THE USE OF ESP32 IN HOME AUTOMATION

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ABSTRACT

As the world around us develops with new forms of technology. It is important we adapt our surroundings to meet such standards/ developments around us. There's a growth of technology around us which implements the use of internet of things (IOT). It is important we fully utilise and adapt to the use of IOT in day to day usage scenarios. This brings about the use of IOT in homes, which later relate to them being called smart home. There is a variety of usage scenarios in which we could implement IOT in our homes, they all help in increasing the comfort and ease of controlling home electrical devices. In this paper I dive into explaining the benefits of such an implementation, I also talk about and show the implementation of the use of IOT in homes through the use of an ESP32 WI-FI Module.

KEYWORDS: IOT, SMART HOMES, ESP32WI-FI MODULE

I. INTRODUCTION

With the developments around the world in technology, the move towards a world of internet, the need of more technology to add onto homes has become something to look into, this has brought about an interest to explore the uses of IOT with home implementations, to improve the quality and comfort of living in ones homes. "Iot is a new paradigm for connecting things in order to automate a system The versatility of IOT and its ability to connect anything make it one of the most demanded technologies of the modern age " (Misra et al., 2021) . My aim is to develop and implement the use of IOT in a home using the esp32 WIFI-MODULE. To create a web page in which we can interact with components/Appliances found in homes, through the use of logic flipping, ON AND OFF STATES. This project consist of readily available and cost effective devices to help connect and control appliances through the internet. Making it adaptable to every house hold at a costly friendly price.

Bergur (2023), states that the number of smart houses is forecast to grow and surpass the 400 million mark by 2024. As of such it is important to learn how to implement and better the smart home industry, and as of such this paper focuses on implementation of IOT through the use of esp32, to facilitate a smart house and take advantage of the so ever growing market.

II. RELATED WORKS

With the growth of IOT, usage having different application multiple designs have been created and implemented. Olutosin T., with his co-author, proposed a mobile application based prototype smart home healthcare system for efficient and effective health monitoring for the elderly and disabled for their convenient and independent living while at home

Ketan et al., (2023), proposed a smart door locking system using iot. It helps users in accessing the doors within a specific range. Android software will access the door lock and the transfer of data will be performed by using the Bluetooth technique. Allowing for users to manage their door locks through their cell phone within a certain proximity

Vincent et al., (2021) presented an IOT real time embedded system for gas-smoke detection with autonomic alarm system. The project consist of components such as the gas sensors and smoke detectors, which are interfaced with an internet ready real time embedded arduino mega2560 development board. During the detection of smoke or gas the data is given to the Arduino mega2560 development board which then through iot sets the alarm High

Kishan et al., (2023), proposed a low cost system which uses the ESP8266 node to monitor the moisture in the soil of plants in the home. Once the soil becomes dry a pump automatically turns on to water the plants, once the soil is moist the pump turns off, all this activated are updated through the online application "blynk", and of such user can monitor events.

Maurizio et al., (2018), presented a design of a smart coaster that has low power consumption and uses iot to notify waiters on the condition of coffee in a cup, being the level off coffee and temperature. The project has been developed around the CMWX1ZZABZ SoC developed by maurata, because it integrates, in a really small foot print, both the MCU and the LoRa radi.

III. PROPOSED METHODOLOGY

This system will be built with the use of the ESP32 NODEMCU, LEDS and Transistors which will act as an interface between the ESP32 and the LEDs. This helps by disallowing the use of power directly from the ESP32 NODEMCU. A privately accessed web page will be created, it will act as the control interface for our connected device (ESP 32). Tabs which control the logic states of the ESP32 pins will be added. When turning on one led the command will be sent through

IV. BLOCK DIAGRAM

The main control for this setup is the Esp32, it controls the states of the LEDS, by setting logic 1 or logic 0, which in-turn turns the LEDs and fans on and off respectively. The Esp32, will receive control signals from the cloud which are given through the use of a personalised web page, and will in-turn update the status of each connected led/fan. Fig. 1 shows the proposed system and its blocks of connectivity, it consist of the ESP32, NPN transistors (to avoid using the ESP32 to power up LEDs and fans), the LEDs and finally the 5v DC fans. The ESP32 will connect to the internet wireless, in which commands will be sent through the cloud, having a particular unique IP address to access the web, the ESP will take its controls from the same cloud web. The block diagram below depicts how system is to be.

