Arduino Based Home-Automation

A
Project Submitted to
Veer Surendra Sai University of Technology, Burla
in partial fulfilment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

by

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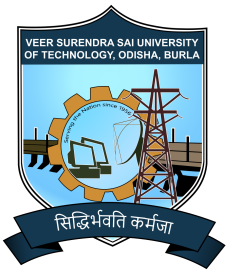

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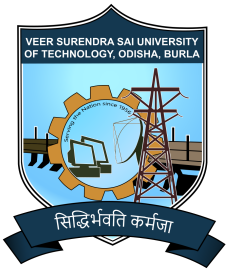

CERTIFICATE

This is to certify that the report entitled **"Arduino based Home-Automation"** submitted in partial fulfilment of the requirements for the degree of Bachelor of Technology in **Electrical Engineering**, during the session 2023-2024 in the department of Electrical Engineering of **Veer Surendra Sai University of Technology, Burla**, is a Bonafede work carried out by them under my supervision and guidance.

I believe that the report fulfils part of the requirement for the award of degree of Bachelor of Technology. Neither this dissertation nor any part of it has been submitted for any degree or academic award elsewhere.

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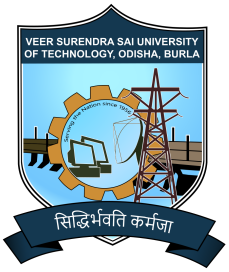

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DECLARATION

This is to certify that the report entitled **"Arduino Based Home-Automation"** which is submitted by us in partial fulfillment of the requirement for the award of the degree, Bachelors of Technology, in Electrical Engineering, Veer Surendra Sai University of Technology, Burla, Odisha, comprises only our original work and due acknowledgement has been made in the text to all other material used. It has not been previously presented in this institution or any other institution to the best of our knowledge.

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ABSTRACT

The world is rapidly embracing automation as a solution to the increasing demands on people's time. Home automation systems offer a convenient and efficient way to control various devices and appliances according to our needs. This paper presents the development and design of a home automation system using Arduino integrated with a WiFi module. The system is designed to be easily controlled through an Android application, providing users with a simple and reliable technology for managing home appliances such as fans, bulbs, air conditioners, and automatic door locks. The utilization of Arduino Mega and a WiFi module ensures cost-effectiveness, ease of installation, and straightforward explanation of the system's functionality.Arduino offer a practical and cost-effective solution for modern smart homes. The integration of wireless communication, sensor technology, and a user-friendly interface through an Android application enhances convenience, security, and energy efficiency.

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1 Introduction

1.1 Overview

In todays era human beings are going toward automating everything to achieve comfort as much as they can by the help of advanced technology. Since people spend most of their time at home, automating a house would be an attractive subject for ease of life. With a home automation system, people are able to control many household activities automatically. Nowadays most people have their smartphone nearby them; therefore, adding an interface on the smartphone to control an automated system is an exciting and advantageous project.

Home automation systems could control lighting system, heating and air conditioning, appliance and security door locks to bring more accessibility, convenience, safety, ease and energy efficiency.

Security is an important subject that could be added to a home automation system. Gathering all different security systems such as alarm, the fire alarm, access control (door lock), CCTV, intrusion detection system (IDS), etc. makes our life safer. All the security systems mentioned above could be involved under the home automation system project. Energy saving is another benefit of the home automation system.

1.2 Objective

The objective of this project is to design and build a smart home automation system which will bring more comfort, security and energy saving to our lives. It will work accordingly to various requirements or needs of user. The major targeted areas of this projects are as follows:

Enhancing Convenience: It will simplify regular daily basis repetitive actions like controlling light, home entertainment devices etc with the help of gesture or voice command or smartphone. Smart home technology can contribute to a more comfortable living environment.

Improving Energy efficiency: By integrating energy management features, smart home systems can optimize energy usage within the home. Which will monitor energy consumption in real-time, and automatically adjust devices to minimize waste.

Security and Safety: It will help houseowner to monitor Motion sensor, intruder detection, smart lock and alarm.

