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Abstract

Robots are common practice in industrial production, where they already control production processes. In many hospitals they support medical staff during complicated operations. There are robots in some libraries, that support the time-consuming process of inventory. However, in general libraries have been a rather unusual place for introducing robot applications so far and especially humanoid robots are still more than unusual in public nowadays.

Can humanoid robots be useful in daily life? What makes sense and what is just technical gimmick? For almost two years, the Technical University of Applied Sciences in Wildau has owned two so called Pepper robots[1]. Pepper is a human-shape robot. It is about 1.20 meters tall and weighs 28 kilograms (60 lb). Pepper is well equipped, highly versatile and can be programmed for specific needs. The model Pepper was launched in 2014 by the French-Japanese company Softbank Robotics Corporate as a genuine day-to-day companion for human beings. It has been available in Europe since September 2016. In Wildau, the RoboticLab Telematics, together with the library team, is experimenting with Pepper to be used as a self-employed library assistant to help visitors and to support the staff of the library. How does the printer work? Where do I find my book? Can you explain the facilities of the library to me? Pepper helps out as a charming new attraction of the university library in Wildau. In this paper, the steps necessary to transform a brand-new Pepper robot into a library assistant for the library at TH Wildau are discussed[2]. Furthermore, first experiences are provided. Some of them were very unexpected.

Keywords: computer science and library partnership, telematics, humanoid robot, Pepper robot, self-employed library assistant, user centered library, service design

A university library and a vision

The university library of TH Wildau has been a central place for studying and learning. It also has been a place for innovation and implementing forward-looking services for its users, many of them presented in previous IATUL conferences.[3][4][5][6]

In late summer 2016, Softbank Robotics Comp[7] started to sell its humanoid robot Pepper (see Figure 1) in Europe. Since 2014, the robot has been in use as a receptionist in banks, hotels and restaurants in Japan already. So, a new idea was born soon after: What about using Pepper as a mobile library assistant in the university library in Wildau (see Figure 1)? This idea

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[1] https://www.softbankrobotics.com/emea/en/robots/pepper (June 2018)
[2] https://icampus.th-wildau.de/bewerbung-bdj-2018/index.html
[3] http://docs.lib.purdue.edu/iatul/2012/papers/41/
[4] http://docs.lib.purdue.edu/iatul/2013/papers/52/
[5] https://internationalassociationofu2016.sched.com/event/6ZRN/parallel-session-2a-collaboration-a-library-and-telematics-tandem-about-an-inspiring-partnership-for-introducing-new-library-services
[6] https://docs.lib.purdue.edu/iatul/2017/partnership/4/
[7] https://www.softbankrobotics.com/emea/en (June 2018)

was triggered additionally, since the team of the library planned to open up as a 24/7 – library.[8] Additional help in the field of user service would have been highly appreciated by the library team. Could a humanoid robot like Pepper fill this gap? The team of the library was motivated to figure it out. In September 2016, two Pepper robots were purchased, one for development and one for productive use within the library. The team of the RoboticLab Telematics[9] as a long-term partner of the library has shared this vision since then and taken over the responsibility for the technical development of the applications necessary to turn the described vision into reality.

Figure 1: A special library assistant in action

Since then, almost two years have passed. Let's take a look behind the scenes to see what has been happening since then.

Introducing Pepper – a humanoid robot

First of all, we need to have a closer look at the robot. What are its strengths? What are its limitations? Pepper is about 1.20 meters tall and weighs 28 kilograms (60 lb). It is moving on a wheel base, which means, it won't be able to climb stairs. So, all possible scenarios will be restricted to one level of the library as long as Pepper is not able to use the elevator itself. Its friendly looking appearance can be even enhanced by its capability to perform a fairly natural gesticulation with its arms and hands, its upper body, and its head.

