MONITORING AND CONTROLING SMART HOME DEVICES BY VOICE DEMAND

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ABSTRACT

This paper presents a solution to design a smart home device controller by voice. From the design solution, the author has designed the system with Python software and embedded it in Raspberry Pi 4. The system allows users to monitor and control home appliances through voice. By the testing process, the system has met the basic and can control home appliances. It has been tested and installed at the office of the Department of Electronic Engineering - Faculty of Electronics – Thai Nguyen University of Technology to demonstrate the applicability of the product.

Keyword: *Smart home, controlling and monitoring by voice*

1. INTRODUCTION

In the past, controlling a machine by talking to it was just a science fiction story. But this fantasy is gradually becoming a reality with the great development of technology, especially the development of Artificial Intelligence (AI) and other platforms to create a user interface that allows using voice to control technology devices: Voice user interface (VUI).

VUI today appears everywhere. Nearly all tech giants spend a big budget to develop this technology. In recent years, VUI has also appeared widely in many consumer products and especially applied in controlling smart home devices (Smart home). Along with the great development of artificial intelligence technology, users' expectations for VUI are increasing with the benefits it brings. With the introduction of voice processing and device control technology into life, especially the control of smart home devices has practical significance in helping people's lives, quality life has been significantly improved and enhanced. In this paper, the authors focus on researching and designing a monitoring system and controller for smart home devices by voice based on Python software and embedded in Raspberry Pi 4.

The article is divided into 5 parts: (1) Introduction; (2) Overview of IoT and smart home; (3) Detailed design of the system; (4) Performance results; (5) Conclusion

2. OVERVIEW OF IOT AND SMART HOME

2.1 Overview of IOT

IoT stands for internet of things in which devices, vehicles (referred to as “connected devices” and “smart devices”), buildings, and other devices are embedded with electronic components, software, sensors, actuators, and the ability to connect to a computer network make it possible for these devices to collect and transmit data. IoT has evolved from the convergence of wireless technology, micromechanical technology and the Internet. Simply put, it is a collection of devices that are able to connect to each other, the Internet, and the outside world to do a certain job.

Internet of Things – IoT was found by the founders of the MIT Auto-ID Center in 1999, Kevin Ashton coined the phrase Internet of Things to refer to recognizable objects as well as existence of them. The term Auto-ID refers to any of a broad class of verification techniques used in industry to automate, reduce errors, and increase performance.

Fig -1: IoT - Internet of Thing

With an IoT system, there are 4 main components, that are Things, Gateways, Network and Cloud and Services-creation and Solution Layers

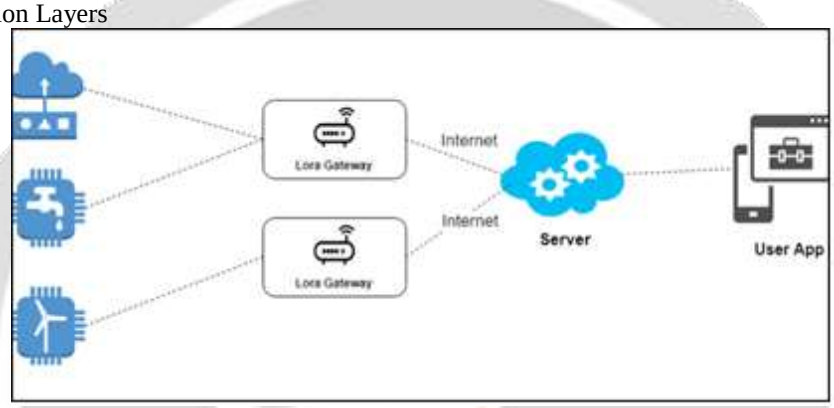

Fig -2: Components of IoT

The benefits of IoT for business depend on the specific implementation, should businesses have access to more data about their products and their internal systems. Manufacturers are adding sensors to product components so they can pass back data on how they are performing. This will help businesses detect errors before damage occurs

Fig -3: IoTs in the enterprise

2.2 Smart home

From the developments of AI technology and user needs, the smart home concept was born. A smart home is an integration of environmental control and monitoring systems such as controlling lights, temperature, humidity to suit the environment, multimedia communication, security, etc. and many other features aim to make life more comfortable and safe and contribute to the rational use of resources such as voice control, control via mobile application.

