Development of an Intelligent Virtual Assistant to Activate the Devices of a Residence by Voice Command

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Abstract. Home automation is increasingly present in people's lives and is already a reality in many Brazilian homes with differentiated solutions aimed at the needs of each user. However, this technology still has a very high cost, which makes it difficult for most of the Brazilian population to acquire it. Thus, the present work aims to present the development of a low-cost smart virtual assistant prototype, using the Python programming language and the open source Arduino platform, which will allow the activation of devices in a home by voice commands.

Keywords: Intelligent Virtual Assistant; Python Programming Language; Arduino Open Source Platform.

1 Introduction

In 1962, the American animation studio Hanna-Barbera Productions produced a cartoon series called “The Jetsons”. The series showed the daily life of a middle class family who lived in the future, in the distant year of 2062, in a house full of technological facilities, such as: flat screen TV, video conferencing, holograms, devices activated by voice commands , 3D printed food, sliding doors with presence sensor, escalators and moving walks, flying cars, among others. And there was even a robot named Rosie who performed all the housework and who was also the babysitter for the youngest of the family [1].

Currently, it is possible to have something similar to the residence of the “Jetsons” family. Thanks to home automation, it is possible to activate devices in a home, locally or remotely, through a cell phone, a tablet, a computer or a command center, with a simple touch of a button or by a command of voice [2].

One of the major obstacles to the growth of home automation in the country is the cost, which is still quite high. In addition, automating an already-built building requires a much higher automation deployment cost, due to the necessary modifications to be carried out in the building. When automation is planned in the building design phase, the costs of implementing automation are much lower [3].

Due to the complexity of each project, the technologies used and the needs of each customer, the cost of implementing a home automation system can vary greatly. It can range from R$1,000.00, for the automation of lighting in a room, for example, up to R$250,000.00, for the automation of the entire residence [4].

Home automation is not a new technology as many people think. Its beginnings date back to the 1970s, initially in the United States, where the first automated houses were conceived and became known as Smart Houses. However, their high cost and implementation difficulty made them a luxury item or science fiction works [5].

Home automation is the use of technology to facilitate and make automatic some routine household tasks that in a conventional home would be the responsibility of its residents [4].

Its use aims to reduce the time spent on daily tasks, reduce electricity and water consumption, in addition to increasing the sense of well-being and improving the quality of life of residents [2].

In addition to the numerous benefits that home automation can provide to its users, such as: convenience, safety, ease of installation and operation, saving electricity and water, increasing the useful life of electronic equipment and mainly the appreciation of the final price of the property [6].

It is also worth mentioning that the application of this technology in homes can also improve accessibility and quality of life for the elderly, bedridden patients, people with some type of disability and people with mobility difficulties [3], [7].

Turn on, off and adjust the volume of the audio and video system; turn on, off and adjust the luminous intensity of the lights; open and close blinds or curtains; turn on, off and regulate the temperature of the air conditioning; turn on faucets; heat the bath water; open and close doors; open and close the garage door; control access by biometrics; trigger the alarm; monitor the house by security cameras; schedule cleaning and heating of pool water; turning the garden's irrigation system on and off; turning off low electrical outlets in a home to avoid accidents with small children or turning on the gas fireplace are some of the tasks that can be performed, without having to get up from the couch, with the use of home automation [7], [8].

According to the Brazilian Association of Home Automation [9], around 300,000 homes in Brazil have some type of automation, and this number may grow much more, as according to a survey carried out by the association, 78% of Brazilians have interest in this service, a number higher than the world average, which is 66%. However, this technology still has a very high cost, which makes it difficult for most of the Brazilian population to acquire it, thus being restricted to people in society with high purchasing power.

Thus, the present work aims to present the development of a low-cost smart virtual assistant prototype, using the Python programming language and the open source Arduino platform, which will allow the activation of devices in a home by voice commands. In addition, the proposed smart virtual assistant will have the following features: make your presentation, inform the current time and date, wake the user at a predetermined time, remind the user the correct time to take a certain medication, inform the forecast of the time, inform the dollar rate, perform Google and Youtube searches, access Facebook and Hotmail accounts, run programs, play music, display photos, congratulate the user on their birthday, send messages via WhatsApp, send and -mails to congratulate the birthdays of the day, recite Bible verses, activate the security camera, activate the burglar alarm, schedule times to turn devices on and off, activate the electric lock through facial recognition, change the wallpaper from the desktop, inform the percentage of the battery charge of the notebook, inform the notebook configuration, empty the trash, reset the notbook, turn off the notebook and disable the smart virtual assistant.

