

Voice Controlled Home Automation System using Natural Language Processing (NLP) and Internet of Things (IOT)

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Abstract—The primary objective of our project is to construct a fully functional voice based Home automation system that uses Internet of Things, Artificial Intelligence and Natural Language Processing (NLP) to provide a cost-effective, efficient way to work together with home appliances. There are many smart home solutions in the market that aim to automate the basic operations of these home appliances using various technologies such as GSM (Global System for Mobile), NFC (Near-Field Communication) etc. However, most of these systems focus on mimicking the basic operation of the electrical switch. Our project aims at providing a fully automated voice based solution that our users can rely on, to perform more than just switching on/off the appliances. The user sends a command through speech to the mobile device, which interprets the message and sends the appropriate command to the specific appliance. We plan on implementing four basic home appliances as a “Proof-of-Concept” for this project which includes Fan, Light, Coffee Machine and Door Alarms. The voice command given by the user is interpreted by the mobile device using Natural Language processing. The mobile device acts as a central console; it determines what operation must be completed by which appliance to fulfill the user’s request. The central console might likewise be either a desktop application, web application or a smart phone application as nearly all of the data transferred can be processed by the cloud. However, for the convenience of the user and increased mobile capabilities we will be using a smart phone in this project. The appliances are associated with the mobile device through an Arduino Board that establishes the concept of Internet of Things. The Arduino Boards are interfaced with the appliances and programmed in a manner that they respond to mobile inputs.

Index Terms— Home Automation System, Arduino Boards, Natural Language Processing (NLP), Artificial Intelligence (AI), Internet of Things (IoT).

I. INTRODUCTION

Our project is built upon the on the concept of Internet of Things. We have determined to implement seamless integration of all the appliances in the home via a central console. The project greatly changes the way in which we communicate with our home appliances. It also reduces the need for any personal contact with any of them as it delivers a wholesome experience of wireless, voice controlled system. We plan to implement this project with

the aid of Arduino boards with the capability to perform IoT (Internet of Things) operations. Installing the boards in every appliance of the house will allow us to establish real-time communication with them via Wi-Fi. We plan on using Arduino MK1000, known as Genuino MK1000 outside of the United States to implement this project.

Arduino MKR1000 was primarily designed for practical and economic solution for innovators seeking to create Wi-Fi enabled projects with minimal pre-requisite knowledge in the field. It is built upon the Atmel ATSAMW25 SoC (System on Chip), which is a member of the SmartConnect family of Atmel Wireless devices, that specializes in IoT (Internet of Things) projects and devices.

The ATSAMW25 is primarily composed of three distinct blocks

- SAMD21 Cortex-M0+ 32bit low power ARM MCU
- WINC1500 low power 2.4GHz IEEE® 802.11

The ATSAMW25 comprises of a single 1*1 stream PCB Antenna. The design of the board entails a Lithium Polymer charging circuit which helps the Arduino/Genuino MKR1000 to operate on battery power or peripheral battery, charging the Lithium Polymer battery when it is running on a peripheral source. The switching of a single source to another is done instantaneously and automatically.

It has a proper 32 bit computational power similar to Arduino Zero board, the usual array of I/O interfaces, power efficient Wi-Fi along with a Crypto chip for reliable data transmission, and the simplicity of utilization of the Arduino Software (IDE) for code programming and development. All of the above listed features makes this board the most preferred option for the emerging IoT battery- powered projects such as ours. Its condensed form factor makes it even simpler to operate and aids in design.



Fig: Arduino/Genuino MKR1000

It has a USB port that can be used to provide power (5V) to the board. The Arduino/Genuino MKR1000 has the capability to run with or without the Lithium Polymer battery involved and has very limited power consumption. The Wi-Fi module of the MKR1000 supports certificate SHA-256. Most of the Arduino sketches can be developed in any programming language of choice with a compiler that yields binary code. The Atmel Corporation provides a standard development environment for its microcontrollers, AVR Studio and the latest version of Atmel Studio, which can be used for programming Arduino.

