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Design and Development of IntelliHome

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Abstract - *This paper centers on the critical objective to develop home automation system in more proficient way and giving more highlights alongside security to the consumer. Other than this we have focused on accomplishing other goals like Designing and Developing IntelliHome product to encourage ease of access to electric domestic appliances and subsequently lessening of utilization of Power, improving security by implanting smart lock feature, observing climate parameters like Temperature | Humidity | Rainfall, Progressing the plant or garden watering framework and all these applications in single smartphone application. It is valuable for elderly or disabled people to urge farther access to electric appliances through their smartphones, to know most exact climate condition of their residency or a holiday home before visiting, keeping up gardens and plants even if they forget to water. We have made isolated modules to perform each task and connected to the microcontroller NodeMCU. Our project's goal is to provide the best and most useful home automation system, known as INTELLIHOME. We did our best to identify the flaws in the existing system and created a new one. Different electronic components were employed to conduct required hardware functions, and Google Firebase was used to transport data to the cloud. The project's social benefit would include more security in daily life, more accurate weather forecasts, and easier garden or plant management. We now live in a smart world where IoT has progressed to a higher level. INTELLIHOME ensures a comfortable smart home experience. The project's future potential is enormous, since every normal person or consumer seeks for the best alternative accessible. Almost all electronic gadgets will benefit from this technology in the near future, thanks to home networks and the internet. For the time being, we've just designed the product for a few appliances and uses. We can improve and upgrade the system in the future to make it more efficient.*

Key Words: **Microcontroller, Biometric Sensor, Smartphone application, Security, Safety.**

1.INTRODUCTION

To live or work happily, everyone prefers to live or work in a secure, safe, and well-maintained environment. We all spend the majority of our time at home. As a result, the goal of our project IntelliHome is to make routine tasks in the home easier and more convenient. Essentially, it provides users with security, a comfortable living environment, and more perks. Its goal is to improve inhabitants' safety and security while also improving their quality of life and convenience at home. Smart home technologies can also help you save money on energy. The capacity to control appliances, an automated watering system, and a smart lock system for greater security will benefit the elderly and disabled, among others. The term "intelligent house" was coined by IntelliHome. Intelligent or Smart Home is a networked collaboration of technology and services that provides many automated applications for a better quality of life. The most significant goal of this project is to improve the efficiency of home automation systems while also delivering more features and ensuring consumer safety. Apart from that, we have concentrated on achieving other goals such as designing and developing the IntelliHome product to make it easier to access electric home appliances and thus reduce electricity consumption, monitoring weather parameters such as temperature, humidity, and rainfall, and automating the plant or garden watering system, all of which can be done through a single mobile application. Controlling appliances through smartphone, Personal Weather Station, Advanced plant watering system, and all-in-one Smartphone Application are among the features.

2. LITERATURE REVIEW

There are a variety of smart home systems on the market, each based on a distinct technology. Bluetooth-based home automation systems, Zigbee-based home automation systems, GSM-based home automation systems, and Wi-Fi-based home automation systems are all examples of mobile phone-based home automation systems.

A. Literature Survey

Bluetooth based home automation system using cell phones:[1] In a Bluetooth-based home automation system, household appliances are connected to the Arduino BT board at input output ports via relay. The program for the Arduino BT board is written in the high-level interactive C language for microcontrollers, and the connection is made via Bluetooth. The unauthorized users won't be allowed but the authorized users are accepted to access the appliances, which is protected by a secured password. A Bluetooth connection is established between the Arduino BT board and the phone for wireless communication. This system makes use of the

python script, which can be installed on any Symbian OS environment, making it portable.

Zigbee based home automation system using cell phones:[1] The system is built and deployed utilizing Zigbee to monitor and control the home appliances Network coordinators keep track of and save device performance. This is accomplished through the use of a Wi-Fi network, which employs a four-switch port standard wireless ADSL contemporary router. The SSID of the network and the Wi-Fi security parameter have already been defined. The message is initially processed by the virtual house algorithm for security purposes, and once it is declared secure, it is re-encrypted and forwarded to the home's real network device. Messages were transmitted to the end over the Zigbee network by the Zigbee controller. The virtual home algorithm's safety and security of all messages it receives. To lower the cost of the system and the time it takes to deploy it, Zigbee communication was chosen.