The key objectives of smart home automation is to provide homeowners with remote access and control over their home systems. This allows them to monitor and manage their property from anywhere with an internet connection, providing peace of mind and convenience. By optimizing energy usage, reducing waste, and promoting eco-friendly practices, this automation program contributes toward the sustainability . this project consolidates numerous home management tasks into a single integrated system, that simplifies the overall management of household activities.

2 Overview Of Home Automation

2.1 List of home automation function

Home automation offers a variety of functions aimed at enhancing convenience, security , energy efficiency, and comfort within a household. Here are some common functions of home automation:

Smart lighting control - Home automation systems allow you to control lighting remotely, set schedules for lights to turn on/off, adjust brightness, and even change colors in some cases. This can save energy and enhance security by simulating occupancy when you're away.

Temperature Regulation - With smart thermostats, you can remotely control your heating and cooling systems, set schedules, and adjust temperatures based on your preferences. This helps in energy conservation and maintaining a comfortable environment.

Security and surveillance - Home automation systems often include security features such as smart locks, motion sensors, doorbell cameras, and surveillance cameras. These devices allow you to monitor your home remotely, receive alerts for suspicious activity, and even grant access to visitors when you're not at home.

Appliance Control - Many home appliances can be integrated into automation systems, allowing you to remotely control them or set schedules for their operation. This includes things like smart plugs for controlling non-smart devices, smart kitchen appliances, and more.

Home Entertainment - Automation systems can integrate with home entertainment devices such as TVs, speakers, and streaming services. You can control these devices remotely, set up automated routines for entertainment, and even create immersive home theater experiences with synchronized lighting and sound.

Voice Control - Integration with virtual assistants like Amazon Alexa, Google Assistant, or Apple's Siri enables voice control of various aspects of your home automation system, providing hands-free operation for many functions.

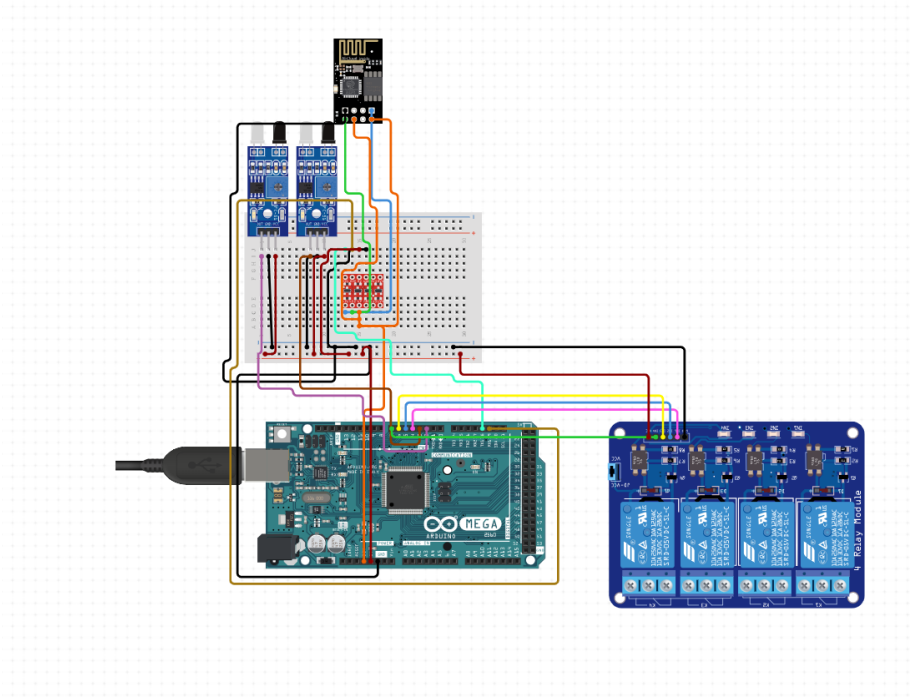
Energy Management - Home automation systems often include energy monitoring features that track energy usage throughout your home. This data can help you identify areas where you can reduce energy consumption and save money on utility bills.

Water Management - Smart water sensors and valves can help detect leaks and monitor water usage, potentially preventing costly damage and conserving water resources.