Speaking of the head: This is the part containing the actual computer of this technical devise – a quad core CPU with 1.9 GHz and 4 GB RAM as well as 8 GB flash memory. The head also contains several sensors and actors, e.g. four microphones and cameras, and touch sensors. Another important part has been the multimedia touch tablet, located at the chest of Pepper. Since the default language detection mechanism provided by the manufacturer does not work very well – you can only program the robot to listen to individual words – this has been used as the most reliable and least frustrating possibility for a user to interact with Pepper. The most practical way to let Pepper interact with other technical devices or with a database or server infrastructure is via WiFi.

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[8] Meanwhile, the university has offered the 24/7-opening service to its users.
[9] https://icampus.th-wildau.de/icampus/home/en/roboticlab-study-course-telematics (June 2018)

Last but not least, in the lower part of the corpus several sensors are placed that can be used for obstacle detection. Also, these sensors will be helpful to figure out if there are stairs ahead leading down.

For developing purposes, there is quite a wide selection of programming tools available: You can start to program Pepper with a graphical development environment called "Choregraphe" using basic functions already provided.[10] For more complex applications there are programming interfaces for different programming languages available, e.g. Python, Java, Javascript and C++.[11] For further details we refer to the official documentation provided by the manufacturer.[12]

Realizing the vision – steps to go

Although, the robot comes well equipped, it won't do anything except you implement the desired functionality before. In fall 2016, this was a problem for the team of the library: People came to see Pepper in action, but without one of its developers from the RoboticLab team, it wasn't possible to show anything. So, the very first step to go, even before thinking about a concept for realizing a mobile library assistant with Pepper, was to establish independency from a software developer for operating the robot. This has been realized by developing a web-based remote control, which can be used by everybody who has been granted access to it. This remote control has been extended by new functions since its first release.
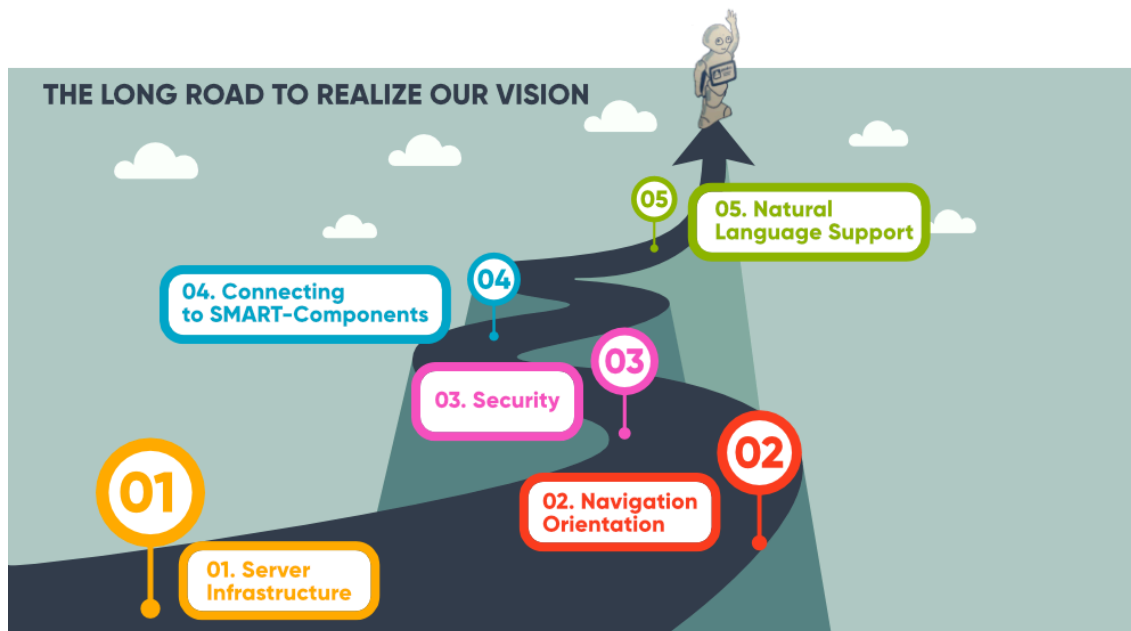

THE LONG ROAD TO REALIZE OUR VISION

05. Natural Language Support

04. Connecting to SMART-Components

03. Security

02. Navigation Orientation

01. Server Infrastructure

Figure 2: Pepper as a mobile library assistant – steps to go[13]

Now, let us talk about realizing the vision to use Pepper as an autonomously operating mobile library assistant. As visualized in Figure 2, this has been a long way, which is an even rockier road than we had expected at the beginning. There are some basic concepts that have to be considered and realized on its way.

