

DTMF Phone Call Control Home Appliance Using Arduino and GSM Module & Home Automation

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ABSTRACT

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Arduino UNO is a basic research project that uses DTMF technology to regulate various loads (electrical appliances). DTMF, or Dual Tone Multi Frequency, is a signalling mechanism commonly used in telecommunications. In the DTMF-based Load Control System utilizing Arduino UNO paper, multiple communication methods including DTMF and GSM are used to control our household appliances using mobile phones. The DTMF technology serves as the foundation for the microcontroller-based DTMF-based load control system's operating concept. With DTMF technology, a corresponding and distinct tone is produced when a key or button is touched on a telephone. Two distinct frequencies are combined to create this tone. Each key corresponds to two frequencies, and when the key is pressed, a tone is produced that is an overlap of those two signals. There are 12 keys on a standard telephone keypad, which includes two symbol keys and 0 to 9 number keys. The result of our home automation system is a PIR-based light control system and an automatic water tap.

Keywords: DTMF, Automation, Energy Saving, Home appliances.

INTRODUCTION

Conventionally, electrical appliances in a home were controlled via switches that regulate the electricity to these devices [1]. Today, we have entered the era of technology. Gone are the days when manual operation was performed. In the past, manual operations were carried out. The use of homeautomation is growing in popularity and adoption worldwide. Because it makes using household equipment more comfortable and convenient, smart home automation is crucial. Making everything in the house automatically controlled by technology allows home automation to perform tasks that would often be completed by hand [2]. Numerous tasks around the house are handled by home automation. This study presents a novel home automation system that uses Dual Tone Multi Frequency (DTMF) in conjunction with a wireless module to provide smooth wireless management of several household gadgets [3]. Any remote location can be used to operate the suggested system. Although it is a wireless system, by employing mobile phones for this purpose rather than a separate wireless module. A cell phone driven system has a large range (service provider range), more control keys, and a lower risk of interference because each call has its own frequency. The DTMF tone decoding theory is the basis for cell phone controlled systems. Dual Tone Multi Frequency is referred to as DTMF [4]. Electricity is becoming increasingly necessary for human society. Many household appliances are used by humans in their homes. Depending on the situation, he may or may not require these appliances. This equipment must be controlled remotely for the sake of comfort. In addition, we require the ability to operate industrial machinery remotely. The notion of automating a home using a PC and phone connections. The dual tone multi frequency (DTMF) signals that could be transmitted through a wire loop to turn on and off different appliances using a personal computer were the foundation of the system [5]. The study, which was also based on the telephone network, gave us the idea of utilizing the user identification number to prevent unauthorized use of the control unit. An attempt was made to address automation for both home and industrial applications using a dual tone multifrequency remote control system that was also installed on existing phone lines [6]. Modern homes are using an increasing number of smart systems. The process of implementing a

smart home control system based on DTMF remote transmission is demonstrated. Later, it was proposed to use Dual Tone Multiple Frequency (DTMF) signalling to regulate water flow irrigation. Lisa demonstrated how to use a GSM network to control a gadget in general [7]. Additionally, a web-based remote exploration and control system that uses an Android smartphone has been developed. In this work, a DTMF detection circuit that is connected to a mobile device can automatically recognize the DTMF tone signal and produce an output of 4-bit digital code. This digital output code to operate any electrical equipment. Additionally developed is the DTMF signal for teleoperation of a mobile robot. Making the control process simple, adaptable, and safe is the goal of the system kit created in this study. Our goal was to use mobile phones to remotely control the machines. The cell phone has become an essential component of our everyday lives, which is why we chose it. To turn the gadgets on or off, we have built a control kit. A microcontroller that has been programmed and linked to a mobile device has been employed. The user's command is received by this one. The program defines the syntax for the commands. The user uses his mobile device to connect to the receiver. He can use the GSM network to interact with the recipient. Using a DTMF tone created with his phone, the user transmits the authentication code and a control instruction. The MT8870 decoder IC was previously employed for DTMF detection in most of the mentioned studies. However, we used an algorithm called the Goertzen algorithm to create the decoder inside the microcontroller. The problem statement of a DTMF-based load control system can be defined as implementing a system that uses Dual-Tone Multi-Frequency (DTMF) tones to remotely control and manage electrical loads.

