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Gesture based Home Automation Application

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Abstract - *In this paper, we present a novel solution of Gesture Detection using inexpensive time of flight (ToF) sensors. Also, we build a system that utilizes the gesture detection system to "smart" the house peripherals such as air conditioners, Lights, Fans, and other such AC appliances. In traditional home automation where appliances control is, usually, served by utilizing Google Assistant or Amazon Alexa's keyword spotting and speech to text services. Although the user-friendliness that these products provide is unparalleled, these always-listening devices pose a great threat to user privacy. This paper provides a solution to this problem, where the IoT devices are disconnected from the cloud and technically raise zero privacy issues.*

Key Words: Gesture Detection, Time of Flight, Wake Word, Privacy, Internet of Things

1. INTRODUCTION

The Internet of things (IoT) describes the network of physical objects- "things"- that are embedded with sensors, software, and other technologies to connect and exchange data with other devices and systems over the Internet. However, this definition has evolved greatly during the past decade. Now, almost every wearable could be defined as an "IoT" device. With increasing IoT products daily, the risk of exploitation of user's private data has become an extremely concerning issue in the 21st century [1].

Home Automation devices such as Amazon Echo, Google Home, Apple Home Pod all of which make use of similar technology and offer similar services to third party vendors, who could develop their own such IoT devices that can control home appliances. The issue with such devices is that they are always-listening in order to detect wake-words such as "Hey, Google" for Google Home, "Alexa" for Amazon Echo, "Hey, Siri" for Apple Home Pod. After the wake word detection, these devices record use speech input for a short amount of time and sends this speech to their propriety speech to text services, and eventually detects the commands in the speech based on the context of the statement. The fundamental issue here the always listening part, where conversations could be recorded and sold to third-party vendors for targeted advertising and other unknown uses. In order to mitigate this exploitation of user's private data strong privacy policies, and strict constitutions are required.

We present a completely different approach to Home Automation- "The Gesture Based Home Automation". The gesture-based control is not a "new" technology in 2020. Multiple research has been done on this very topic where Gesture Controlled Robot, Gesture Controlled Robotic Arm systems have been built. So, we furthered the gesture detection system to finally build the gesture-based home automation system using inexpensive ToF sensors and a Discovery Board as a microcontroller/microprocessor.

2. SYSTEM ARCHITECTURE

To begin with gesture detection, there are numerous techniques to detect gestures such as Real-Time Image Processing, Sonic Sensor-based Detection, Machine Learning based System, Motion Sensor-based detection. However, we decided to go with multiple time of flight (ToF) sensors to detect hand gestures.

The system relies on gestures detected by ToF Sensor. In this system, we are using two ToF sensors to detect different hand gestures by utilizing measured distances, which finally translates to controlling home appliances.

3. HARDWARE COMPONENT SETUP

The figure below explains the block diagram of hardware components.

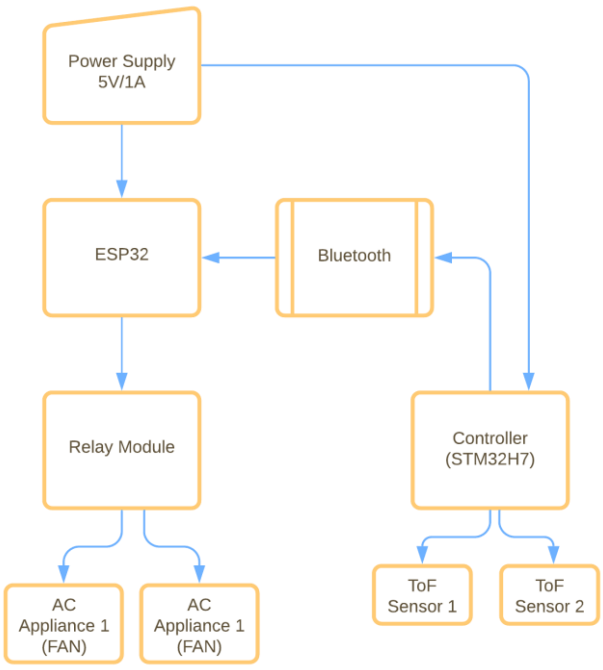

Figure - 1: Hardware Component Block Diagram

The figure above explains the hardware setup of the design. Starting with Controller STM32H7, which is the main controller of the design, interfaces with two ToF Laser Ranging Sensors. Once the ToF sensors detect the gesture, this controller would send a command according to the detected gesture to esp32 via Bluetooth Protocol. Here, ESP32 is acting as a Slave Device and STM32 is acting as a Master Device.