To achieve the proposed objective, the following methodological resources were used: Bibliographic research, carried out from the detailed analysis of previously published materials, consisting mainly of books, academic papers and websites. The development of intelligent virtual assistant software, using the Python programming language, which will allow the sending of voice commands performed by the user. The development of the intelligent virtual assistant hardware, using the Arduino open source platform, which will allow the activation of home devices by voice commands sent by the user. Performing the functional test of the intelligent virtual assistant's software and hardware. And finally, a comparative study between the 3 (three) main voice recognition technologies (Vosk, IBM Watson Speech to Text and Speech Recognition) and the results obtained.

2 Related works

In this section, the most relevant academic studies that contributed to the development of this work will be presented, listing their positive and negative aspects.

The study entitled “A cloud based and Android supported scalable home automation system”, by Korkmaz et al. [10], presented the development of a prototype of a home automation system that would allow the activation of household appliances in a home through an application installed on the smartphone or through a website. This study was restricted to remotely activating appliances, but presented as a positive point the possibility of using the system by several users, simply registering a login and password.

The study entitled “Raspberry Pi as a Sensor Web node for home automation”, by Vujović and Maksimović [11], presented the development of a prototype of a residential fire alarm. When a signal was detected by temperature sensors installed in the residence, based on predefined fuzzy logic rules, the alarm was triggered.

This study was restricted to the development of a prototype of a residential fire alarm, but presented as positive points the decision-making through the use of fuzzy logic and also the possibility of the user being able to monitor temperature sensors over the internet in real time.

The study entitled "Development of a prototype smart home intelligent lighting control architecture using onboard sensors a mobile computing system", by Samuel et al. [12], presented the development of a prototype of an intelligent lighting system. This study was restricted to the development of a prototype of an intelligent lighting system, but presented as positive points the possibility for the user to choose the color of light emitted by the lamp of the luminaire, the possibility of the luminaire being turned on or off according to the ambient brightness and also the possibility for the user to be able to control the luminaire over the internet when not at home.

The study entitled "IoT based Voice/Text Controlled Home Appliances", authored by Uma et al [13], presented the development of a prototype of a home automation system that would allow the activation of household appliances in a home by voice commands or messages of text. This study was restricted to remotely activating appliances, but presented as a positive point the possibility for the user to program times to turn appliances on and off.

The study entitled "Development and verification of a smart remote control system for home appliances" by Lin et al. [14], presented the development of a prototype of an intelligent remote control for activating household appliances in a home. The activation of the appliances would be carried out by commands sent by an application installed on the smartphone. This study was restricted to remotely activating appliances, but presented as a positive point the possibility of the user being able to control all the appliances in his/her home from one place, thus eliminating the need to have several remote controls.

Finally, the study entitled "An internet of things-based smart energy meter for monitoring device-level consumption of energy", by Muralidhara, Hegde and Pm [15], presented the development of a prototype of an electric energy meter smart, which could be deployed in homes and industries to measure the electricity consumption of a household appliance or industrial equipment. The system was designed to operate as a standalone device that could be placed between the household appliance or industrial equipment and the power grid. This study was restricted to the development of a prototype of an intelligent electric energy meter, but presented as a positive point the possibility of the user being able to monitor the electric energy consumption of a household appliance or industrial equipment over the internet in real time.

3 Technologies used for prototype development

In this section, the technologies that were employed for the development of the intelligent virtual assistant prototype will be presented.

3.1 Arduino open source platform

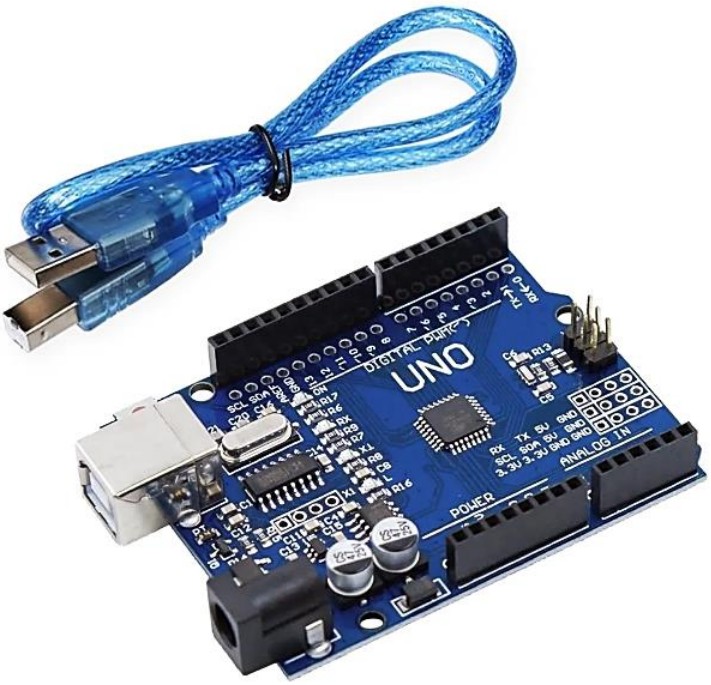
Arduino is a development platform for electronics, automation and robotics projects. It was created in 2005, in the Italian city of Ivrea, by a group of 5 (five) researchers: Massimo Banzi, David Cuartielles, Tom Igoe, Gianluca Martino and David Mellis. The goal was to develop a device that was both inexpensive, functional and easy to program, thus being accessible to students and amateur designers. Furthermore, the concept of free hardware was adopted, which means that anyone can assemble, modify, improve and customize their own Arduino, starting from the same basic hardware. Arduino is composed by hardware (controller board) that can be easily connected to a computer through a USB cable and by software (Integrated Development Environment) that enables Arduino programming using a language based on C/C++ [16].