In **Step 1**, a database and server-infrastructure has to be established to be able to deploy all necessary applications on the robot, handle all data that the applications need to provide services to its users as well as to connect to external services that are planned to be used.

Since Pepper shall be used as a mobile robot, **Step 2** is to develop and to implement a navigation and orientation concept for Pepper within the library. Special indoor orientation algorithms are the basis for this. There are several technologies that can be used theoretically. However, a usage of the well-known GPS technology cannot be considered since its signals

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[10] http://doc.aldebaran.com/2-4/software/choregraphe/index.html (June 2018)

[11] http://doc.aldebaran.com/2-1/index_dev_guide.html (June 2018)

[12] http://doc.aldebaran.com/2-4/family/pepper_technical/index_pep.html (June 2018)

[13] https://de.freepik.com/vektoren-kostenlos/unternehmen-meilensteine-mit-kreisen-und-pfeil_1296164.htm

cannot be received reliably inside buildings. In the context of this work, a method using image processing has been used. As a result, Pepper can always localize itself on the first level of the library in Wildau. Furthermore, the robot knows the direction in which it is looking and can move by itself from one point to another without damaging itself or others. Especially, it can move to its charging station, which is located at a certain place in the library. This will happen automatically when the battery needs to be charged. Also, the volume at which Pepper is talking, is set to a certain limit depending on the spot of the library the robot is standing at.

Step 3 pays attention to all security aspects: Pepper must not damage itself or others. For example, it must stop if there is an obstacle or a staircase leading downstairs. Also, aspects such as theft prevention or attempts to hack the robot need to be considered here.

Since the Pepper robot has been a technical device, it can communicate with other technical devices directly. This can be done via WiFi. In **Step 4,** opportunities and chances are considered that will be enabled by the described fact. Just to underline this idea, let's consider an example: Pepper can request information about the temperature or the quality of air in certain areas of the library to suggest the currently best place to sit and work to a user asking for this kind of advice. Therefore, a network of special sensors needs to be placed within the library. This scenario has already been implemented in the library at TH Wildau. Others are currently under development.

Of course, the ideal solution for people interacting with a humanoid robot is to be able to speak to it as to any other human and to get a correct and useful answer. For realizing that, we need to consider so called natural language processing (NLP) methods. In **Step 5** on the way to Pepper working as a mobile library assistant, this has been the focus. Here, IBM Watson's Natural Language Understanding service[14] has been used and will be exchanged by an open-source solution currently under our investigation. The most time-consuming part of this subtask is to train the application with enough examples, so that Pepper can give answers to as many library related questions as possible.
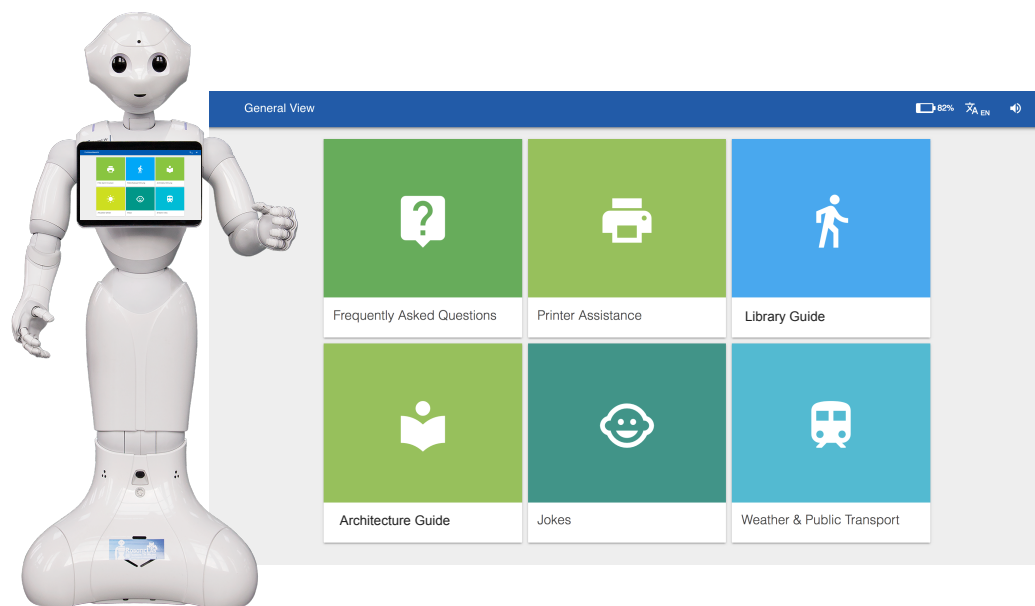

