Virtual Assistant for IoT process management, using a middleware

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ABSTRACT

The implementation of virtual assistants, the automation of homes, smart cities, management of remote sensors, among other technologies related to the internet of things (IoT). They allow to improve the control, monitoring and management of your processes. The present research work employs a Message Oriented Middleware (MOM) for interconnecting devices allowing to monitor the domestic energy consumption of a household (KWH, fees to be paid by day, week, month) in real time, using a wizard virtual (chatbot) which facilitates the Administration and control of the connected electrical devices. Through a combination of ubiquitous distributed sensing units. Adding data, reasoning and awareness of the context.

CCS Concepts

• Human-centered computing→Human computer interaction • Computer systems organization→ Real-time systems • Information systems→Data management systems • Hardware → Power and energy

Keywords

Virtual Assistant; Chatbot; IoT; Middleware; Natural Language; Instant Messaging; Telegram; Arduino.

1. INTRODUCTION

IoT will reach 26 billion units installed in 2020, which will generate incremental revenue of $300 billion dollars mainly in services. Transforming business processes more accurate and visible in real time [1]. According to [2], the internet of things (IoT) to be a combination of the Internet focused on the future and ubiquitous computing. It is composed of two components defined Internet and things. Internet as an infrastructure of global network with auto-configurable, scalable and dynamic expansion capabilities based on standard and interoperable communication protocols. Things like virtual objects / devices information with identity, physical attributes, virtual personalities and use of intelligent interfaces. Things that are heterogeneous in nature and which are perfectly integrated in the information network.

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Due to the demand of IoT is necessary the use of a software platform called middleware (logic of mediation). Providing abstraction to applications of things and offering multiple services. Characteristic element of a distributed system. Allowing the interaction, communication or connectivity between applications and their respective stored services. Opening an active area of research. [3], [4].

According to [5], [6], advances in technologies ubiquitous wireless networks and portable sensors and sophisticated messaging systems existing at present. They allow to develop services and applications that facilitate human-machine interaction [7], simplifying the connection between everyday home Internet devices. In this context, such applications have evolved, allowing communication to be feasible by "application of conversational bots chatbots" [8], and algorithms of machine learning, translation and analysis. Existing standalone applications such as: Amazon Alexa [9], Microsoft Cortana [10] and Siri's Apple [11], among others [12].

This research aims to develop a virtual assistant that manages electrical devices connected in a House, to determine your energy consumption (KWH, date, fee payable). Forming an intelligent network [13], through the use of a Message Oriented Middleware (MOM), which stores and manages the information of consumers, in order to improve the efficiency and reliability and cost savings energy levels.

The article has been organized in the following manner: section II describes the background and related work that sustains this inquiry, section III implementation, section IV shows the results and discussions and finally, in section V is establishing the conclusions on the basis of the results obtained and describes future work.

2. BACKGROUND AND RELATED WORKS

2.1 Messaging Systems

Nowadays these applications are the most used of the Internet, allowing exchange of text messages, videos, images, audios and files between users who have allowed to communicate with each other in this way, these systems use protocols that support instant messaging, it should be noted that some messaging systems allow a client-server communication and other client to client, the most

used protocols are: Internet Relay Chat (IRC), Extensible Messaging and Presence Protocol (Jabber / XMPP), Windows Live Messanger (MSN / WLM), Mobile Transport Protocol (MTProto), Open System for Communication in Realtime (OSCAR) and YCHT / YMSG (Yahoo!) [14].

2.2 Telegram

It is a multiplatform instant messaging application for Android, MacOS, Windows and Gnu / Linux, which allows two or more users to send and share files in different formats (text, image, video, audio and file), this application is committed to security and user privacy through data encryption, positioning it as the best messaging platform [15], in the same way it has taken giant steps to be the pioneer in implementing the "bots conversational or chat bots" through programming code, using Telepot, Telegram Bot API, among others. Continuously updates its platform with new features.

2.3 Conversational Bots or ChatBots

They are automated computer programs, that is, they are programs that do not require a human operator, most of these programs are capable of maintaining a conversation with humans, using Artificial Intelligence (AI), natural language processing (NLP: Natural Language Processing) in a system of questions and answers (QA systems: question-answering systems) whether you want to request information or take action [16]. The first generation Chatbots were designed to help operate chat rooms or to entertain chat users, for example, question bots or appointments [17]. Chatbots can interact with users through text, images, videos, links and call-to-action buttons.

2.4 Natural Language Processing (NLP)

It is the field that combines several technologies of computer science such as: artificial intelligence, automatic learning or statistical inference, with applied linguistics, with the aim of understanding and processing by computer the human language for certain tasks, such as automatic translation, interactive dialogue systems, analysis of opinions, among other functionalities that will be adapted to new technological advances. According to [18], the implementation of natural language in intelligent systems has allowed us to divide into two main approaches for a human-machine communication..

