# SD Card Forensics on ESP32

RAS Minor Mini-Project - 1 PC408

***Phase 1 : Design***

Dhirubhai Ambani University

**Mentored by : Dr. Tapas Kumar Maiti**

**Jhil Patel**

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## INTRODUCTION

With the rapid growth of IoT devices, secure data logging has become critical, especially for applications like evidence collection, monitoring, and industrial automation. Logs stored on removable memory, such as microSD cards, are vulnerable to tampering by unauthorized parties. If manipulated, these logs can mislead forensic investigations and compromise system reliability.

This project focuses on designing a secure logging mechanism using an ESP32 development board and a microSD card. The system will first operate without security to demonstrate how an attacker can modify logs remotely. Later, security enhancements like hashing and tamper detection will be added to prevent and detect manipulation.

## HYPOTHESIS

If sensor data stored on a microSD card is not protected, an attacker can alter the recorded information without being detected. Implementing cryptographic file hashing and verification routines will allow the system to detect such tampering, ensuring data authenticity and integrity even after attempted attacks.

## MATERIALS

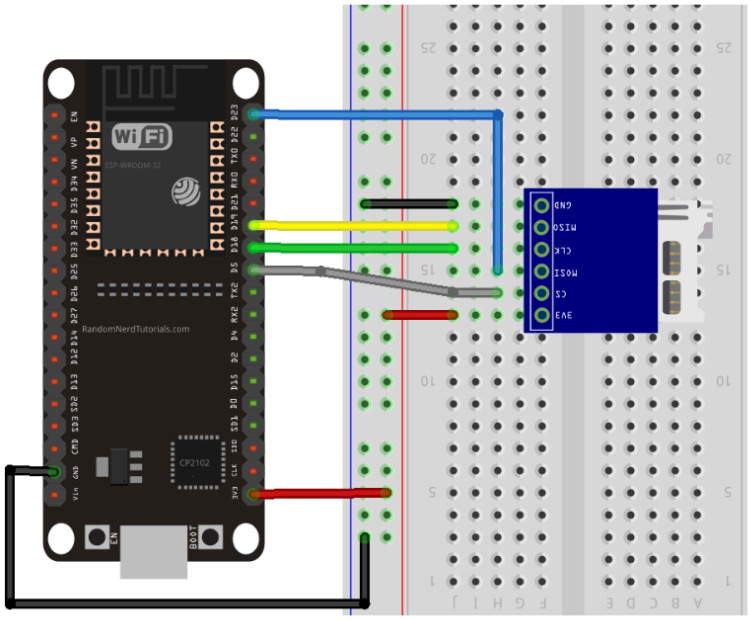
1. ESP32 Development Board
2. microSD Card Module & microSD Card (FAT32 formatted)
3. Jumper Wires & Breadboard
4. Wi-Fi-enabled smartphone (to simulate attacker device)
5. Arduino IDE / Wokwi for simulation
6. SHA-256 integrity checking library (for Phase 3)

## PROCEDURE

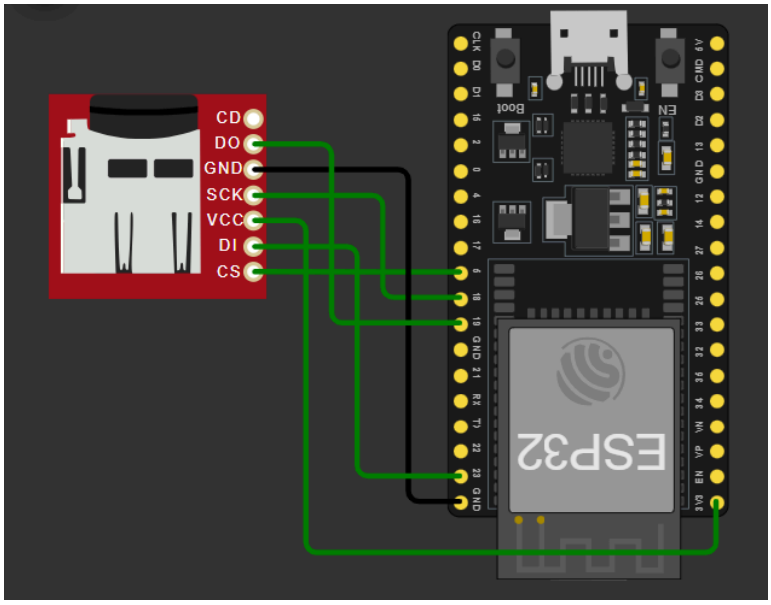
1. Connect ESP32 to microSD card module for log storage
2. Program ESP32 to log dummy sensor data to microSD
3. Enable Wi-Fi connectivity on ESP32
4. Allow external commands via network (HTTP/UDP) to modify logs
5. Simulate an attack using a smartphone to send malicious overwrite commands