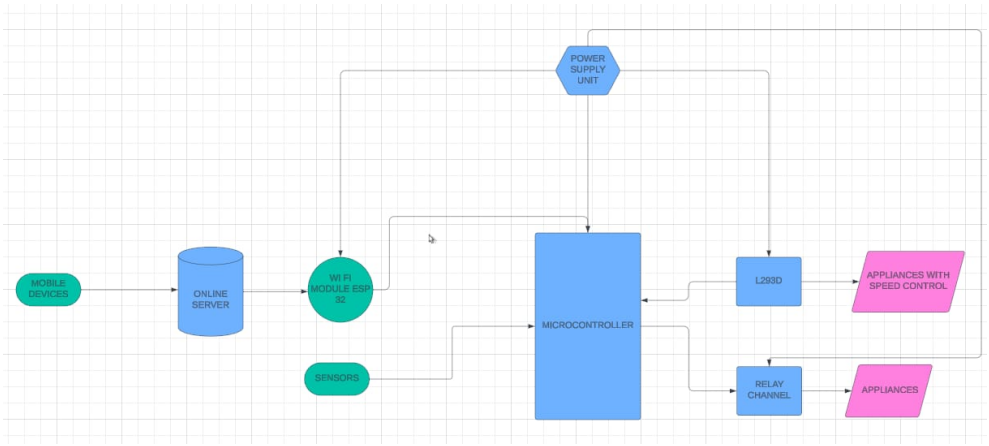
Automated Blinds and Curtains - Automated window coverings can be controlled remotely or set to open and close automatically based on schedules or environmental conditions, such as sunlight or temperature.

Health and Wellness Monitoring - Some advanced home automation systems integrate health and wellness monitoring devices, such as fitness trackers or health sensors, to provide insights into occupants' well-being and enable personalized adjustments to the home environment.

2.2 Connection Protocol



2.3 Block Diagram



2.4 Security Feature

This project consists of a special security feature which will help to disconnect the home automation system form the online server in case the mobile software gets hacked or the password gets stolen we can bring the hardware into the manual format.

In this project instead of using a unified or centralized micro controller for connecting to internet, we have used esp 32 which gets programmed separately and connects to the internet separately, so when ever the software gets hacked or the password gets stolen we can turn off the esp 32 and the entire project will be shifted to the manual state. After changing the password we can reset the project and the entire system will reset to normal.

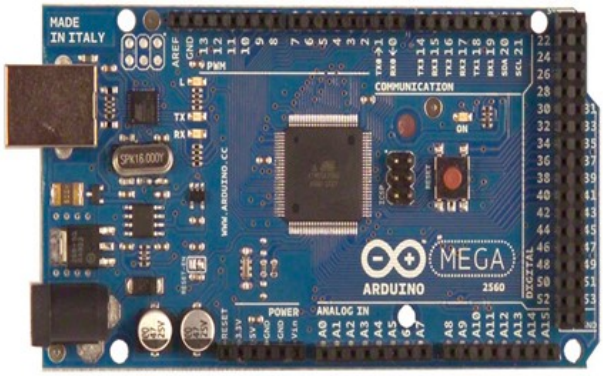
3 Details Of Implementation

3.1 Components

3.1.1 Microcontroller :-

In this project we used Arduino Mega 2560. The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller. It was simply connected to a computer with a USB cable or power with an AC-to-DC adapter or battery to get started.

The Mega 2560 can interface with various sensors such as motion sensors, temperature sensors, humidity sensors, light sensors, etc. It can control actuators such as relays, servo motors, stepper motors, etc., which are used to perform actions like turning on/off lights, controlling door locks, opening/closing curtains, etc. The Mega 2560 can be connected to user interface devices such as LCD screens, touchscreens, or even mobile devices through Bluetooth or Wi-Fi and it can communicate with other devices in the smart home network using protocols like Wi-Fi (using shields or modules like ESP8266 or ESP32), Bluetooth, Zigbee, or even wired protocols.