This includes addressing challenges such as signal transmission, decoding, and efficient load management. In a DTMF-based load control system, DTMF tones are used to send commands to control electrical loads remotely. The system typically consists of a transmitter that sends DTMF tones and a receiver that detects and decodes these tones. The decoded tones are then used to activate or deactivate the desired electrical loads. This type of system can be used in various applications, such as home automation or industrial settings, to conveniently control and manage the operation of different devices and appliances [5]. In a DTMF-based load control system, the DTMF tones are generated by pressing the buttons on a telephone or a keypad. These tones consist of two simultaneous frequencies that represent different numbers or symbols. The tones are then transmitted through a communication channel, such as a phone line or wireless connection. On the receiving end, the receiver detects and decodes the DTMF tones using a decoder circuit or software. The decoded tones are then processed to determine the specific command or action to be taken. For example, a particular combination of tones may be assigned to turn on a specific electrical load, while another combination may be assigned to turn it off. This type of load control system provides a convenient and reliable way to remotely manage electrical loads. It can be used for a wide range of applications, including controlling lights, appliances, or even industrial machinery

PROPOSED SYSTEM

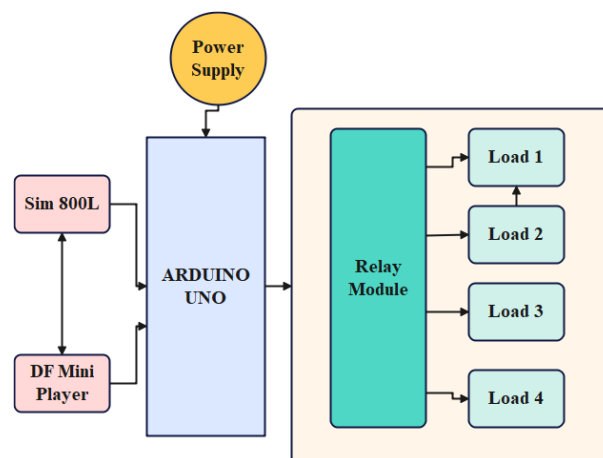


Figure. 1. Block Diagram of DTMF phone call control home automation

Block diagram of home automation is shown in fig 1. The aim of a DTMF-based load control system is to manage and control electrical loads using DTMF (Dual Tone MultiFrequency) signals. It allows users to remotely control and schedule the operation of different electrical devices or appliances. With a DTMF-based load control system, you can use your phone to send DTMF signals, which are the sounds produced when you press the buttons on a telephone keypad. These signals are received by a control unit connected to your electrical appliances. The control

unit interprets the signals and can turn devices on or off, set timers, and schedule operations. It's a convenient way to manage your electrical loads remotely [6]. Circuit diagram of DTMF automation depicts in fig. 2

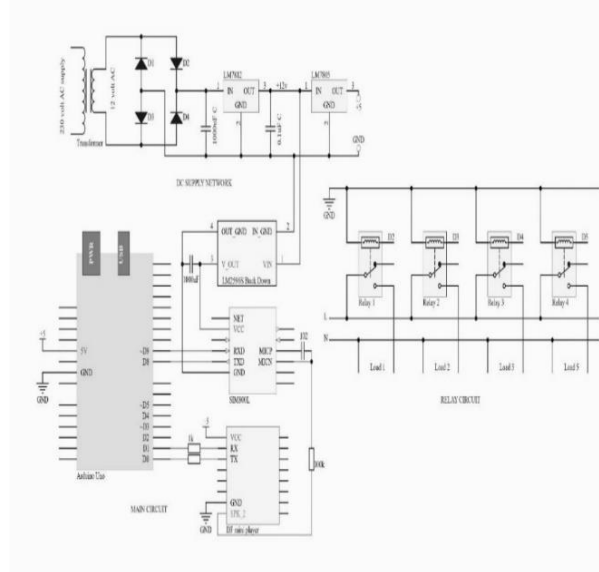


Figure. 2. Circuit Diagram of DTMF phone call control home automation

A. Working

DTMF stands for Dual Tone Multi-Frequency, and it refers to the sounds produced when you press the buttons on a telephone keypad. In a DTMF-based load control system, you start by connecting your electrical devices or appliances to a control unit. This control unit is equipped with a DTMF receiver that can receive and interpret the tones generated by pressing the buttons on your phone's keypad. When to control a specific device, you simply dial the designated phone number associated with the control unit. Once the call is established, you can use the keypad on your phone to send specific DTMF signals, corresponding to commands or instructions. The DTMF receiver in the control unit decodes these signals and performs the desired operation on the connected electrical device. For example, you can turn on or off a particular appliance, set timers or schedules to control when it operates, or even adjust its settings remotely. This way, you can effectively manage and control your electrical loads from any location using your phone. It offers convenience, flexibility, and the ability to optimize energy consumption in your home or workspace [8]