3.2 Relay module

The relay module is intended to allow the Arduino to activate loads of great power and supplied with alternating voltage, such as: electric lamps, electric locks, electric motors, appliances, among others [17].

3.3 Python programming language

Python is an open source programming language, conceived and developed by Guido Van Rossum, a Dutch mathematician, in the early 1990s. Currently, Python is one of the most used programming languages in the world and has a huge community of developers that constantly seeks to improve the software [18].



Arduino open source platform

Relay module

Python programming language

Figure 1. Technologies used for prototype development

4 Prototype operation

In this section, a description of how the smart virtual assistant prototype works will be presented.

Figure 2 presents the steps that describe how the smart virtual assistant prototype works.

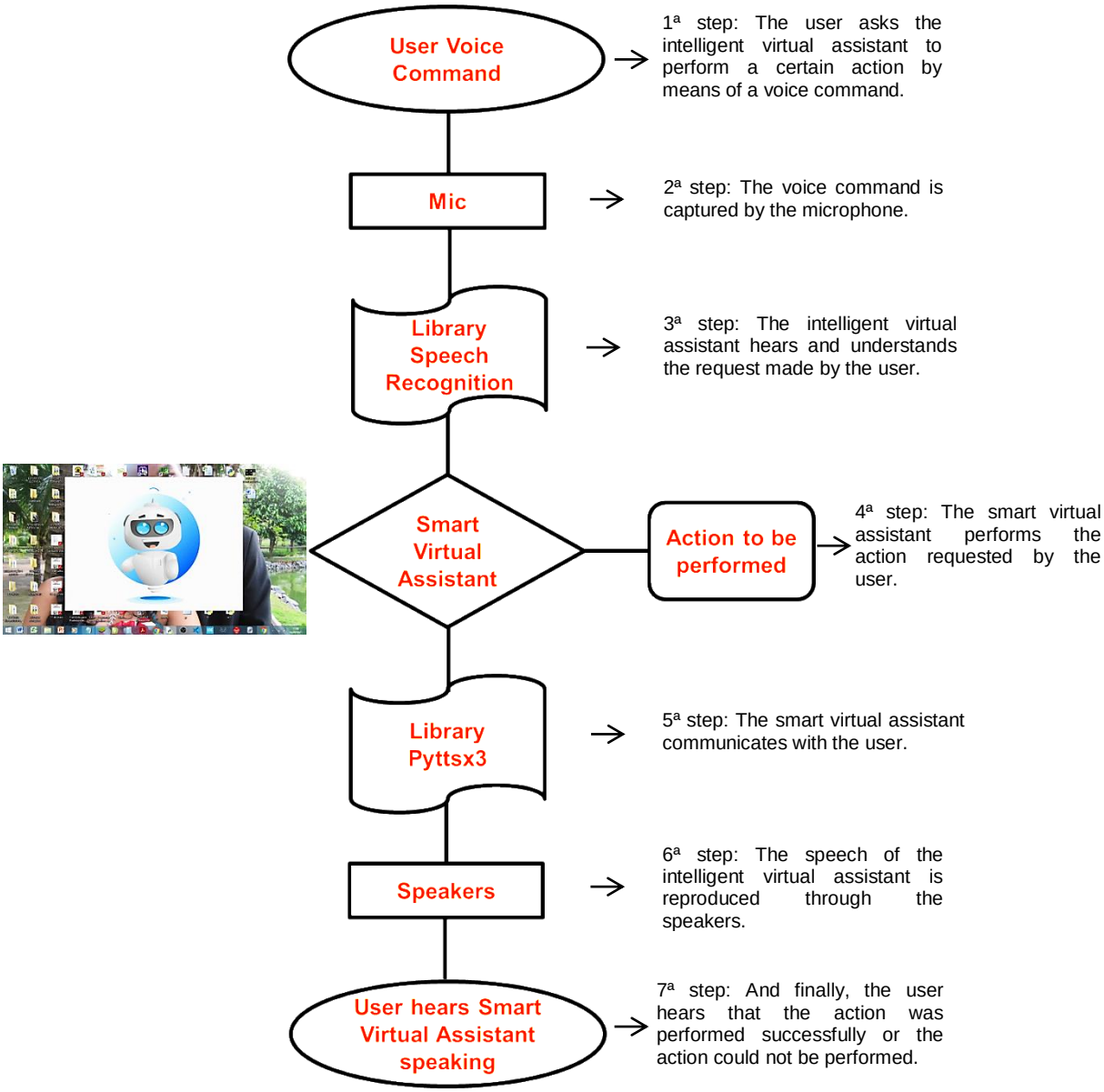


Figure 2. Prototype operation flowchart

A detailed explanation of each feature, the software source code, the hardware electrical circuit and all the intelligent virtual assistant documentation is available for free download, on Google Drive, at:
https://drive.google.com/drive/folders/1gxJ15OcaGCEo_ctUTzFUs3ULWf1XYmfX?usp=sharing

And finally, the video that demonstrates all the features of the intelligent virtual assistant is available for viewing, on Youtube, at:
https://www.youtube.com/watch?v=9TyqN5hDRjM

5 Results and discussion

In this section, a comparative study will be presented between the 3 (three) major voice recognition technologies (Vosk, IBM Watson Speech to Text and Speech Recognition) and the results obtained.

5.1 Comparative study

The Vosk library is a speech recognition API for various programming languages like Python, Java, Node.JS, C#, C++ and others. This library has as positive points the support for 17 languages and dialects (English, Indian English, German, French, Spanish, Portuguese, Chinese, Russian, Turkish, Vietnamese, Italian, Dutch, Catalan, Arabic, Greek, Filipino, etc.), the voice recognition process takes place without the use of the internet and its use is free. However, it has a low hit rate for the Portuguese language as a negative point, that is, many words in the Portuguese language are not recognized. All information about the library can be found at: https://github.com/alphacep/vosk-api.

IBM Watson Speech to Text is a speech recognition API created by IBM. This API has as positive points the support for several languages (Arabic, English, Spanish, French, Brazilian Portuguese, Japanese, Korean, German, Mandarin, etc.) and also allows the creation of a custom language template. However, it presents as negative points that its use is not free and the need to have a good internet connection, as the entire voice recognition process takes place in the cloud on IBM's servers. All information about the API can be found at: https://www.ibm.com/cloud/watson-speech-to-text.

