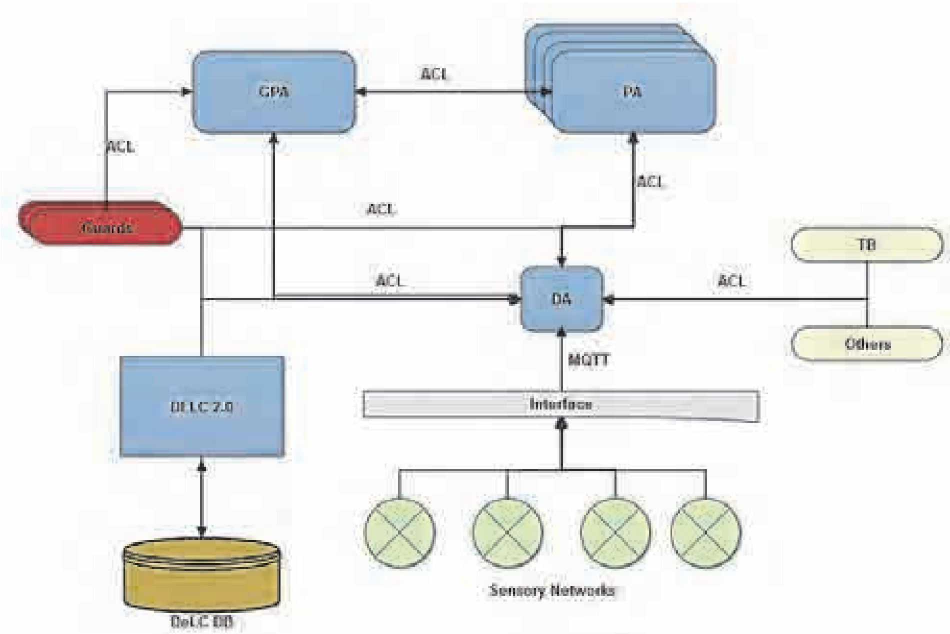

Fig. 1. Architecture of Learning Intelligent System for Student Assistance

Personal Assistant (PA) is JADEX[15] agent that is running on the mobile device of the user and it is used to interact with the user, providing him information and guidance. It has access to a private sensor network that is on the device itself and the type of sensors depends on the profile of the assistant that is being used by the student.

Generic Personal Agent (GPA) - JADE[16] agent which purpose is to create the instances of PA based on starting information received by the user in the installation phase.

Dispatcher Assistant (DA) – is JADE agent that is used to receive and dispatch messages through the system. First it is used to receive information from the outside sensory networks through an interface that sends all the information by MQTT[20] protocol based on that the dispatcher read the information and decides what information to which assistant to be send immediate and which to be stored for later use, for example an instance of PC may need the information about incoming bus right away so the information is needed right away there and will be send to that instances only and then the information will be kept for later use in case PA needs it. All messages send by DA are based on ACL allowing homogenous environment for all agents communication. The last task of DA is to receive messages from the rest of the agents from the systems and decided which message where to be sent.

4.4. Life Cycle

LISSA life cycle is separate in four phases as shown in the algorithm below.

ALGORITHM 1: Life Cycle

/* Registration */
B_0 ← get_percept;
while need_information(Q_0, A_0) **do**
$A_{\sum}$← ask_question;
end-while
profile ← register($A_{\sum}$, student_id);
/* Initialization */
Desires ← create_PC(profile, B_0);
B ← B_0;
I ← I_0;
/* Deliberation */
while true **do**
percept ← get_percept;
B ← update(B, percept);
D ← identify_goal(Λ, B, Desires);
I ← compose_goal(B, D, I);
/* Planning */
π ← plan(B, I, Ac);
while not (empty(**π**) **or** succeeded(I, B) **or** impossible(I, B)) **do**
    α ← head(**π**); execute(α); **π** ← tail(**π**);
percept ← get_percept;
B ← update(B, percept);
if reconsider(I, B) **then**
Desires ← update(B, I, Desires);
if needed **then** update(profile);
break;
end-if
end-while
end-while.

The first phase is the **registration**. It`s starts with the input of the faculty number of the student then the info is send to the GPA that checks if the number exists and the person is actually a student. Then list of questions are generated and send to the user that needs to be answered so the system can identify the needs of the person more correctly, based on the answer of this questions another list of questions may be generated and send back to the student. This goes on until the system has enough information to be able to generate student profile.

Initialization is executed every time the user starts the program. This allows synchronizations between the information on the device that the user has used to log on and the server. In this phase the GPA sends a copy of the PA`s personal calendar *(create_PC)* that contains all the incoming events for the student.