And Vietnam is not out of this trend. In the Vietnamese market, there are a series of brands such as BKAV, Lumi, Hager, Acis, Arkos, Gamma with competition in price as well as technology. More and more urban areas are applying such as: Thang Long Number One, Mandarin Garden, Royal City, Times City, etc.
Basic systems in smart homes include:
- Lighting management system.
- Access control system
- Management system of electricity, water, gas
- Fire alarm system
- System of state control switches
- Temperature control system

2.3 Methods of controlling devices in the smart home

a. Control by Smartphone:

Controlling electrical appliances remotely by phone or by internet is a great need of modern life. When smartphones become an inseparable object for most people, smarthome is gradually becoming a big trend in the future.
The smart home solution is equipped with electrical appliances manufactured by IoT technology and integrated with a wireless network that automatically connects to each other via a central controller. As a result, homeowners only need to download the smart home software to an Internet-connected phone to be able to control these devices at home or anywhere.

b) Voice control:

A smart home that controls devices by voice is simply understood as performing operations on/off… electrical appliances in the house with your own voice. Instead of using switches or controlling with smartphones. Using this feature not only makes it easier to control electrical appliances, but also creates an opportunity for homeowners to express their "powerful" voice.

c) Gesture control

A gesture can be defined as a physical movement of the hand, arm, face, and body with the purpose of conveying information or meaning. Therefore, gesture recognition includes not only tracking human movement, but also interpreting that movement in terms of semantically meaningful commands. Gesture recognition can be thought of as a way for computers to begin to understand human body language.

d. Control with Website interface

Currently, controlling smart home devices is gradually becoming simpler through the website interface accessed by the browser of devices such as phones or computers. Accessing a website is also easier and more time-saving than creating and accessing a separate application.

3. DETAILED SYSTEM DESIGN

The smart home monitoring and control system by voice in the article has the following features:
• Control devices via voice: Lights, Fans
• Control electrical devices from computer, phone via web browser
• Monitor room temperature and humidity with temperature and humidity sensors
• And some other functions will develop: Control some devices such as TV, air conditioner, door lock,....
The system is designed for the office of the Department of Electronic Engineering - Faculty of Electronics – Thai Nguyen University of Technology. The central processing unit receives audio information from the microphone, from the user's computer or phone to control the office's light bulbs, and then plays the feedback through the speakers. The temperature and humidity sensors have the function of collecting sensor data and sending it to ESP32, then the ESP32 updates the data to the phone computer to notify the user.

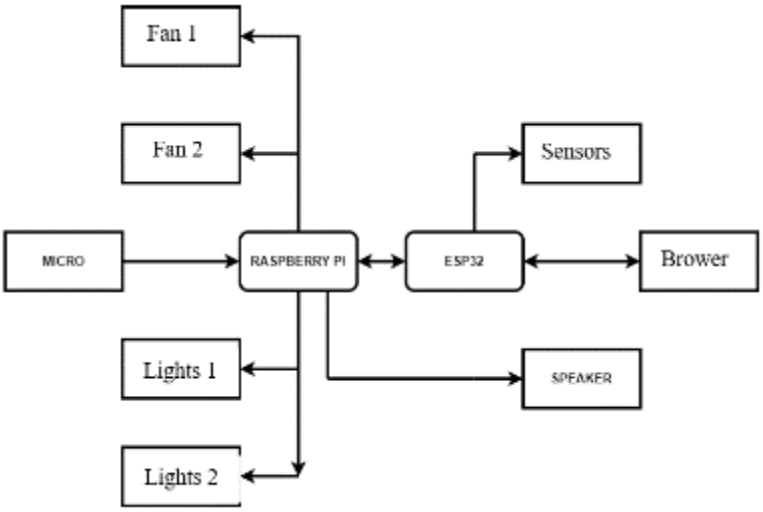

Fig -4: System architecture

The system as shown in Fig- 5 includes: a central control block using the Raspberry Pi 3 model B+ board, connected to sensors, a voice recognition block, a control processing block over the Internet using ESP32 (via interface UART), display block. Controls and information display are processed in parallel between the control processing unit via the Internet and the central processing unit.