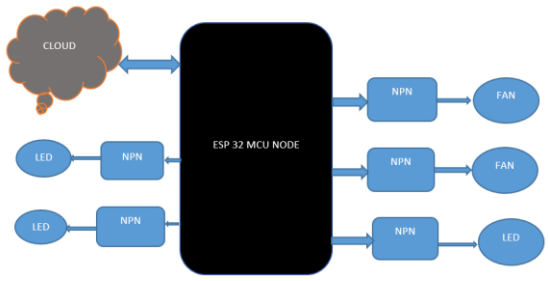

Fig. 1 Block diagram of proposed system

COMPONENTS USED

- Esp32
- Transistors
- Leds
- 5v DC fans

ESP32

According to Alexendra et al.,(2017), The ESP32 is a low-cost, low-power system on a chip series of microcontrollers with Wi-Fi and Bluetooth capabilities and a highly integrated structure powered by a dual-core Tensilica Xtensa LX6 microprocessor. is a dual-core system with two Harvard
Architecture Xtensa LX6 CPUs. All embedded memory, external memory and peripherals are located on the data bus and/or the instruction bus of these CPUs. The microcontroller has two cores – PRO_CPU for protocol and APP_CPU for application, however, the purposes of those are not fixed. The address space for both data and instruction bus is 4GB and the peripheral address space is 512KB. Moreover, the embedded memories are 448KB ROM, 520KB SRAM and two 8KB RTC memory. The external memory supports up to four times 16MB Flash, **Espressif Systems (2017).**

TABLE. 1 ESP32 SPECIFICATIONS

Chip (Module)	ESP32 (ESP-WROOM-32)
Details:	
CPU	Tensilica Xtensa LX6 32 bit Dual-Core at 160/240 MHz
SRAM	520 KB
FLASH	2MB (max. 64MB)
Voltage	2.2V to 3.6V
Operating Current	80 mA average
Programmable	Free (C, C++, Lua, etc.)
Open source	Yes
Connectivity:	
Wi-Fi	802.11 b/g/n
Bluetooth®	4.2 BR/EDR + BLE
UART	3
I/O:	
GPIO	32
SPI	4
I2C	2
PWM	8
ADC	18 (12-bit)
DAC	2 (8-bit)
Size	25.5 x 18.0 x 2.8 mm
Prize	£8

"The ESP32 can be programmed using various development frameworks and languages. The most commonly used programming language is C++, and it can be programmed using the Arduino IDE or PlatformIO. In addition, the ESP-IDF (Espressif IoT Development Framework) provides a

comprehensive set of libraries and tools specifically for ESP32 development" (Darko et al., 2023)

Fig. 2 ESP32

Transistors

"A transistor is a device that regulates current or voltage flow and acts as a switch or gate for electronic signals. Transistors consist of three layers of a semiconductor material, each capable of carrying a current. Transistors are, for the most part, the simplest types of active circuit elements that are capable of increasing, or amplifying, the power of electrical signals. They do this by transferring power, usually derived from a DC power supply, to the signal" (Rabab, 2022). A variety of transistors exist for both PNP and NPN. For this project I will use the bipolar junction transistor (BJT) 2N2222 NPN transistor. This transistor is able to switch relatively high volumes of currents compared to other small signal transistor as of such I choose to use it.

TABLE 2.

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	40	Vdc
Collector–Base Voltage	V_{CBO}	75	Vdc
Emitter–Base Voltage	V_{EBO}	6.0	Vdc
Collector Current – Continuous	I_C	600	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	W mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

The table above shows the main characteristics of the BJT 2N2222 Transistor.