GSM based home automation system using cell phones:[1] Because of mobile phones and GSM technologies, GSM-based home automation is drawing attention. For GSM communication, we looked at SMS-based home automation, GPRS-based home automation, and dual tone multi frequency (DTMF)-based home automation.

Wi-Fi based home automation system using cell phones:[1] The server, the hardware interface module, and the software package are the three essential components of a Wi-Fi-based home automation system. Wi-Fi, or Wireless-Fidelity, is a method of data transport that utilises radio waves. It offers high-speed internet access as well as network connectivity. It's a wireless network that allows you to communicate with people in different parts of the house and connect different gadgets. It can be used for a range of purposes and in a variety of specifications. Equipment can be placed in almost any location. In your home, there are no unnecessary cords. There's no need for additional ethernet output, and it's also more efficient and has a wider range. Wi-Fi has become a popular option for many individuals.

B. Comparison

[2] Comparison between different systems:

Sr No.	System	Communication Interface	Controller	User Interface	Applications	Benefits
1.	Wi-Fi based using Arduino Microcontroller	Wireless LAN and Wi-Fi shield	Hardware interface module	web based Application.	Temperature and humidity, Motion detection, Fire detection, Door status, Light level ,Video monitoring, Controlling appliances	Low cost, Secure, Ubiquitously accessible, Auto-configurable, Remotely controlled
2.	Web service and android app Based using Raspberry pi	Web server and interface card	Raspberry pi	Android application	Controlling shutter of window	Autonomous, and Quite scalable
3.	Cloud Based Using Hadoop System	Cloud based data server uses Hadoop Technology	Home gateway and Router	Smart device	Monitoring and Controlling Home Appliances	Effectively manage Semi structured and unstructured data, Reduce computational burden of smart devices
4.	Email Based using Raspberry pi	Internet Modem	Raspberry pi	E-mail	Switching LED	Smart, Economic and Efficient

Table -1: Comparison

C. Researches [3]

Several studies have been conducted on the use of IOT devices in home automation platforms. In the past, research on the IOT was conducted in conjunction with a study of numerous internets of things applications. The future expansion of the Internet of Things (IOT) is entirely dependent on us.

Ahmed ElShafee (2012) [4]: This paper presents a design and prototype implementation of a novel home automation system that connects its components using Wi-Fi technology as a network architecture. As a result, they came to the conclusion that the home automation system's required aims and objectives had been met. The prototype shows the fundamental level of home appliance control, and the system design and architecture were considered and remote monitoring has been implemented. Finally, their system is better from the scalability and flexibility point of view than the commercially available home automation system.

Vinay Sagar K (2015) [5]: This system is designed to be low-cost and scalable, allowing it to control a wide range of devices. By connecting simple appliances to the Internet of Things, home automation has been experimentally demonstrated to work adequately, and the appliances have been successfully controlled remotely through the internet.

Neha Malik (2017) [6]: The author goes over the many types of intelligent home automation systems and technology. The endeavor was focused on the home automation idea, in which smart devices are used to control and monitor operations.

Shaikh Amreen (2017) [7]: The author discusses the many forms of intelligent home automation technology and systems. The project was centered on the home automation concept, which involves the use of smart devices to control and monitor activities.

Anurag Tiwari et al. (2017) [8]: The writers discussed the IoT Challenges and Ongoing Research. IoT systems are extremely common and widely used. As a result, the likelihood of security and privacy issues has increased. As a result, the safety of everything connected to the internet may be jeopardized. IOT has been unable to establish itself as a reliable technology due to security and privacy concerns.

Satish Palaniappan (2015) [9]: Sensors such as motion sensors, light sensors, and temperature sensors can be integrated into homes to allow automated device switching based on conditions. More energy may be saved by ensuring that the house is occupied before turning on devices, checking the brightness, and turning off lights when not in use. The technology can be tightly connected with home security solutions to give homeowners more control and protection. The next stage would be to expand this technology to automate a large-scale environment like offices or factories.

3. SYSTEM DESIGN

A. System Design for Plant watering:

The plant watering system additionally requires a water container, water pump and a 12V power supply. The water pump will be kept in a container filled with water as it is required to flow the water through a tube to the plants. The water pump requires 12V power supply to operate and that will be provided with the help of a 12V power supply and a relay channel. The input pin of the relay channel is connected to an esp32 pin which controls the relay channel to switch on or off the water pump.