Our project uses a mobile application to interact with these Wi-Fi signals emitted from these appliances. The application sends out instructions to the Arduino boards and also respond to the feedback from them. When any command is sent from a remote place, the Arduino boards receive them from the Wi-Fi router which they are connected to when they are connected through to the mobile device.

The Internet of Things (IoT) has immense potential to change many of our daily activities, routines and behaviors. The persistent characteristic of the internet sources means that a large amount of data relating to almost every facet of human activity, both communal and private will be produced, transmitted, collected and stored. Consequently the integrity and confidentiality of the communicated data as well as the authentication of

the services offering that particular data is crucial. Hence security is a critical functionality of the IoT. So we provide an authentication process in the mobile application that involves the use of a username and a password.

The natural language processing (NLP) is a field of computer science that helps us to infer what the user is trying to say through his voice commands. The NLP in our project gives the user the freedom to interact with the home appliances with his/her own voice and normal language rather than complicated computer commands.

Natural Language Processing (NLP) is a field of computer science, artificial intelligence, and computational linguistics that helps computer system understand and respond to commands given in natural (human) language. NLP is can be categorized in the field of human-computer interaction. Most of the challenges in NLP are listed as follows: human language understanding, enabling computers to derive meaning from the voice commands given to it through human (natural) language, and others involve natural language interaction between computers and humans. Most of the latest NLP algorithms are built upon machine learning, especially statistical machine learning.

The primary concept of machine learning is different from that of most prior techniques at language processing. Former implementations of the language-processing jobs usually involved the straight forward coding of a very large set of rules. The principle of the machine-learning standard calls instead for utilizing universal learning algorithm – mostly based on statistical inference – to routinely learn the most likely rules by the analysis of a large sample (corpora) of typical real- world examples. A *corpus* (plural, "corpora") is a large sample of documents (or sometimes, discrete sentences) that have been hand-annotated with the accurate values to be learned.

II. RELATED WORKS

The industry and the Academicians have worked together in perfect harmony to make great advances in the field of Home Automation Systems. Many technology giants including Apple, Amazon and Google have been keen on making viable consumer products for the common man. Most of these gadgets have been released during the course of this year, some of them include: Amazon Echo, Apple HomeKit and Google Home. However none of these systems aim to possess omnipresence or include artificial intelligence to predict the user's commands. Most of these advancements have come only in the past year (2015) urging both companies and academicians to make further advancements in this particular field.

Certain home automation systems have suggested complete dependence on wireless sensors and nothing else. These systems also use very primal technology such as HTML web pages to co- ordinate between these Arduino boards. They have also indicated the use of mobile platform which does not add any functionality to the existing proposed system, rather increase the complexity of implementation. The high dependence on wireless sensors may also lead to erroneous results. [1]

Other home automation systems insist on using Arduino boards as the only solution. Most of these systems can also be replaced by either ZigBee, Raspberry Pi or any other programmable board as their functionalities are not altered. These systems also have a heavy reliance towards using mobile device as their central console alone, giving very less flexibility of changing this. This is a concern for the user, because most of the time mobile devices are carried along with the user everywhere they go rather than statically staying in the house. They also do not support voice commands from the user. [2]

The most noble causes of the home automation is to help make the lives of paralyzed people much easier. These home automation systems built upon voice recognition are for the differently abled people suffering from quadriplegia or paraplegia (who cannot shift their limbs but can speak and listen) and it enables them to control the various home appliances and can actuate the bed elevation just by the voice commands according to their need and comfort. The proposed system comprises of a voice recognition module, Arduino Uno microcontroller, relay circuit to and a modifiable bed. The voice recognition unit needs to be skilled in advance to be used to recognize commands. However all of the listed functionalities are limited to adjustable beds. The proposed concept is extremely clichéd and lacks sound design principles. [3]

Most of the other home automation systems use Bluetooth in their mobile device for implementation. This has various demerits in every aspect. Primarily the Bluetooth has a very small range and the proposed system could only work in small homes, excluding homes with larger area. Bluetooth does not support remote operations, (i.e.) the appliances cannot be controlled by Bluetooth from a remote geographical area.