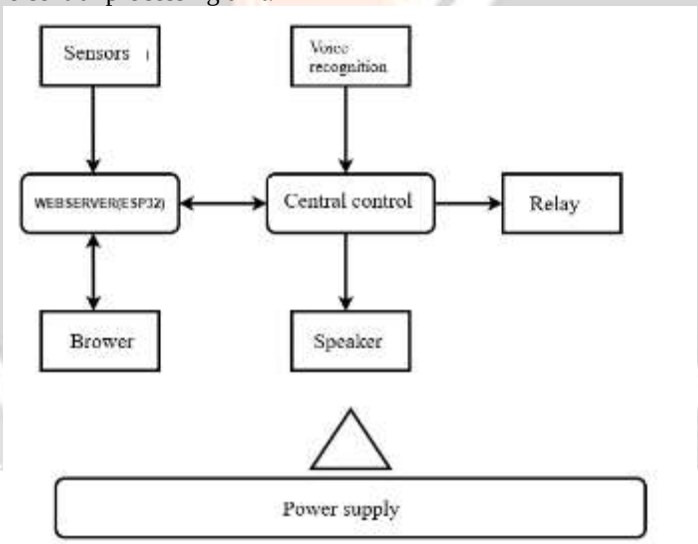

Fig -5: System block diagram

3.1 Hardware

- KIT Raspberry Pi

The Raspberry Pi uses a Linux-based operating system. The GPU hardware is accessed via Image Firmware that is loaded onto the GPU at boot time from the SD card. Image Firmware is called Binary Blob, while ARM associated with Linux driver code was originally based on closed source.

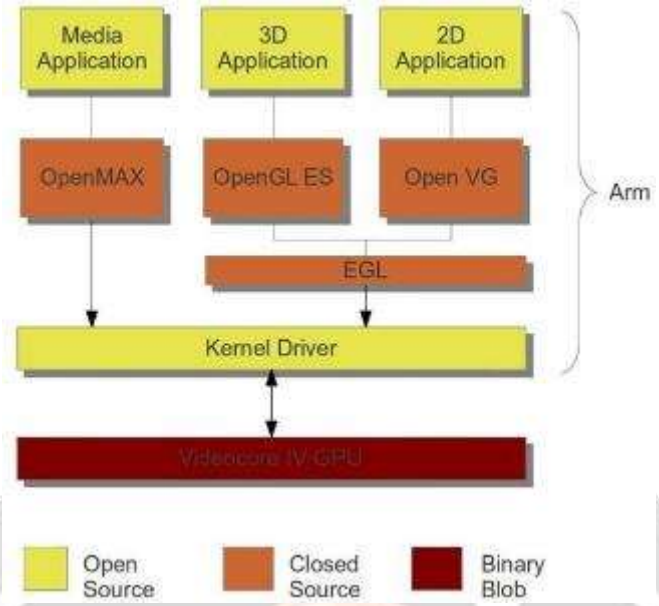

Fig -6: Raspberry Pi Structure

- Relay block:
This block functions as an electronic switch to control the on and off of electrical equipment.
- Sensor block:
Temperature and humidity sensor: DHT11.
- Voice recognition block:
To be able to receive voice sounds from the environment, we need to use a microphone device to receive audio data and transfer that data to the audio processing block.

- Web server:
The web server uses ESP32 module, ESP32 has the ability to communicate and connect to the Internet via wifi and has low power consumption.

3.2 Software

Python was chosen as the official programming language for the Raspberry Pi 3. With Python we can easily control the GPIO pins of the Raspberyr Pi 3 as well as connect to other platforms used in this article.
To support speech recognition, the article uses the Google Speech API tool. And this is a tool that supports Vietnamese.

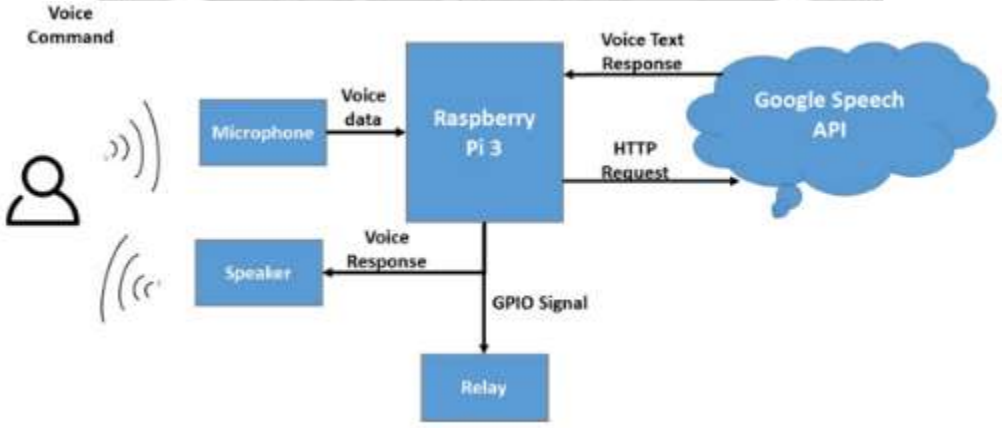

Fig -7: Google Speech API

The user commands the central processor (Raspberry Pi 3) through the Microphone. Voice data is recorded by the Raspberry Pi 3 and saved as a flac audio file, through the processing sending an HTTP Request to the Google

Speech API to convert the audio data to text data. From here, the central processor will analyze the returned text data to execute the corresponding control command.