B. System Design for Personal Weather Station:

The weather station has been designed with a DHT22 sensor which consists of a temperature as well as humidity sensor. The DHT22 uses thermistor and a capacitive humidity sensor to measure the surroundings weather and sends a digital signal to the data pin. It is connected to the esp32 module and so, the esp32 sends the digital data to the database which is then displayed on the mobile app.

C. System Design for Solenoid Lock:

The solenoid lock tongue is always open when it is has not been supplied any voltage i.e., in zero voltage supply state. So, when voltage is supplied to the solenoid lock it gets triggered and its tongue closes. We use zero voltage supply state to keep the door locked when not in use. The lock has 2 wires, positive and negative. The positive wire is connected to the 12V power supply, and the negative wire is connected to the relay and this relay is connected to the esp32 module. So, when the esp32 triggers the relay pin, the smart lock is supplied 12V and it starts operating and the door is unlocked.

D. System Design for all-in-one Smart phone Application:

The mobile application has a few tabs for various home applications. The app is designed with keeping security in mind and hence it also has a login page when any user will open the app. It consists of buttons to control the home appliances like the fans, lights, lock. It also has a tab for watering plants and for knowing the surroundings weather conditions. The mobile app has a login page that will require the user's credentials to login to the app and authorize them to control the appliances of their own house and no one else's. We are using Google Firebase as our cloud database connected to the app. The app will store all the login details in the cloud database. The esp32 module has a Wi-Fi module which is connected to the app through the cloud. When the app is used to switch on or off any appliance, it sends the data to the firebase and stores it and sends a signal to the esp32 to operate the same appliance.

4. SPECIFICATIONS

A. Hardware

1) ESP 32 (microcontroller): Espressif Systems, the makers of the ESP8266 SoC, have released the ESP32, a low-cost System on Chip (SoC) Microcontroller. Tensilica's 32-bit Xtensa LX6 Microprocessor with integrated Wi-Fi and Bluetooth is the successor to the ESP8266 SoC and is available in single-core and dual-core varieties.

Features:

Processors:

- CPU: Xtensa dual-core (or single-core) 32-bit LX6 microprocessor, running at 160 or 240 MHz and capable of 600 DMIPS performance.
- Co-processor with ultra-low power (ULP)

Memory:

- 320 KiB RAM, 448 KiB ROM
- Internet access via wireless: 802.11 b/g/n Wi-Fi
- Bluetooth v4.2 BR/EDR with BLE (Bluetooth Low Energy) (shares the radio with Wi-Fi)

Peripheral interfaces:

- 34 × programmable GPIOs
- 12-bit SAR ADC up to 18 channels
- 2 × 8-bit DACs
- ten different touch sensors (capacitive sensing GPIOs)
- 4 × SPI
- 2 × I^2S interfaces
- 2 × I^2C interfaces
- 3 × UART
- SD/SDIO/CE-ATA/MMC/eMMC host controller
- SDIO/SPI slave controller
- Support for IEEE 1588 Precision Time Protocol and Ethernet MAC interface with dedicated DMA
- CAN bus 2.0
- Infrared remote controller (TX/RX, up to 8 channels)
- Motor PWM
- LED PWM (up to 16 channels)
- Hall effect sensor
- Ultra-low power analog pre-amplifier

2) 12V Solenoid Lock: The slug on this 12V solenoid lock has a slanted cut and a nice mounting bracket. It's essentially an electronic lock for a standard cabinet, safe, or door.

3) Dual channel Relay Module: It is a 5V, 10A 2-Channel Relay interface board. It can be used to regulate a variety of appliances and other high-current devices. It can be used to regulate a variety of appliances and other high-current devices. A microcontroller can control it directly with 3.3V or 5V logic signals (Arduino, 8051, AVR, PIC, DSP, ARM, ARM, MSP430, TTL logic). A 1x4 (2.54mm pitch) pin header is used to connect power (5V and 0V) and control the two relays.

4) Mini Water Pump: In the home, a tiny submersible water pump is commonly used for cooking, cleaning, bathing, space heating, and watering flowers, among other things. A tiny submersible water pump is a centrifugal water pump, meaning it uses a motor to drive an impeller that rotates and pushes water outwards.