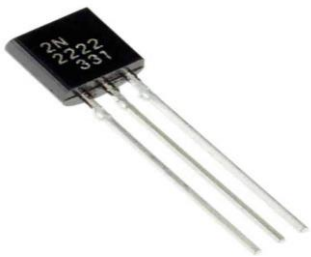

Fig. 3 2N2222 transistor

LEDS

Light-emitting diodes (LEDs) have emerged as a revolutionary technology in the field of lighting, offering energy efficiency, durability, and versatility. LEDs operate by electroluminescence, wherein electrons recombine with electron holes, emitting photons in the process. This mechanism not only makes LEDs more energy-efficient compared to traditional incandescent bulbs but also contributes to their extended lifespan. LEDs find applications in various domains, including residential lighting, automotive lighting, and electronic displays. Their compact size and ability to emit light of different colours have opened up new possibilities in design and functionality. As a result, LEDs have become a preferred choice for sustainable and innovative lighting solutions in the contemporary world (Smith & Jones, 2019)

Fig. 4 LEDs

5V DC FANS

5V DC fans have become integral components in electronic devices and systems, providing efficient cooling solutions within the constraints of a 5-volt direct current power supply. These fans are characterized by their low voltage requirement, making them suitable for a wide range of applications, including electronics and computing. The compact size and energy-efficient operation of 5V DC fans contribute to their popularity in scenarios where power consumption is a critical consideration. Additionally, these fans come in various sizes, typically ranging from 40mm to 120mm, influencing their airflow and cooling capabilities. The choice of bearing type, such as sleeve bearings or ball bearings, impacts the fan's longevity and operational noise. Some 5V DC fans offer speed control options, allowing users to fine-tune cooling performance according to specific requirements. As vital components for thermal management, these fans play a crucial role in preventing overheating and ensuring the reliable

operation of electronic devices (Smith & Johnson, 2020)

Fig. 5 Dc fan

V. CIRCUIT DIAGRAM

This is the layout of the circuit diagram for the proposed methodology. It includes all mentioned components in the components section. The connection for the real life prototype are made as per the circuit diagram.

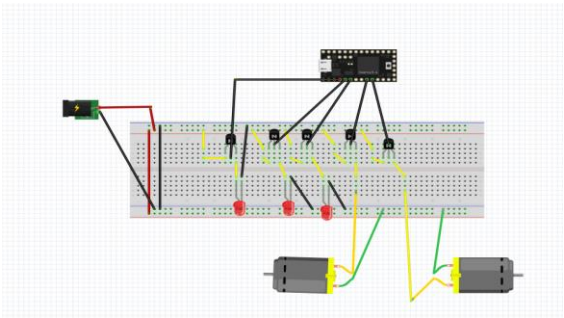

Fig. 6

VI. IMPLIMENTATION CHART

The implementation chart shows the flow of states when using the system. The esp32 connects to the internet, being the cloud designated to a particular unique IP address. The phone is as well connected to the internet and web page through the unique IP address. At such state both the esp32 and phone are logged in. The states of the connected devices initiate on the off state, if the is a change in state the logic will change to logic 1 (state 1), vice versa as per the implementation chart

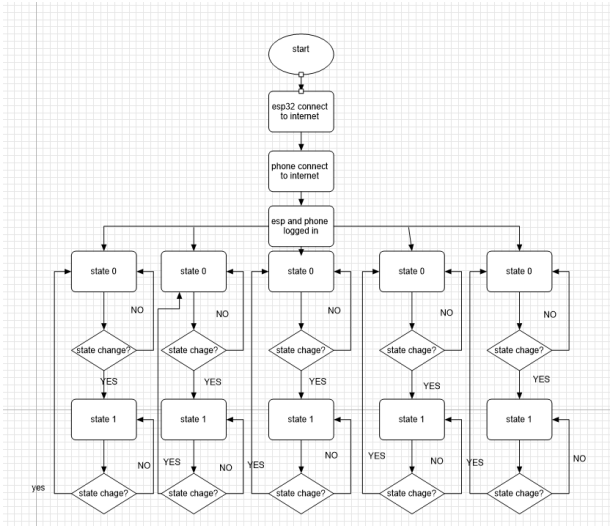

Fig 7

VII. FEASIBILITY STUDY

Technical feasibility

The equipment's and components needed to carry out the proposed methodology are readily available and can be acquired through means of order (online shopping), as of such I conclude the project is technically feasible.