4. RESULTS

After designing and manufacturing, the product has been completed, it meets the basic requirements set out. Some product pictures and test results:

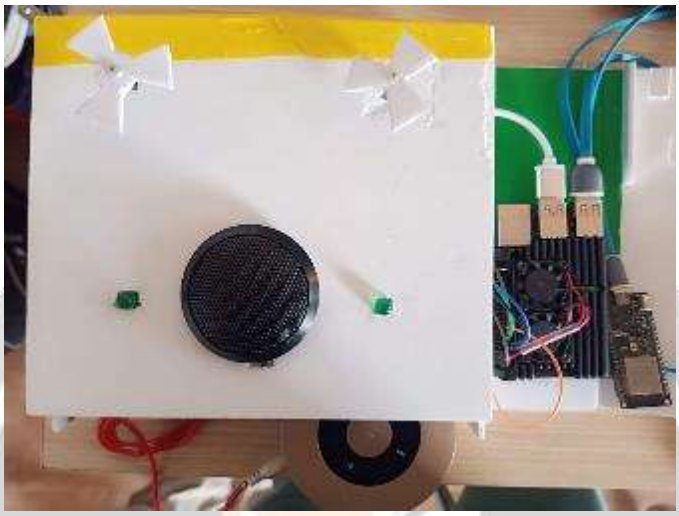

Fig -8: System demonstration model

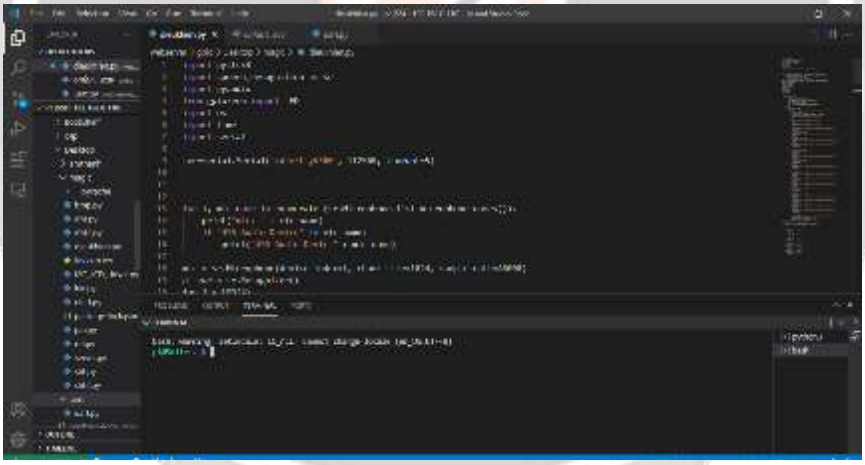

Fig -9: Execution on Raspberry Pi

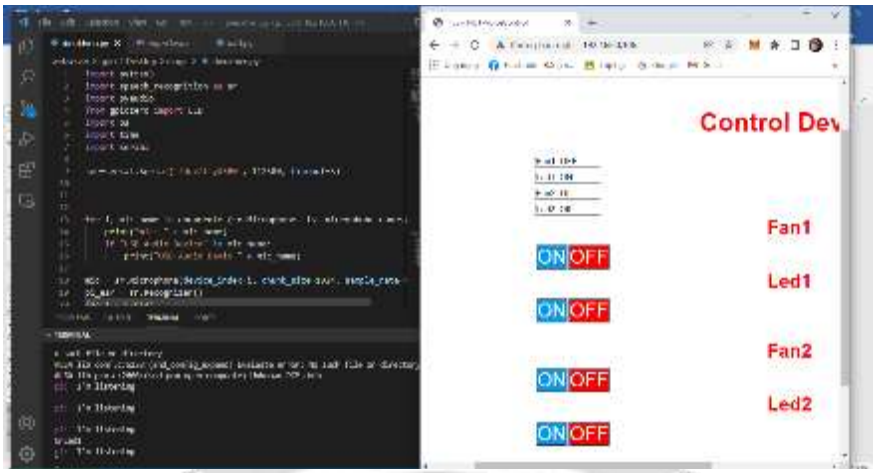

Fig -10: Control device via webserver:

4. CONCLUSIONS

The solution for monitoring and controlling devices through voice has met the minimum requirements of a smart home. With advantages such as: simplicity, fast processing speed, no high processing requirements, voice recognition is quite accurate. The system has been experimentally applied at the Department of Electronic Engineering - Faculty of Electronics - Thai Nguyen University of Technology for students to study and practice. In the coming time, the authors will make more improvements to ensure the system work more stable, improve the control interface on the website and increase the security of the system.

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