- Operating Voltage: 9V
- Operating Current: 130 ~ 220mA
- Flow Rate: 80 ~ 120 L/H
- Maximum Lift: 40 ~ 110 mm

- Outlet Outside Diameter: 7.5 mm
- Outlet Inside Diameter: 5 mm

5) DHT22: With a single wire digital interface, the DHT22 is a low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to monitor the ambient air and delivers a digital signal on the data pin. The sensor is calibrated and requires no additional components, so you can start measuring relative humidity and temperature straight away. It's simple to use, but data collection necessitates careful timing while performing. It can only give you new info every 2 seconds.

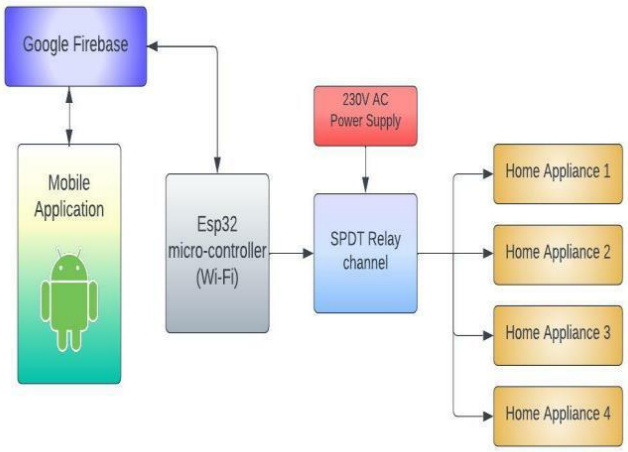

Fig -1: Block Diagram

The above block diagram is to explain the overview of how the whole IntelliHome system works:

1. Mobile Application: The app is created for the users to control their home appliances. It consists of various tabs and buttons to control each appliance. It is connected to the Google Firebase.

2. Google Firebase: This cloud database keeps record of everything that is being operated on the app or the esp 32 module. It takes data from the app and sends it to the esp32 module and vice versa.

3. Esp32: The esp32 module is used to change the mode of any appliance as per user's will. It is connected to the database and all the home appliances.

4. SPDT Relay Channel: The relay channel is connected to each appliance so that it can provide the required power to each appliance and switch to any appliance when triggered by the esp32 module.

5. Power Supply: The 230V AC power supply is required to supply power to the appliances through the relay. It is directly connected to the relay channel.

6. Home Appliances: All the home appliances are being controlled by the user through the app and it is operated by the esp32 module at hardware level.

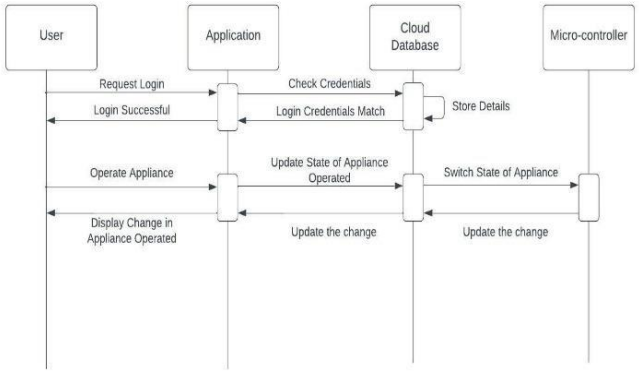

Fig -2: Sequence Diagram

It shows the visual representation of the system that we have designed. It helps in understanding how each object of the model is interacting with each other.