Market Feasibility

Bergur (2023), states that the number of smart houses is forecast to grow and surpass the 400 million mark by 2024. This goes out to show that such implementations of smart homes is in demand all over the world. Hence doing this project will aid in supplying the demand of smart homes, as of such the proposed methodology is market feasible

Cost feasibility

According to Rel. (2018), cost feasibility is used to establish whether program alternatives are feasible within a defined budget limit. The budget I have is P1000.00, and all that I require to proceed with the proposed methodology is will under the stated budget cost. This is shown in the budget table. As of such the proposed methodology is cost feasible

VIII. BUDGET

COMPONENTS	QUANTITY	ESTIMATED COST	COST
ESP32 NODEMCU	1	P150.00	P204.25
LEDS	1 (pack of 100)	P20.00	P25.78
CONNECTING WIRES	2 (pack of 30 strips)	P14.00	P20.00
TRANSISTORS	1 (box of 100 transistors)	P50.00	P62.30
5V DC FANS	X2	P40.00	72.22
SHIPPING	-	P150.00	P456.70
TOTAL	-	-	**P841.25**

IX. PROTOTYPE IMPLEMENTATION

To implement the proposed methodology I had to create a prototype for the system. Initially I had to create a web interface for the system. The server is a private cloud domain server. I made the web interface to include state switches which indicate on/ off states as per condition in real time

Web page setup and interface

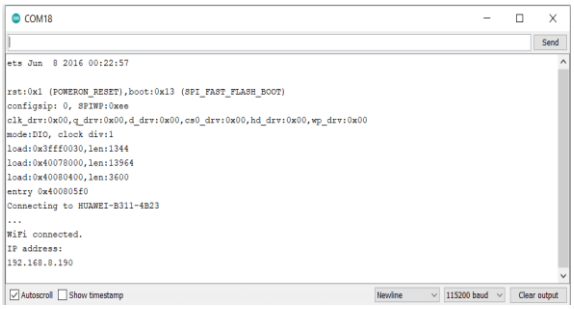

Fig. 8

The above shows the serial monitor connected to com 18, of the computer used to upload the ESP32 program. It shows that the ESP32 has successfully connected to the designated router (Gateway), it also shows the unique IP address designated for the web interface. I use the IP address to login to the interface, I insert the number as it is on the search bar on any browser a long as my smartphone is connected to the internet. This allows me to control connected devices where ever I am in the world.

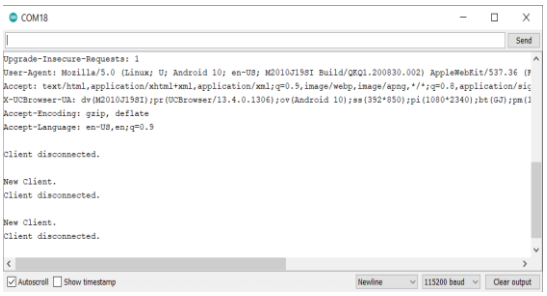

Fig. 8

The above is a view from the serial monitor showing that a client (being the user), has opened up the web interface. Either by computer or smart phone.

Web interface

The below show the interface for our system, through the use of a phone browser and the use of a computer browser. It shows the logic switches as well as the states of the outputs in the physical domain.