Many appliances within the same range may pick up the commands given to particular device resulting in erroneous behavior. They also do not use Natural Language Processing and artificial intelligence to understand what the user is trying to perform. [4]

Most of the other home automation systems purely depend on GSM technology for implementation. Even though their remote capabilities are tremendous, the overhead of operating it in a small home environment is huge. The boards are tough to be compliant to GSM technology and increase the cost of implementation exponentially. [5]

III. EXISTING SYSTEM

The existing technologies, in these regard are far outdated than what we have proposed. Most of the smart home automation systems that are existing only automate the basic process of changing the state of the appliances to ON/OFF. There are many smart home mechanization systems in the market that aim to automate the basic operations of these home appliances using various technologies such as GSM (Global System for Mobile), NFC (Near- Field Communication) and Wi-Fi [11] [12].

The existing smart home systems that have either been implemented or proposed have an elaborate procedure to interact with the home appliances. Some include pressing a button in a static location while some others include giving commands through a mobile device. Various technology companies have been trying to create amazing products in the department of home automation system since a decade ago. However, the Internet of things has become a briskly growing field only in the recent past.

Many viable consumer products are being sold by various technology giants in order to bring the technology to the common man. Most of these gadgets have been released during the course of this year, some of them include: Amazon Echo, Apple HomeKit and Google Home [13]. However none of these systems aim to possess omnipresence or include artificial intelligence to predict the user's commands.

IV. PROPOSED SYSTEM

Our project aims to provide the most easy and efficient way to interact with home appliances by giving voice commands in human (natural) language. We plan on eliminating the tedious process of clicking through various application screens with just one voice command. The natural language processing in the project provides a personal connection with our system. Primarily the user is authenticated by entering the specified username and password in the mobile device. The user sends a voice command to the mobile device, which interprets the message and sends the appropriate command to the specific appliance [14]. The voice command given by the user is interpreted by the mobile device using Natural Language processing.

The mobile device acts as a central console; it determines what operation must be done by which appliance to fulfill the user's request. The central console can also be either a desktop application [15], web application or a smart phone application as all of the data transferred can be processed by the cloud. However, for the convenience of the user and increased mobile capabilities we will be using a smart phone in this project.

The appliances are connected to the mobile device through an Arduino Board that establishes the concept of Internet of Things. The Arduino Boards are interfaced with the appliances and programmed in such a way that they respond to mobile inputs. Our project automates the operation of every single appliance in the house, which greatly reduces the power consumption due to excess use/wastage of the appliance's services.

Architecture Diagram

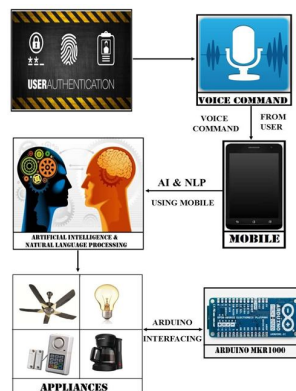


Fig 1: Architecture diagram using Arduino MKR1000

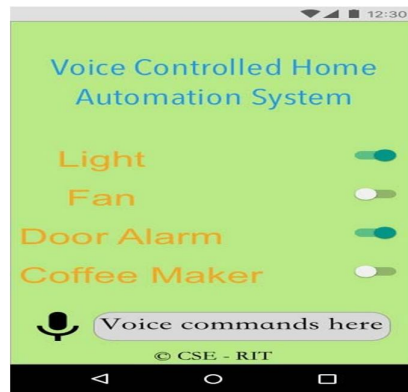


Fig 2: Screenshot of the Mobile Application

V. CONCLUSION

Most of the existing automation systems follow a specific set of commands or procedures in order to interact with their home appliances. These cumbersome procedures distance the users away from the technology. To overcome all of the existing issues and address the solution our project proposes voice commands to interact with home appliances using Arduino and a mobile device. These voice commands which are processed by Natural language processing helps the users to build a better connection with the technology and encourages them to use it more. It also eradicates the mundane task of operating home appliances manually.

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