B. Component Specification

1) Microcontroller (Arduino UNO)

Arduino is a modular, user-friendly hardware and software platform for open-source electronics prototyping. It is intended for enthusiasts, designers, artists, and everyone else who wants to make interactive settings or objects. In essence, the Arduino Uno is based on the ATmega328 microprocessor (MCU). It has six analog inputs, 14 digital input/output pins, a reset button, an ICSP header, a power jack, and a USB port for programming the on-board MCU. It has everything required to support the MCU and is run with the aid of a 16 MHz crystal oscillator.

2) GSM Sim800L Module

A well-liked module that facilitates communication over GSM (Global System for Mobile Communications) networks is the GSM SIM800L. It has features for connecting to the internet, sending and receiving SMS messages, and placing calls. Devices can communicate via cellular networks thanks to the GSM SIM800L module's compatibility with GSM networks. Because it offers 2G and 3G connectivity and operates on many frequencies, it is compatible with most GSM networks across the globe. The module uses serial communication to connect to other devices, including computers or microcontrollers. Usually, it makes use of the Universal Asynchronous Receiver-Transmitter (UART) protocol, which allows devices to communicate serially to send and receive commands and data. [9]

3) DF Player Mini Mp3 Module

The DF Player Mini MP3 module is a popular and compact audio player module that allows you to play MP3 and WAV files from a micro-SD card. The module is easy to use and comes with a UART (Serial) interface for communication with a microcontroller or other devices. To use it, you need to connect it to your microcontroller or other devices and send commands to control the playback and other features. [10]

4) FOUR Channel 5v Relay Module

A relay is a device that enables us to switch a circuit on or off using voltage that is significantly higher than what an Arduino could manage. The low-voltage circuit on the Arduino side and the high-voltage side that is linked to the load are completely isolated by the relay. Here is channel 4, 5V relay for this article. Each channel on this 5V 4-channel relay interface board requires a driver current of 15–20 mA. It can be utilized to regulate a wide range of household appliances and high-current equipment. It features a common interface that a microcontroller may directly operate. Relay module is an electrical device that allows you to control up to four high-voltage or high-current circuits using low-voltage signals, typically at 5V. Each channel on the module can be controlled independently, making it suitable for various automation and control applications. Can be use it to switch on/off lights, appliances, motors, and other electrical devices with a microcontroller, Arduino, Raspberry Pi, or other control systems. [11]