Fig. 9 Smart phone interface

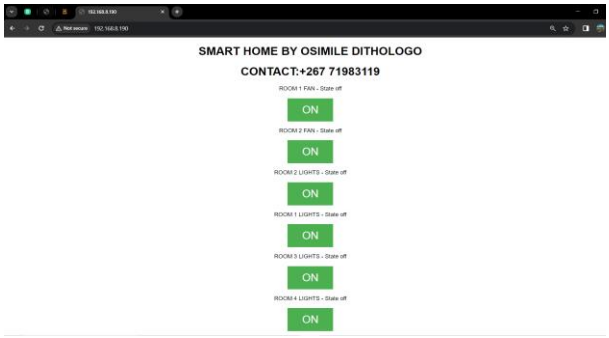

Fig. 10 Pc web interface

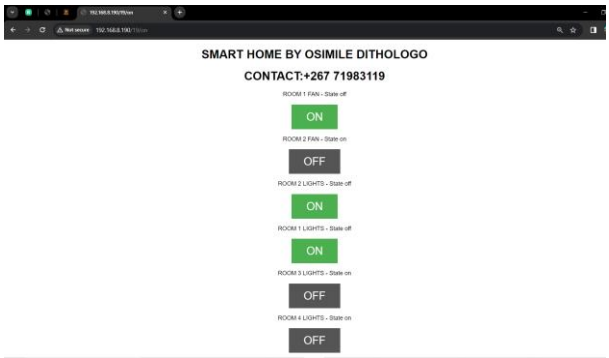

Fig. 11 different states

Fig. 11, shows the web interface having different states of control as per desire.

Prototype

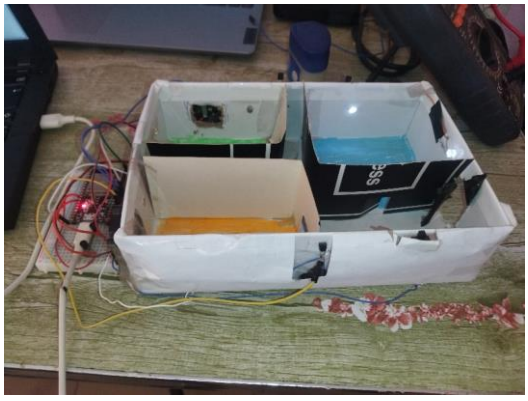

Fig. 12

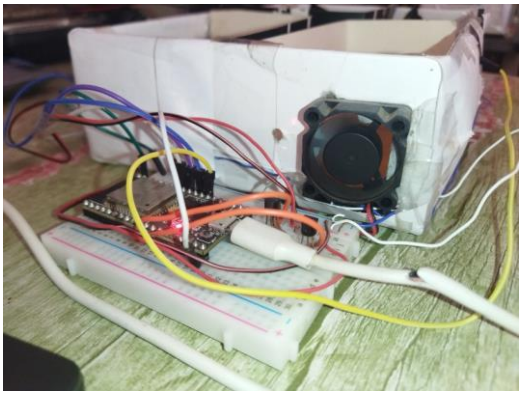

Fig. 13

Fig. 14

The above is the prototype set up and outlook, along with the web interface, this will demonstrate the working of the project. It is a model which can be later be implemented to house hold appliances through the use of relay to control the logic statuses of appliances e.g lights.

Advantages of Project

- Low cost implementation.
- User friendly interface (simple to understand and use).
- Improve the comfort of once daily life (one could switch on their geyser on their way home and switch it off when they arrive, rather than getting home and switch it on and have to wait for the water to be hot).
- Remote access (can access anywhere in the world)
- Customization (system could always be customized to meet clients requirements).

X. CONCLUSION

The main aim of the paper/project was to develop a system that could improve once daily living by incorporate the so ever growing technologies and concepts into their homes. Through the various researches done for implementing this project, the project was successfully done and implemented in a form of a working prototype that highlights the implementation of the proposed methodology. IOT was the major impact of this project, through the use of the ESP32 WI-FI MODULE. The project was a success and I aim to improve it by adding more components such as sensors (Gas, motion sensors etc.), to also improve security of the home through the use of IOT.

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