2.4.1 Pragmatic or pragmalinguistic

It is a subfield of linguistics that is interested in the way in which context influences the interpretation of meaning. The context should be understood as a situation, since it can include any extralinguistic aspect: communicative situation, knowledge shared by speakers, interpersonal relations, etc. A string of words can have one or more semantic interpretations [19], [20], these interpretations can be incomplete if the context-dependent information on the current situation of each possible interpretation is not added.

2.4.2 Resolution of references

According to [19] "The most obvious need for pragmatic information is in the resolution of the meaning of referents, which are phrases that directly refer to the current situation." The receiver who interprets a conversation, the first thing to have in account is knowing where or from whom such information comes, and using this information to resolve the referent and give meaning to what is said or interpreted, that is, the recipient must be able to discern who is "me" and when it is "today" "The resolution by reference is the interpretation of a definitive pronoun or noun phrase that refers to an object in the world (In linguistics, mentioning something that has already been introduced is called an anaphoric reference.) Referencing something that has been introduced it is called cataphoric reference).

The resolution is based on the knowledge of the world in the parts prior to the speech, commonly the resolution of references is a problem in which a reference of a list of candidates must be selected [19].

With the passage of time and new technologies, it has been possible to design a large number of resolution algorithms by reference, two of the best known are the algorithm pronoun references [20] and Pronominal Anaphora Resolution [21].

2.5 Internet of Things (IoT)

It is a concept that refers to the digital interconnection of devices with Internet, these devices have a unique identifier and the ability to transfer data through the network, allowing to interact independently with any other individual, either a Machine-Machine communication (M2M) or Human-Machine (M2H) [22]. These devices can be controlled remotely inside or outside the network.

2.6 Middleware

It is also known as information exchange logic between applications, located in the layers of applications and the lower layers (operating system and network), this software is responsible for assisting an application to communicate and interact with other applications, databases, networks , hardware and operating systems [23]. The classification of middleware software is divided into two main categories, which are divided into subcategories.

2.6.1 Integration Category

This type of middleware has a specific characteristic of being integrated in a heterogeneous systems environment. Each of these middleware are characterized by having a different communication protocol or a different operating mode among the other software.

2.6.1.1 Message Oriented Middleware (MOM)

In accordance with [24], [25] is a type of middleware (technology) that consists of the transmission of data between applications using a communication channel that carries self-contained units of information (messages) in an environment of applications distributed.

Message-Oriented Middleware (MOM). There are two models that are described below:

point to point: the messaging system uses queue allowing to disconnect the transmitter from the receiver. When a component wants to send a message to another, place the message in the queue on the receiver (which means to know him) and ignores the message. Middleware includes requests of sent in a predetermined order of waiting.

publish/subscribe: messaging system is responsible for the complete management of the messages. Each message is associated with a specific event, so that components that are interested in receiving the messages associated with the event are subscribed to it. The middleware is something more oriented to events.

2.6.2 Application Category

This type of middleware fits several application-specific functions [24]. These middleware are characterized by having access to

databases, web browsing, being in real time, being desktop and most special, each works specifically with an application.

3. IMPLEMENTATION

3.1 Chatbot

To design the virtual assistant, we started with a basic architecture, which contemplates communication with users, using the Telegram instant messaging platform, through the human-machine conversation, as shown in Figure 1, this process will allow direct capture the orders sent by the user, either by voice (audio) or text, through an interface.

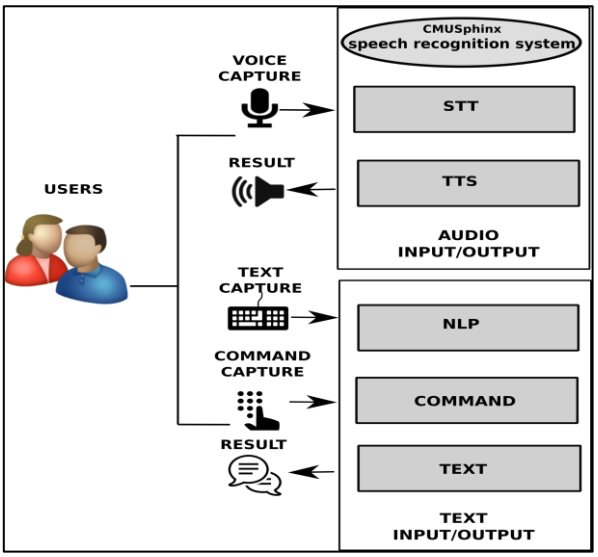

Figure 1. Chatbot functionality architecture.