Finally, the Speech Recognition library is Google's speech recognition API for the Python programming language. This library has as positive points the support for several languages, high hit rate regardless of the chosen language, a low response time between voice commands and the execution of actions, allows you to isolate the noise from the environment and its use is free of charge. However, it presents as a negative point the need to have a good internet connection, as the entire voice recognition process takes place in the cloud on Google's servers. All information about the library can be found at: https://github.com/Uberi/speech_recognition.

5.2 Results obtained

Table 1. Comparison between the 3 (three) main voice recognition technologies

	Support for multiple languages	High hit rate	Low response time	Allows you to isolate ambient noise	Voice recognition process takes place without using the internet	Free use
Vosk	x				x	x
IBM Watson Speech to Text	x	x	x			
Speech Recognition	x	x	x	x		x

Therefore, based on the data presented in Table 1, the result of a comparative analysis between the 3 (three) main voice recognition technologies, it was demonstrated that the choice and use of the Speech Recognition library in this work proved to be extremely advantageous, not only in terms of technological efficiency, but also made it possible to reduce prototype development costs.

6 Conclusions

In this section, the final considerations of the present work and suggestions for future research will be presented.

In the present work, the development of a low-cost smart virtual assistant prototype was presented, using the Python programming language and the open source Arduino platform, which would allow the activation of devices in a residence by voice commands.

After performing all the tests, it was found that the intelligent virtual assistant prototype worked satisfactorily, with a very small response time between voice commands and the execution of actions, for a system where the entire recognition process voice takes place in the cloud on Google's servers.

It is expected that this work will help and serve as a basis for future home automation projects using the Python programming language and the open source platform Arduino. And still contribute significantly to make this type of technology more popular, collaborate to make it cheaper and also allow access to all Brazilians.

As a suggestion for future work, the functionalities of the intelligent virtual assistant can be improved and extended.

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