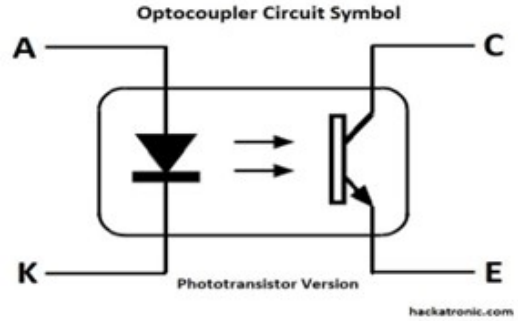
3.1.2 Relay module circuit:-

In this project model Relay module circuit is consists of Relays of 12volt rating, Optocoupler, Transistor, Resistor, LEDs.

Relay :- Basic function of a relay in home automation projects, serving as switches to control various electrical devices remotely. By interfacing relays with microcontrollers or specialized home automation systems, users can turn the devices on or off from a distance, often using a smartphone app, voice commands, or predefined schedules. Here we used relays of 12 volt rating.

When current flows through the coil, it generates a magnetic field, which causes the contacts to change state. In a Normally Open configuration, the contacts are open when the relay is not energized (no current flowing through the coil), and they close when the relay is energized. In a Normally Closed configuration, the contacts are closed when the relay is not energized and open when the relay is energized.

Optocoupler :- An optocoupler, also known as an opto-isolator, is an electronic component that transfers electrical signals between two isolated circuits by using light. It consists of a light-emitting diode (LED) that emits light when current flows through it, and a photosensitive semiconductor device (such as a phototransistor, photodiode, or photoresistor) that detects the emitted light and produces an electrical signal proportional to it. The LED and the photosensitive device are typically housed in a single package but are electrically isolated from each other.



Optocouplers provide galvanic isolation, meaning there is no direct electrical connection between the input and output circuits. It can also be used to shift voltage levels between different parts of a circuit, allowing components with different voltage requirements to communicate safely.

In the home automation project, optocouplers may be employed in various applications such as:-

- Controlling relays to switch lights, appliances, or HVAC systems.
- Reading sensor data from analog sensors like temperature and humidity sensor.
- Interfacing with high power device like motors or solenoid.
- Isolating communication signals between different subsystems, such as between a central control unit and peripheral devices.

Transistor:- Transistors are widely used in home automation projects primarily for switching and amplification purposes.

- In home automation systems when transistor is used as a switch, it operates either in it's cut off state (fully off) or saturation state (fully on), depending on the control signal applied to its gate or base terminal.
- Transistors can amplify signals, which is useful for boosting weak control signals or sensor outputs in home automation projects.
- Transistors like power MOSFETs and BJTs, are employed for controlling motors in home automation applications which modulate the current supplied to the motor using pulse-width modulation (PWM) techniques.

Resistor:- Resistor in the relay circuit serve several functions like :

- Resistors are often used to limit the current flowing through the relay coil. When a relay coil is energized, it acts as an inductive load, and without proper current limiting, it could draw excessive current from the control circuit, potentially damaging the controlling components like microcontrollers or transistors.
- It can also be used for noise filtering purposes in relay circuits.

LED:- It is a semiconductor device that emits light when an electric current passes through it.

- LEDs are known for their efficiency, durability, and versatility. They consume less power compared to traditional lighting technologies like incandescent bulbs and fluorescent lamps, making them environmentally friendly and cost-effective in the long run.

3.1.3 WiFi Module

In the Arduino based smart home automation project model Wi fi module enabling wireless communication between various devices and the central control system .It can remotely control and monitor their smart home devices from anywhere with an internet connection. Whether they're at home or away, users can use a smartphone app or web interface to adjust thermostat settings, turn lights on or off, view security camera feeds, and receive notifications from smart sensors. Here we used ESP32-WROOM Wi fi Module.

This is ESP WROOM 32 MCU Module. Which is a powerful, generic Wi Fi-BT-BLE MCU module that targets a wide variety of applications, ranging from low-power sensor networks to the most demanding tasks. The user may also power off the CPU and make use of the low-power coprocessor to constantly monitor the peripherals for changes. ESP32- WROOM integrates a rich set of peripherals, ranging from capacitive touch sensors, Hall sensors, low-noise sense amplifiers. Using Bluetooth, users can connect to their phone or broadcast low energy beacons for its detection. The use of Wi-Fi enables a large physical range, as well as a direct connection to the internet via a Wi-Fi router.