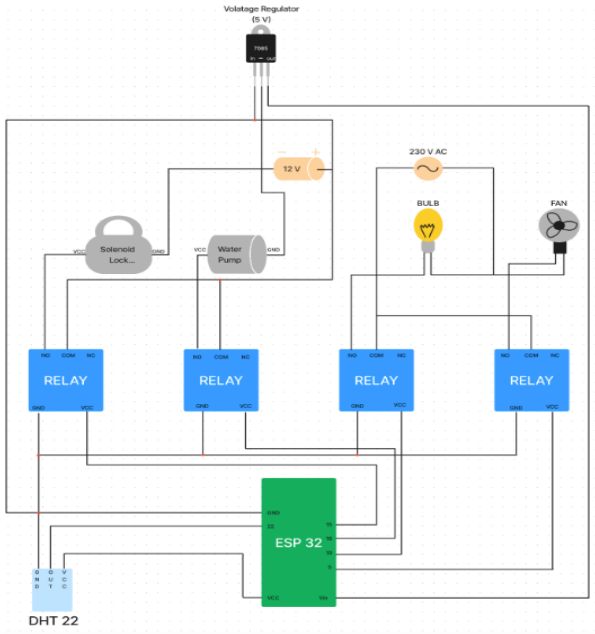

Fig -3: Circuit Diagram

B. Software:

1) Arduino IDE: The Arduino integrated development environment (IDE) is a Java-based cross-platform tool that runs on Windows, Mac OS X, and Linux. It's used to program Arduino-compatible boards and upload them. Here we are going to install COM/Serial Port Driver and ESP8266 Board Package in Arduino IDE to program NodeMCU ESP8266. The Arduino IDE is a free and open-source program for developing and compiling code for the Arduino and NodeMCU modules. On the board of each of them is a microcontroller that has been programmed and accepts data in the form of code. The core code, also known as a sketch, written on the IDE platform will eventually generate a Hex File, which will be copied and uploaded into the board's controller.

2) Android Studio: Android Studio is the official integrated development environment (IDE) for Google's Android operating system, and specifically designed for Android development. It is available for download on Windows, macOS and Linux based operating systems. Features:

• Support for Gradle-based builds. Refactoring and simple fixes for Android.

• Lint tools are used to detect issues like as performance, usability, version compatibility, and other issues.

• Create standard Android designs and components using template-based wizards.

• Users may drag-and-drop UI components in a powerful layout editor, and layouts can be previewed on numerous screen configurations.

• Google Cloud Platform compatibility is built-in, allowing connection with Firebase Cloud Messaging (formerly 'Google Cloud Messaging') and Google App Engine.

• In the Android studio, use the Android Virtual Device (Emulator) to execute and debug apps.

3) Firebase: Google Firebase is an app development platform powered by Google that lets developers to create apps for iOS, Android, and the web. Firebase offers analytics tracking, reporting, and app bug solutions, as well as marketing and product testing.

5. APPLICATION INTERFACE AND WORKING

Now, coming to the actual smart phone application that we have designed to get updates and operate about IntelliHome. The mobile application opens to a login page where the user will have to create their account if they are a new user. Each user will require an email id and a password to log into the app. Once, the account has been created by the user they can login to the app and use it to control the appliances. This account can be shared by user with the family members and operators from same office.

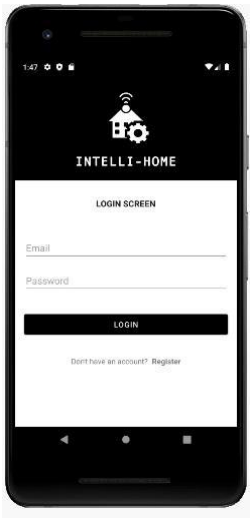

Fig -4: Login Screen

The mobile application interface consists of a tab that includes switches and lock buttons to operate the appliances.

Fig -5: Interface with Options

The fan and light buttons operate the fans and lights of the home while the lock icon button operates the solenoid lock. The icon appears as the current status of the lock i.e., when the solenoid lock is opened the app will display the lock icon as open and when the solenoid lock is locked the app will show the icon in locked state.

Fig -6: Lock Option

So, when the user presses on the lock icon button, the app will ask for the user's fingerprint or face ID (whichever is authorized) to open the lock. If the fingerprint / face ID matches, the lock will open, and the app will pop up a text showing lock is opened as well as the lock icon will be changed to open state. All this data will be stored in the Firebase whenever a home appliance is being operated. The esp32 is connected to the app through the cloud database as well and it operates the lock accordingly.

Fig -7: Plant Watering System

The plant watering tab in the app consists of a start button and a timer to water the plants as per use. The timer is designed to water the plants at a particular time and for a particular period. The start button as it states, will start the watering process by sending a signal to the esp32 through the cloud and then the water pump will start flowing water. The user can put the amount of time they want to water the plants and then press start timer button to proceed. As the timer ends the system will stop flowing water.