Deliberations phase starts as soon the initialization phase ends. The purpose of this phase is to constantly check the environment for changes. The received perceptions are separated in two groups – *standard:* current date, time and location of the user and *special*: they depend on the assistant profile that is begin used for example if we are using the handicap profile we may receive request from the user for movement of the wheel chair as environment change in the special group. Based on the updated beliefs(B), desires and early warning constant Λ, we try to identify goal that is presented as a domain event.

Planning phase – after the goal has been determinate we start prepare a plan for execution, through this phase we update the perceptions once more and based on the new update try to see if there is need for the agent to reconsider the current goal. Based on the result of the task there may arise need for update in the user profile for example if the user has failed an exam then to we must update the profile so it includes the failure and a date for exam retake. Once this phase is over the agent returns to the previous phase and repeats the process.

4.5. Prototype

At the moment we have created a prototype of the system that allows several of its core functionalities. The current prototype shown on Fig.2 gives reminders to the students for upcoming events and warns them when they need to study. This version allows voice commands and also support text to speech so every reminder is being voiced also and not only displayed.

The prototype allows the student to see all the incoming events and event read or request additional information for every one of them – for example who is going to be the lecturer what is going to be discussed etc. For every single event there is list of literature that can be read for preparation, right now the list is static but in the near future we will implement logic for determination of best reading materials for the current user based on his level of knowledge. Another functionality that is available is the directions from place to place where the user can request for a path from his current location to the event place, on this request the agent generate path and shows it to the student. If the student is located inside the campus and needs to go to specific room then he is shown a diagram of the campus and an arrow guiding him to the desired room.

For real results we plan to give the prototype to few students to use them in their studies in the next semester and based on the results we can improve the usefulness of the assistant.

Fig. 2. LISSA home screen

5. CONCLUSIONS

In summary, we have introduced what is LISSA and what part and purpose it has in VES. We have explained the basic life cycle and architecture it has and how the system should look once it is fully completed. At the end we explained the prototype and the functionality that it has at the time of writing this article.

We intend to complete all of the task and functionalities and even expand them in the near future.

REFERENCES:

1. LISSA
2. Stoyanov, S., A Virtual Space Supporting eLearning, Proceedings of the Forty Fifth Spring Conference of the Union of Bulgarian Mathematicians Pleven, April 6–10, 2016, 72-82.
3. M. Soliman, C. Guetl, Intelligent Pedagogical Agents in Immersive Virtual Learning Environments: A Review, The 33th International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO 2010), May 24 - 28, 2010, Opatija, Croatia, 827-832.

4. PAL, The PAL Framework, https://pal.sri.com/.
5. CALO, Cognitive Assistant that Learns and Organizes, http://www.ai.sri.com/project/CALO
6. Companions-project, http://www.companions-project.org/.
7. PAL, Personal Assistant for a healthy Lifestyle, http://www.pal4u.eu/.
8. Siri web page, http://www.apple.com/ios/siri/.
9. Google Now web page, http://www.digitaltrends.com/mobile/how-to-use-google-now/.
10. Y. Tang, S. Wang, Y. Chen, and Z. Chen, „PPCare: A personal and pervasive health care system for the elderly,” in Proc. 9th Conf. Ubiquitous Intell. Comput. 9th Int. Conf. Autom. Trusted Comput., Fukuoka, Japan, Sept. 4-7, 2012, pp. 935-939.
11. S. Tokunaga, H. Horiuchi, K. Tamamizu, S. Saiki, M. Nakamura, K. Yasuda, Deploying Service Integration Agent for Personalized Smart Elderly Care, 15th IEEE/ACIS International Conference on Computer and Information Science (ICIS 2016), June 26-29, 2016, Okayama, Japan, 897-902.
12. J. Santos, B. Silva, J. Rodrigues, J. Casal, K. Saleem, Internet of Things Mobile Gateway Services for Intelligent Personal Assistants, 17th International Conference on E-health Networking, Application & Services (HealthCom), 14-17 October, 2015, Boston, MA, USA, 311-316.
13. S. Tokunaga, H. Horiuchi, K. Tamamizu, S. Saiki, M. Nakamura, K. Yasuda, Deploying Service Integration Agent for Personalized Smart Elderly Care, 15th IEEE/ACIS International Conference on Computer and Information Science (ICIS 2016), June 26-29, 2016, Okayama, Japan, 897-902.
14. Siewe, F., Zedan, H., Cau, A. The Calculus of Context-aware Ambients, Journal of Computer and System Sciences, 2011, 77, 597-620
15. JADEX, https://www.activecomponents.org/
16. JADE, http://jade.tilab.com/download/add-ons/