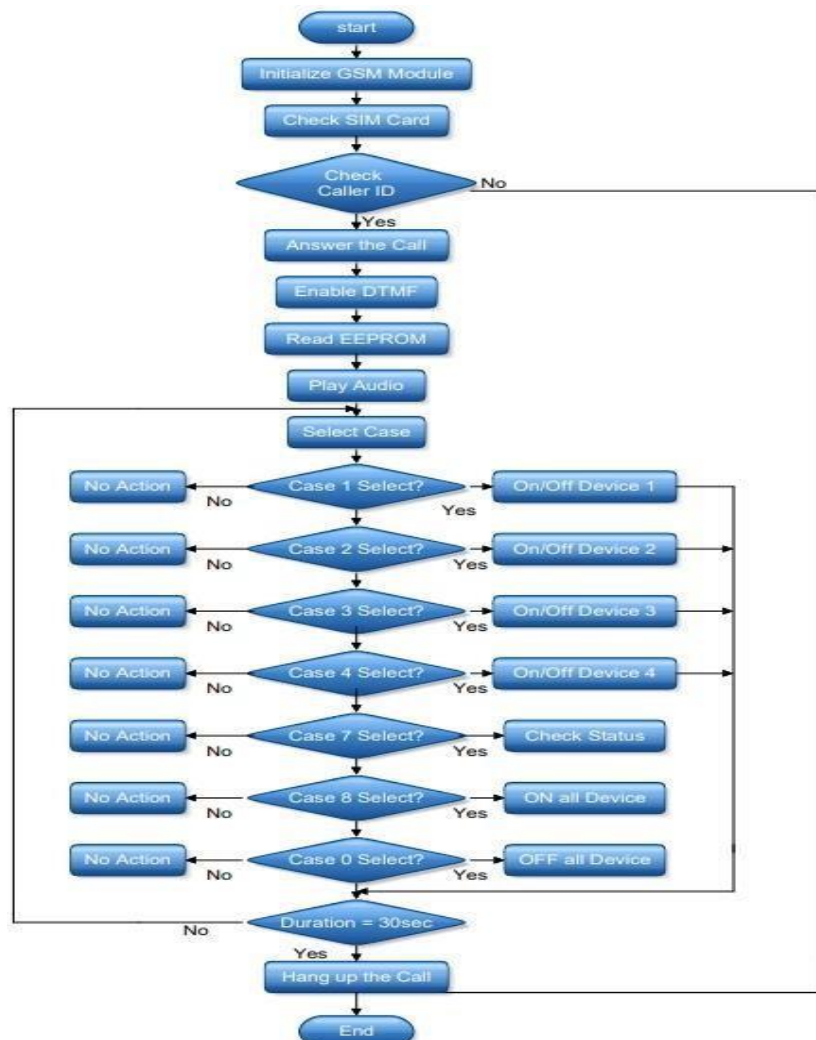


Figure. 3. Flowchart of Arduino Code

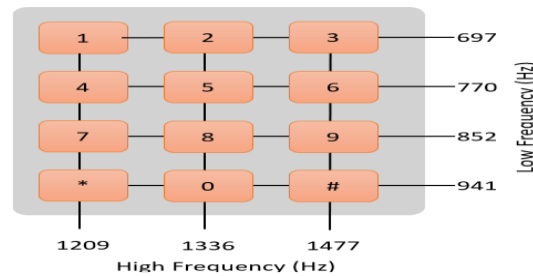


Figure. 4. Dial Pad

Dual tone multi-frequency (DTMF) signals are produced by telephone touch pads to dial a phone which is shown in fig 4. A dual tone results from pressing any key, which generates the tones of the corresponding column and row (see table below). For instance, hitting the 8 button produces the combined tones of 852 Hz and 1336 Hz. To prevent harmonics, the frequencies were selected so that no frequency is multiple of another, no two frequencies are equal, and no two frequencies added together equal to any other frequency. When line distortions are present, this makes it simpler to identify the precise tones that are present in the dial signal. There are multiple steps involved in decoding a DTMF signal. Split the signal into brief intervals that correspond to distinct keystrokes. Identify the two frequency components that each segment contains. Identify the button that was pressed [12], it shows flowchart in fig 3 . Since many interactive voice response (IVR) systems employ dual tone multi-frequency (DTMF) to allow callers to browse their menus, DTMF is useful in call centers. The front end of a phone call that welcomes the caller and presents them with menu selections is called an IVR. When dual tone multifrequency is used, the caller only needs to press the keypad number that matches the menu option number

HOME AUTOMATION

A. Automatic Light Control Using PIR Sensor Generally, we can see streetlights are ON even after sunrise, and no human presence thus by having an automatic light control system, which turns ON and OFF lights when ambient light falls below a specific intensity, for this, we can use an LDR sensor. In this system, we are also using a PIR motion sensor which detects the motion of the object such as humans and animals passing through it, using this motion of the object LEDs are turned ON. Most of the time we see lights are ON even after sunrise and no presence of any person who needs light thus having an automatic light control system that turns ON and OFF lights when it detects a person and when ambient light falls below a specific intensity. The manpower required for controlling the light cuts a huge cost, so using this system we can also reduce the cost of manpower and reduce unnecessary power consumption [13]. We also know that during daytime there is no essence of light, this problem is solved by the LDR sensor. LDR sensor keeps the light OFF in daytime. When the light intensity is low then the LDR starts working and the light is switched on. The main aim of this research is to implement auto-intensity control of LED based on PIR motion sensors. PIR motion sensor detects the human presence and turns the ON/OFF LED light. PIR motion sensors interface with a relay, when the PIR sensor detects motion, it turns ON lights.