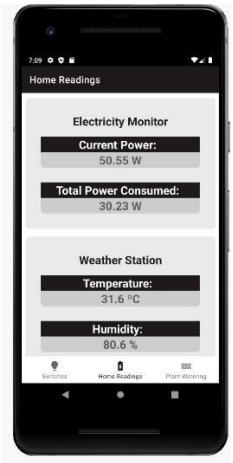

Fig -8: Weather Monitoring

This tab displays the surrounding weather of the house. It displays the temperature and the humidity of the surrounding. It keeps updating every 5 seconds or so. All the data displayed on the app is stored in the database as well.

6. SYSTEM AND RESULTS

We have made a home module to set up different modules for demonstration.

Fig -9: Demonstration Model

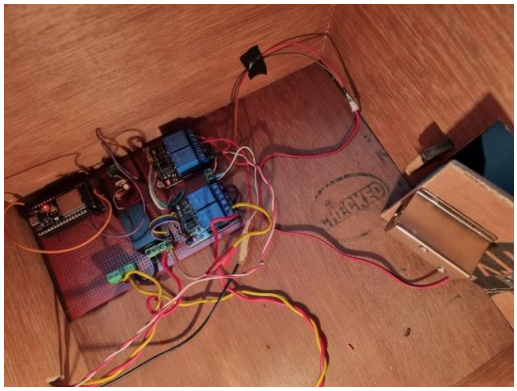

Fig -10: Internal System

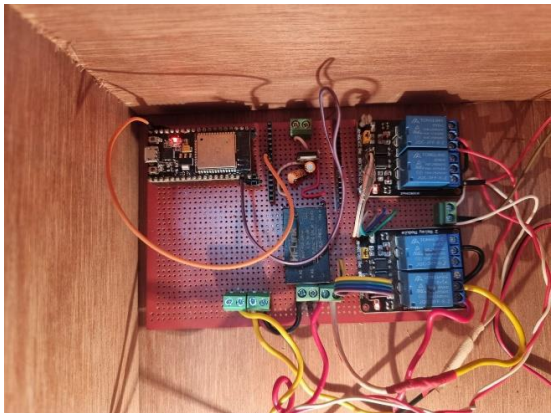

Fig -11: Internal Circuit

Fig -12: Watering System

Fig -13: Smart Lock setup

Fig -14: Appliances and Switches

Login Activity at backend on Google Firebase:

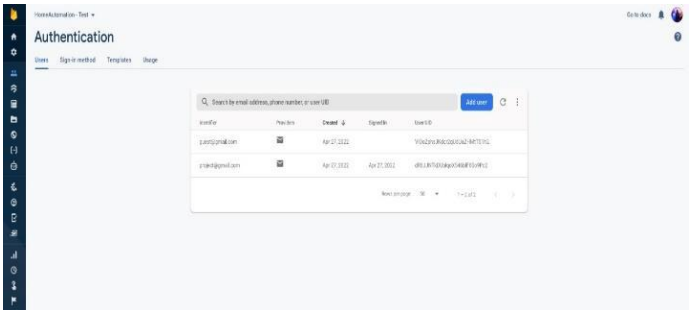

Fig -15: Login Activity at backend

Database:
In this project we are using the Google Firebase as our database. It logs all the data when a user uses the app for any specific appliance. It is connected to both the app and the esp32 module.

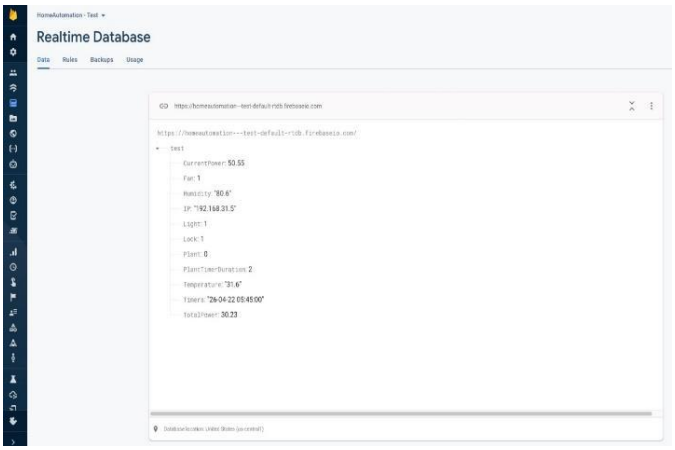

Fig -16: Database

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