After ESP32 receives the command from STM32, it will trigger AC appliances accordingly. ESP32 is a low power IoT chip that could be run on battery power for an extended period of time, so the hub with gesture recognition system would sit idly where the static source of power is available and ESP32 would reside inside outlets and talks with the hub via Bluetooth and controls the AC appliances according to commands received.

3.1 ToF Sensor

The ToF sensor-VL53L0X integrates a leading-edge SPAD array (Single Photon Avalanche Diodes) and embeds ST's second generation FlightSense™ patented technology.

The VL53L0X's 940 nm VCSEL emitter (Vertical-Cavity Surface-Emitting Laser), is totally invisible to the human eye, coupled with internal physical infrared filters, it enables longer ranging distance, higher immunity to ambient light, and better robustness to cover glass optical crosstalk [2].

The vertical-cavity surface-emitting laser (VCSEL) has become a key device in high-speed optical local area networks (LANs) and even wide-area networks (WANs). This device is also enabling ultraparallel data transfer in equipment and computer systems, including storage area networks (SANs) and wide optoelectronics fields. The structure common to most VCSELs consists of two parallel reflectors that sandwich a thin active layer. The reflectivity necessary to reach the lasing threshold should normally be higher than 99.9%. the VCSEL may provide a number of advantages as follows:

1. ultralow threshold operation is expected from its small cavity volume;
2. dynamic single-mode operation;
3. wide and continuous wavelength tuning;
4. large relaxation frequency, even at small driving current;
5. easy coupling to optical fibers;
6. monolithic fabrication and easy device separation without perfect cleaving requirement;
7. Vertical stack integration by microelectromechanical system (MEMS) technology.

This ToF module VL53L0X has a Fully integrated miniature module with a 940 nm laser VCSEL and VCSEL driver with an advanced embedded microcontroller. This module interfaces with STM32 via the I2C peripheral and communicates over the same peripheral for configuration and operation.

3.2 ESP32

The reason behind choosing ESP32 is that it has two cores, one core to run Wi-Fi functions and one core to execute uploaded programs. ESP32 also has a Wi-Fi and Bluetooth module, and 36 GPIO [3]. ESP32 has a fairly large memory. ESP32's ultra-low power capabilities enable node devices to run on battery for a long period of time [4]. One estimate is that one node device consumes on an average about ~15mA at 3.3v in working condition and when in standby-waiting for command from Bluetooth it consumes ~5mA at 3.3v. Operating conditions combined with ultra-low power consumption mode at night enables a 2000mA Li-Ion battery to run the node device for up to a month.

3.3 STM32H7

The STM32 Nucleo-144 board provides an affordable and flexible way for users to try out new concepts and build prototypes by choosing from the various combinations of performance and power consumption features, provided by the STM32 microcontroller. For the compatible boards, the internal or external SMPS significantly reduces power consumption in Run mode. The ST Zio connector, which extends the ARDUINO® Uno V3 connectivity, and the ST morpho headers provide an easy means of expanding the functionality of this board [5].

4. CONCLUSION

In this paper we aim to smart the AC appliances of the house by a novel gesture-based control. We realize that voice-based control is a great risk to user privacy, and the reason why local, edge-based home automation concludes a safe control over one's own house. We present a solution which detects gestures and controls various household appliances.

REFERENCES

[1] Wikipedia, (January, 2021), IoT (Internet of Things) Available:

https://en.wikipedia.org/wiki/Internet_of_things

[2] ST Tof Sensor, VL53L0X (December, 2020), Available:

https://www.st.com/en/imaging-and-photonics-solutions/vl53l0x.html

[3] Espressif ESP32 (January, 2021), Available:

https://www.espressif.com/en/products/socs/esp32

[4] ESP32 Ultra Low Power Mode (December,2020), Available:

https://docs.espressif.com/projects/esp-idf/en/latest/esp32/api-reference/system/sleep_modes.html#wifi-bt-and-sleep-modes

[5] ST (Nucleo Board) (January, 2021), Available: https://www.st.com/en/evaluation-tools/nucleo-h743zi.html