Figure 3: Pepper's tablet view – current services for the users of the library

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[14] https://www.ibm.com/watson/services/natural-language-understanding/ (June 2018)

Current state of work and future plans

Since March 2018, Pepper has been in action in the library of TH Wildau for a couple of hours each day. This is still a test phase: Most of the time, one of Pepper's developers are observing it in the background, interfering when there is help needed, logging possible problems and bugs to be able to improve the system step by step.

Since it is still in the learning phase, the NLP modus is only used on special occasions yet, like open house events of the university. However, this modus will soon be available to users on a daily basis. The preparations for it are underway.

The stable possibility for users to interact with Pepper is to use the tablet. Therefore, all available services are placed on the main menu as you can see in Figure 3: Frequently asked question will be answered as desired. Pepper can explain how the printer operates. There is a library tour available on which Pepper explains several points of interest on the first floor of the library. Pepper can also explain the architecture of the building in which the library is located. It can tell a joke if you ask, give you information about the weather and about departure times of the S-Bahn (public transport to Berlin and other cities departing near the university campus). Pepper is bilingual – it can communicate in German and in English.

Furthermore, Pepper recognizes when its batteries need to be charged, finds its charging station autonomously and connects to it.

Summary

To realize the vision of using a humanoid robot like Pepper as a mobile library assistant, as described in this paper, has been a long and very interesting way. At TH Wildau, a University of Applied Sciences near Berlin, this has been under development. First and very important milestones have been reached. Currently, the humanoid robot Pepper, manufactured and sold by Softbank Robotics Comp and trained as a library assistant by the RoboticLab team of TH Wildau, can be tested by its users and the library staff in the university library in Wildau. The first impressions are very promising. People are curious and interested. In the future, it is important to maintain this enthusiasm. Therefore, Pepper needs to perform reliably in all situations. Offered services need to be useful. However, we think the fun part must not be underestimated. So, the Pepper robot in Wildau will always have a joke in its mind, be prepared to give a little dancing performance and to laugh about itself. On the other hand, the enthusiasm and curiosity people feel about humanoid robots can also be used to improve applications. For instance, in order to train Pepper in NLP a large number of training data are necessary. In Wildau one cornerstone to reach this will be to asked for the help of all users of the library. Pepper is currently being prepared to be able to put this idea into practice.

Using a device like Pepper is still something special in our region. Since we have been one of the first adopters in the usage of it, we get into contact with other developer easily: You help each other with advice, share ideas and plan new project in cooperation. However, let us mention a quite unexpected effect of working with a humanoid robot as well: Pepper has been an object of interest for the local press, TV – shows, organizers of exhibitions and trade fairs. It has been a highlight of events with high school student as well as with younger children – just to name a few.[15] This definitely takes a lot of additional time. On the other hand, Pepper can be seen as a door opener: Each of these events has been a very good chance to promote our university, our library and our research group and to meet interesting people. So we will keep on doing this as long as our time allows.

Acknowledgments

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[15] https://icampus.th-wildau.de/icampus/home/en (June 2018)