B. Circuit Diagram

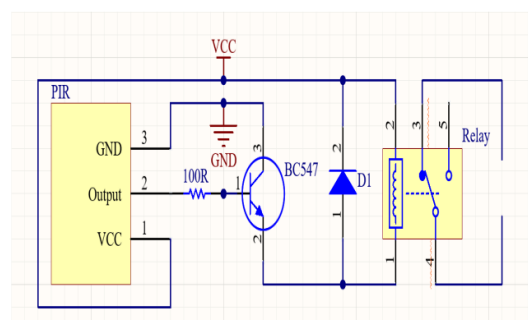


Figure. 5. Circuit Diagram

Motion from people or animals can be detected by PIR sensors. People give out infrared radiation. These variations in radiation are picked up by the PIR sensor when a human enters its sensing range, which raises the sensor's output. Fig. 5 shows circuit diagram of PIR sensor.

C. PIR Module

PIR sensors are also called Passive Infrared sensors which are used to detect the presence of human or animal. It is opensource hardware used in many works. The PIR sensor receives infrared radiation from the human body and turns ON and OFF the light. Infrared light emitted by objects is measured by an electrical sensor. Most PIR-based motion detectors employ PIR sensors. It is also utilized in automatic lighting and security alarm systems. The figure below displays a typical PIR sensor pin arrangement, with pinouts that are easy to understand. Although 5V is usually utilized, the PIR sensor module may be powered from 4.5V to 20V. Give the module a few minutes to calibrate itself after powering it on; two minutes is a good amount of time. After then, look at the output pin. Prior to analyzing the output, it is important to understand that this sensor has two operating modes: Repeatable (H) and Non-Repeatable (L) [14]. 1) Repeatable (H) mode: The output pin in Repeatable (H) mode will go high (3.3V) when a human is detected within range and will go low after a specific amount of time, which is determined by the "Off time control" potentiometer. This setting causes the output pin to go high regardless of whether the individual is still inside the range or has left. The potentiometer known as the "sensitivity control" can be used to adjust the sensitivity. 2) Non-Repeatable (L) mode: When a human is detected within range in "I" mode, the output pin out (3.3V) will go high and remain high as long as the person remains within the sensor's range. The potentiometer can be used to set the time at which the pin will go low after the individual has left the vicinity. The "sensitivity control" can be used to adjust the sensitivity.

D. Automatic Sink Tap

An automatic sink tap, also known as a touchless or sensor faucet, operates by using motion sensors to detect the presence of hands underneath the faucet. When it senses hands, it activates the flow of water without the need for physical contact with handles or knobs. This technology offers several advantages, including improved hygiene by reducing the spread of germs and bacteria, as well as water conservation since the flow is often regulated to prevent wastage. Automatic sink taps are commonly found in public restrooms, healthcare facilities, and increasingly in residential settings due to their convenience and cleanliness benefits [15], [16].

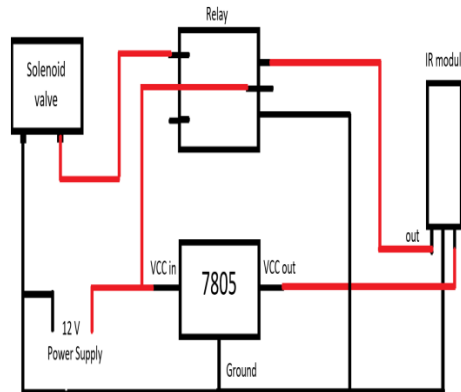


Figure. 6. circuit diagram of Automatic Tap sink

Fig. 6 shows circuit of Automatic sink tap. It uses infrared sensors to detect motion. Someone places their hands within the sensor's range, it sends a signal to a solenoid valve, which then opens to allow water flow. Once the hands are removed, the sensor detects the absence of motion and shuts off the water flow after a preset period, usually a few seconds. Battery or Electric Powered: Most automatic sink taps are powered by batteries or electricity. Battery-powered models are typically easier to install since they don't require access to electrical wiring, making them suitable for retrofitting existing sinks. However, they require periodic battery replacements. Electrically powered models are often connected directly to a power source and may have additional features such as adjustable sensor settings or temperature control.