3.2 Middleware

After the creation of the Chatbot, it is necessary to note that through the middleware is to obtain data in real time, integrating MOM (Message-oriented middleware) for its correct operation, receiving applications through the Protocol http, facilitating communication hardware and software, creating a distributed communication platform, as shown in the Figure 2.

Middleware is the core of integration of hardware and software, allowing a machine-machine communication, receiving data or commands sent from the Chatbot, allowing to create a SQLite prior knowledge database, facilitating of decisions.

3.3 Monitoring

As shown in Figure 2, the platform will have the open API for the ThingSpeak Internet of Things, which will allow the collection and visualization of statistical data in real time through interactive graphics, which will be presented to the user. These graphs represent the KVH consumption and the cost to pay, by date (day, week and month) of each device connected to the Arduino electronic plate.

3.4 Functionality Architecture

The development of a platform that covers several services at the same time, is possible thanks to the implementation of a specialized middleware, which is responsible for receiving, interpreting and sending data to each service depending on the user's need, as you can see in Figure 3.

One of the main features provided by this technology is the integration of MOM (Message-oriented middleware) that facilitates the communication using the http protocol, opening the way to the creation of a smart grid, where several actors, interact in terms of data, both at the energetic level, increasing its reliability and safety that arises from the ability of monitoring and performance in real time over the network

This platform creates a human-machine communication and machine-machine, having the possibility of interpreting the issuer orders, applying processing natural language (NLP) and recognition of voice using speech to text (STT) and text to speech (TTS), procedure that facilitates the user to send data that will be stored in a database (SQLite), displayed in a graphical manner with ThingSpeak and sending an Arduino electronic plate which is responsible for executing the orders received.

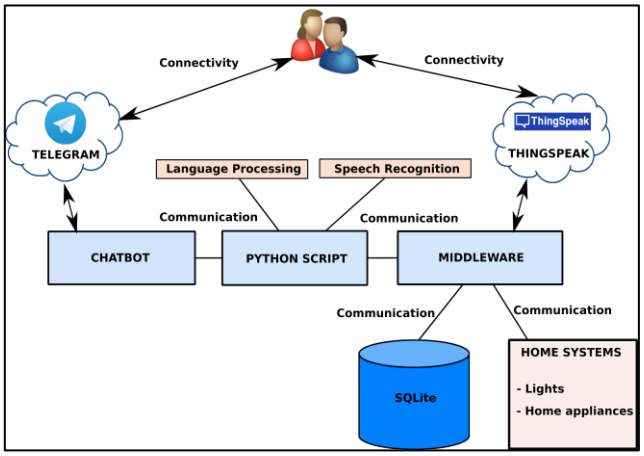

Figure 2. Middleware functionality architecture implemented a Virtual Assistant.

As shown in Figure 1, the information sent from the user through the Chatbot can be: text phrases that describe a specific order, will also be able to send voice messages (audio), which will be transformed to text for be able to interpret the order and proceed to run it, and finally the user shall have the possibility of sending orders through commands pre-established by the Chatbot, as shown in Figure 3.

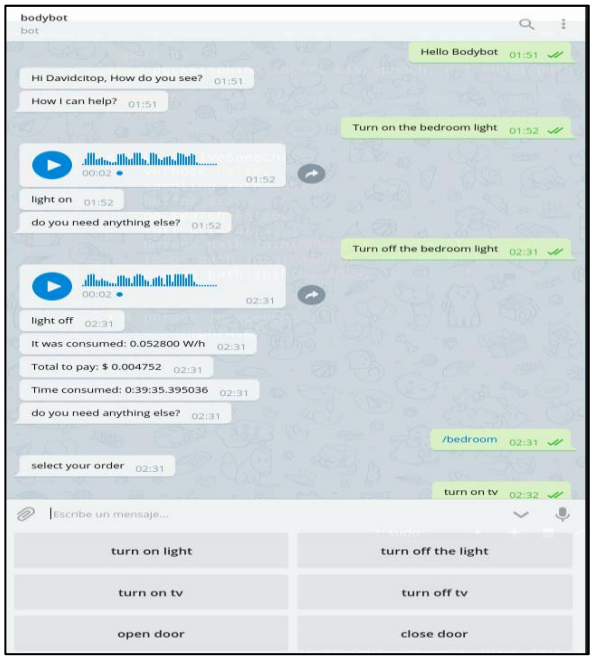

Figure 3. Functionality of the chatbot, by means of commands and commands.

4. RESULTS AND DISCUSSIONS

Currently in the Ecuador energy consumption data makes it monthly in traditional way, visiting each home and obtaining data manually meter, data which are then entered into the system of each company, is for this reason that as case study and validation of the virtual assistant and efficiency in communications with middleware, were carried out tests on a prototype of IoT about a real environment, obtaining KWH consumption data for two months, allowing to obtain the total payroll to pay During this period of time in a remote way, values that they are quantified by applyingthe following formula:

$$X = \frac{W * H * D}{1000}$$

Where each letter means:

X: Monthly consumption.