3.1.4 Sensors

Here in this project model we used IR(Infra-red)Sensors. For more Features we can use LDR(Light Dependent Resistor) sensor, Humidity sensor, PIR(Passive Infra Red) sensor etc.

These sensors have 3 pins in general:

- vcc for power input , which is usually 5v form the microcontroller development board.

- gnd – the ground pin which is connected to the ground pin of microcontroller board.
- analog output pin – this is connected to any of the analog pins of the microcontroller , which will be used to read the output of the sensor , when ever the sensor detects something , the analog output pin voltage with respect to ground changes.

This change is read and recorded by the microcontroller , depending on the value the microcontroller performs certain tasks.

3.1.5 Power supply

The power supply, supplies power to the entire project, the power supply is connected to the relay module, and then this 12v power is converted to 5v and given to the esp 32 and arduino. For this project we need a constant 12v power supply, we can use a lithium ion battery with a charging system, this charging system includes a ac to dc converter. We can also use a solar panel for this purpose, this will reduce the power wastage as this project requires very low power. For this project we have used a SMPS switch mode power supply, this provides constand 12 v power to the project,

- The power requirement of this project is as followed
- current requirement - 2mA
- voltage - 12 v
- total power is = current x voltage = 24mW
- energy consumed per hour = 86.4 joules
- energy consumed per day = 2073.6 joules
- The efficiency of SMPS = 80 percent.
- total energy consumed = 2592 joules.
- Unit consumed = 0.00072 units.

4 Working of Project

This project is divided into four section

- The power supply unit, this consists of smps, which provides constant 12 volts supply.
- Microcontroller unit - The microprocessor 2560 takes input from various sensors and esp 32 WiFi module, then this data is compared with the present value, if the sensor value exceeds the threshold then the desired task is performed. For example the PIR(Passive Infrared Sensor) sensor detect the movement in the surrounding, this sensor emits infrared signals, this signal bounce back from the surface of the object, this signal is read by the sensor. This changes the voltage of analog output pin of the sensor, this varies between 0 to 255 depending on distance of the object. This signal is the fed to analog input of the micro-controller, Micro-controller further decides weather the distance is close enough then the loads gets the power supply.
- ESP 32 WiFi module - This module is connected to the local WiFi of the house, by using the IOT system it connects with the server of blynk website which is a free website that creates serial communication between mobile and the esp 32 the mobile software is designed to provide 0 or 1 signal depending upon the status of the key available in the mobile software, this 0 or 1 is read by the blynk server , which then sends a signal to the esp 32 , this signal makes one of the digital pins of the esp 32 high , this digital pin is connected to the analog pin of Arduino microcontroller , the full value output of the esp 32 is 3.3 v , so when we give high signal to the esp 32 , the digital pin is set to 3.3v , the Arduino takes the analog value and compares it with a preset of 3v , when ever this analog value exceeds 3v one of the relays gets turned on.

- The output circuit – the output of the Arduino is 5 volts max , but the relays takes 12 v to operate so we use amplifier circuit , this circuit uses an optocoupler , which has a ir led and a photo transistor, when ever the ir light falls on the photo transistor , the transistor gets biased and starts conduction form collector to emitter, so the output of the Arduino is connected to the ir pin of the optocoupler via a led and a resistor , so when ever the digital pin of the microcontroller goes high it provides 5v this is used to turn on the ir led of optocoupler , the light form the ir led is sensed by the photo transistor this sets the transistor in active region , but the gain of the photo transistor is low , to solve that we use a bc547 transistor in cascade this increases the gain of the circuit , now a 12 v supply is given to the circuit when ever the photo transistor is on the 12v supply is given to the relay which turns the relay on , a diode is used in parallel to the relay coil leads, as the coil of the relay acts as a inductor which stores the current and can make the current flow in reverse direction when the circuit is off , to avoid this reverse flow of current we use a diode . this protects the circuit and maintains the polarity of the relay. This relay is used as a switch for a ac circuit to turn the loads on or off.