HARDWARE IMPLEMENTATION

Hardware implementation is discussed in this section, fig. 7 shows hardware image of DTMF.



Figure. 7. Hardware Image

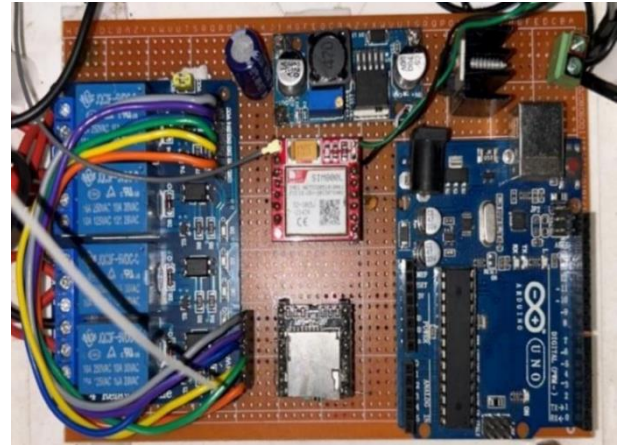


Figure. 8. Hardware Circuit

Complete hardware circuit depicts in fig. 8, and it is tested and worked well.

A. Automatic Light Control Using Pir Sensor

Fig 9 shows the PIR Sensor circuit that demonstrates the successful working of automatic load control using PIR.



Figure. 9. PIR Sensor Circuit



Figure. 10. Automatic Tap

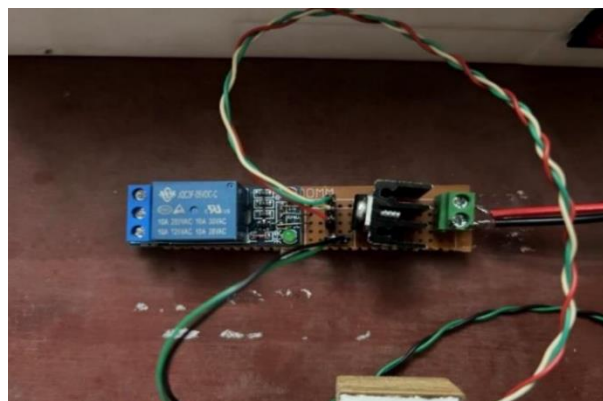


Figure. 11. Automatic Tap Circuit

Fig. 10, 11 shows the automatic sink tap hardware that shows the working of solenoid valve used to control and automation in a tap sink.

CONCLUSION

This paper successfully demonstrates the integration of an Arduino and a GSM module to control home appliances remotely. By decoding DTMF signals generated from a phone call, you can switch appliances on and off from anywhere with a simple phone call. This technology can be useful for home automation and remote monitoring, providing convenience and flexibility for users. However, it's essential to ensure the security of this system to

prevent unauthorized access to your appliances. Additionally, further improvements can be made to enhance the model's functionality and user- friendliness. Overall, this model serves as a foundation for more advanced home automation and remote-control applications. In this work, an Intelligent Energy Saving System that is not limited to any application can be used anywhere in a process industry with a relay. This concept not only ensures that our work will be usable in the future but also provides flexibility to adapt and extend, as needs change. It has studied and implemented a complete working model using a relay. This work includes the study of energy saving systems in many applications. The development of the automatic sink tap marks a significant advancement in both convenience and hygiene within public and private spaces. By seamlessly integrating sensor technology, water conservation efforts are enhanced while minimizing the risk of cross- contamination. Further refinement and widespread implementation of such innovations promise to redefine standards of efficiency and sanitation in our daily life. DTMF control has some advantages like

- 1) Accessibility: DTMF control is accessible from any phone, making it convenient for remote control of home automation systems.
- 2) Simplicity: DTMF tones are easy to use and understand, making it user- friendly for people of all ages.
- 3) Cost effective: DTMF technology is relatively inexpensive to implement as it doesn't require specialized hardware or software.
- 4) No internet dependency: DTMF doesn't rely on an internet connection, making it more reliable in areas with poor connectivity.
- 5) Basic security: DTMF codes can provide basic security by requiring a PIN or code for access, adding a layer of protection.

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