W: Power (vattio)

H: Hours of use per day

D: Days per month

1000 (KWH)

This formula was applied nationally by companies who are responsible for the distribution and marketing of power at the national level in Ecuador, allowing to obtain accurate results of the KWH consumption, taking into account the KWH in the Ecuador cost is $0.09 in the residential sector, facilitating the achievement of the following results.

Table 1. Data to calculate the total energy consumption in the month and the value to pay

Home appliances	Power (W)	Hours of use per month	Energy consumed per month
Fridge	400	24	288.00
Light room 1	80	8	19.20
Light room 2	80	5	12.00
Light room 3	80	8	19.20
Light room 4	80	8	19.20
Light room 5	80	6	14.40
TV 1	70	6	12.60
TV 2	70	6	12.60
Total (Kwh)			397.20
Cost Kwh ($)			0.09
Total to pay Monthly ($)			35.79

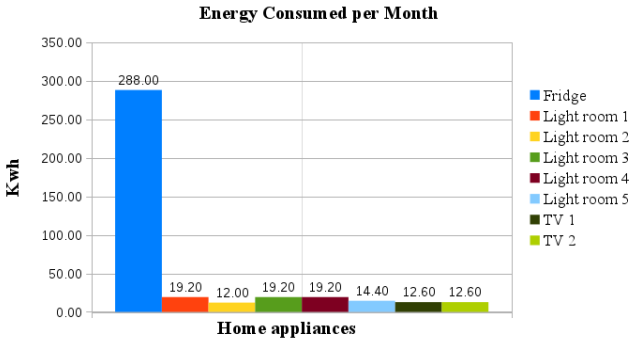

Figure 4. Energy consumed per month.

Table 2. Data to calculate the total energy consumption of the day and the value to be paid.

Home appliances	Power (W)	Hours of use per day	Energy consumed per day
Fridge	400	24	9.60
Light room 1	80	8	0.64
Light room 2	80	5	0.40
Light room 3	80	8	0.64
Light room 4	80	8	0.64
Light room 5	80	6	0.48
TV 1	70	6	0.42
TV 2	70	6	0.42
Total (Kwh)			13.24
Cost Kwh ($)			0.09
Total to pay Daily ($)			1.19

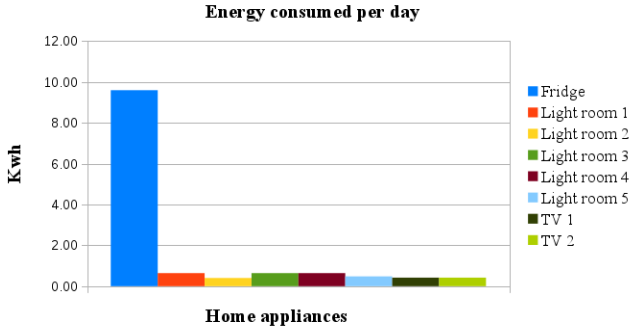

Figure 5. Energy consumed per day.

It should be noted that the results of every connected device make a variation of consumption in different periods of time during 24 hours a day, 7 days a week, during 2 months, identifying which of these consumes more energy at the end of the day week, or month, in order to detect excessive energy consumption, saving time, resources and money. This process facilitates the user to display real-time energy consumption, and allows you to have total control of your home.

Unlike other research conducted monitoring in time real or the applicability of a middleware in single IoT focus observe processes, but does not realize the costs and benefits of evaluating consumption of each device connected to the network, in such a way that the user keep is informed of the total return to pay.

5. CONCLUSIONS AND FUTURE WORKS

The middleware applied in this research facilitated the process automation hardware and software through the integration of MOM (Message-oriented middleware), allowing the users to manage and monitor the energy consumption of their homes in real time, saving time and resources.

The virtual assistant was adapted to facilitate communication speech to text (STT) and text to speech (TTS) applying (NLP) natural language processing, improving communication, human, in such a way that orders or commands sent by part of the users may be interpreting them and processed, giving appropriate responses to their requests.

The results obtained in this research made them is possible thanks to an Arduino electronic plate, which allowed that domestic devices are connected to the network using a unique identifier, making consumption of each device power 24 hours a day, taking into account that the applicability of this research adapted it to the energy of Ecuador situation, since it will depend on the KWH cost of each region.

As future work is proposed to incorporate the virtual assistant, a neural network that facilitates the automatic learning of interactions with users, obtaining a record in real time of the human-machine interaction, classifying and storing in a database, orders, conversations and commands of IoT, avoiding data redundancy.

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