- **Arduino code**

- **Python code**

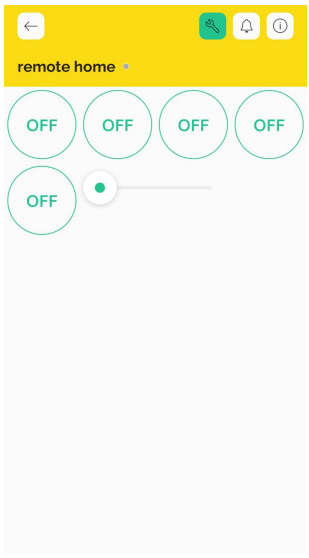
5 Advantage

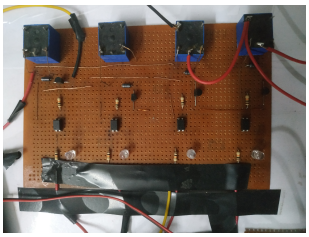
- **Everything is automated, making it easy to use:** Home automation systems eliminate the need for manual operation of various devices and tasks, making daily routines more convenient and efficient.
- **Controlled by mobile applications, no extra training required:** Using mobile apps for control means users can operate the system with familiar interfaces, reducing the learning curve and making it accessible to a wider range of people without specialized training.
- **Flexibility to change controlling systems as needed:** Home automation systems based on platforms like Arduino offer flexibility, allowing users to customize and modify the control logic according to their specific requirements or preferences.
- **Works on Arduino-based systems, easy to understand:** Arduino-based systems are popular in DIY electronics and are known for their ease of use and extensive community support, making it easier for users to understand and work with the underlying technology.
- **Time-saving:** Automation streamlines tasks and reduces the time spent on manual operations, freeing up time for other activities or increasing overall productivity.
- **Control of every home appliance through one application:** Centralized control through a single application simplifies management and reduces the need for multiple control interfaces, enhancing user convenience.
- **Easy installation and user-friendly:** Home automation systems designed with user-friendliness in mind offer straightforward installation processes and intuitive interfaces, ensuring a smooth user experience.

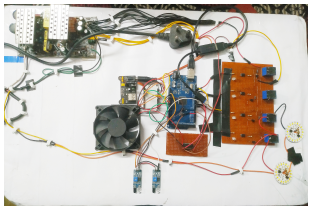
  These advantages highlight the convenience, flexibility, and efficiency that SMPS-based home automation systems can provide, making them a popular choice for modern households seeking to enhance their living spaces with smart technology.

6 Results

- The main objective our project was to design and build a smart home automation system which will bring more comfort, security and energy saving to our life.
- By using mobile application we controlled the working of various loads including bulbs and fans which in general needed switch operation.
- Through this project we also demonstrated the use of arduino mega 2560 to work as and signal receiver and transmitter which worked as an interface between different peripherals in use.
- Here we also demonstrated the security feature of this model where if in case the system gets hacked the security feature comes into play which makes the system run in manual mode only through switch and gesture mode.
- The implementation of IR sensors in this model also made it easy to use and operate through object detection.
- Further more running programs in our desktop connected to our automation system which makes the desired task easy to access and operate.
- Through this project we also demonstrated the reduction in power consumption relative to that of the non automated system, making the system efficient to use.







7 conclusion

The Arduino-based home automation project successfully demonstrated the efficacy of leveraging open-source hardware and software to create a versatile and cost-effective solution for enhancing residential environments. Through the integration of Arduino microcontrollers, sensors, and wireless communication technologies, the system provided users with remote control over various home appliances and systems, improving efficiency and convenience. While the project showcased the potential for DIY enthusiasts to develop sophisticated home automation systems, further refinement in reliability, security, scalability, user interface, and integration with IoT ecosystems will be essential to ensure broader adoption and seamless integration into modern smart homes.

Overall, the Arduino-based home automation project demonstrated the potential for DIY enthusiasts and hobbyists to create sophisticated and adaptable solutions for modernizing and enhancing the functionality of residential environments. With continued innovation and refinement, such projects have the potential to contribute to the widespread adoption of smart home technologies and the realization of more efficient and connected living spaces.

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9 Appendix