6. Record behavior of system without protection (Phase-2 baseline)
7. Plan implementation of SHA-256 hashing + verification to detect tampering

## DESIGN REFERENCE

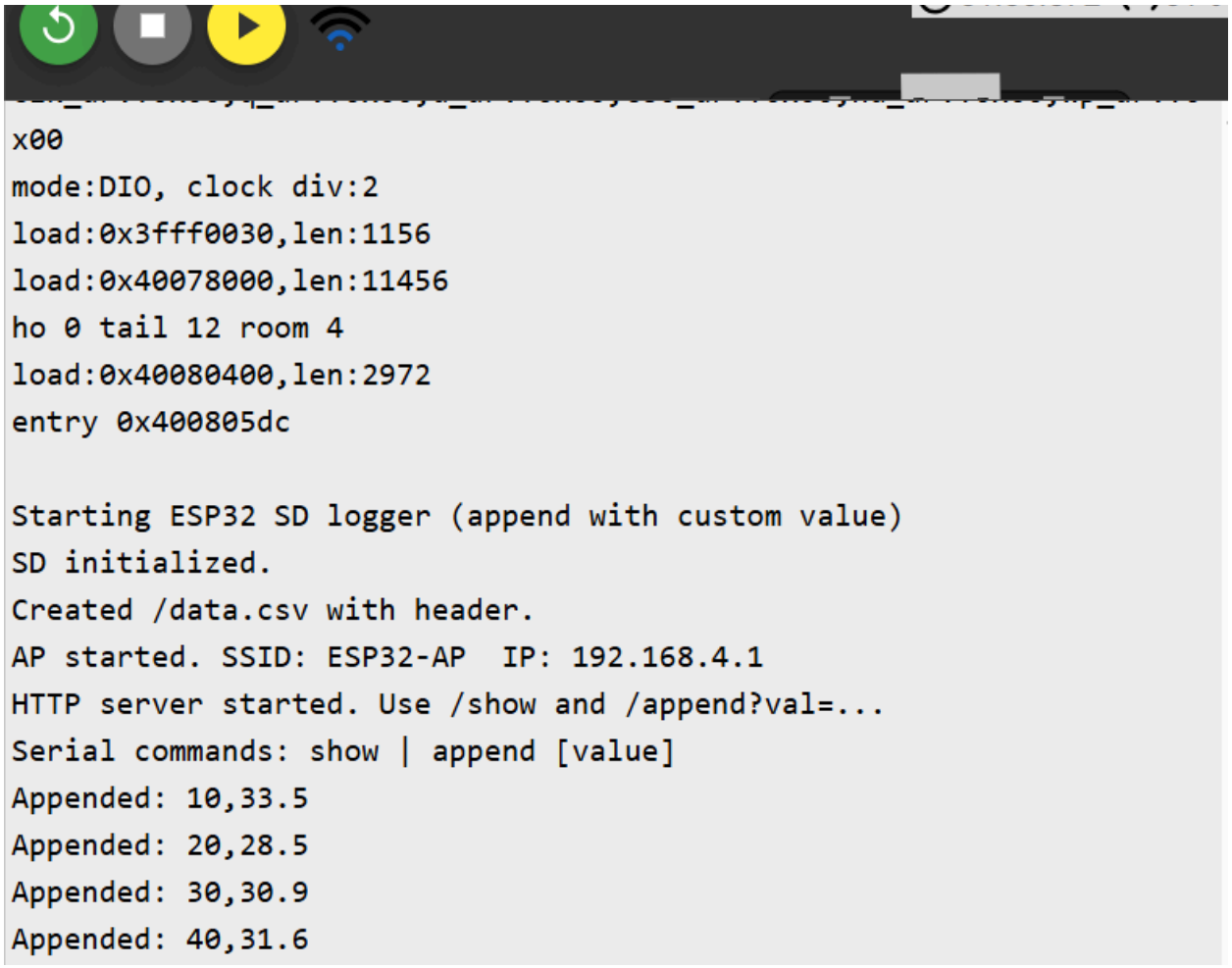


## SIMULATION ON WOKWI

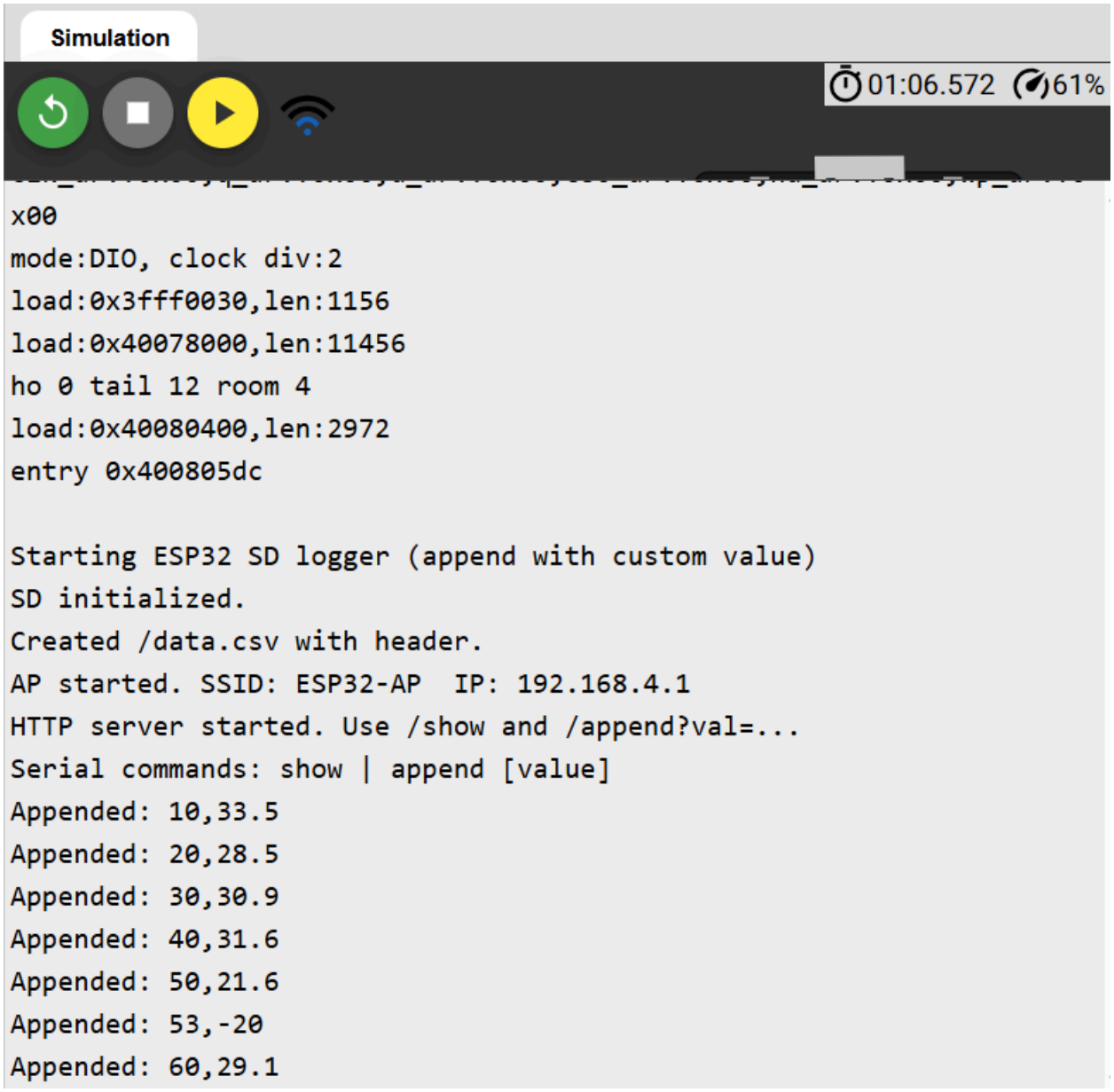


## SIMULATION DRY RUN RESULTS

In normal flow the temperature sensor data is logged every 10 seconds for dry run




Manually appending a value to simulate an external data injection, for example an out-of-range temperature of −20°C.




Displaying logged SD card data

```
---- /data.csv ----
time_seconds,value
10,33.5
20,28.5
30,30.9
40,31.6
50,21.6
53,-20
60,29.1
```

In the absence of a security layer, manual appends and legitimate data are treated identically by the system. As a result, malicious or accidental data injections may remain untracked, since there is no visible way to distinguish authentic records from tampered ones.

## SIMULATION VIDEO LINK

https://youtu.be/qBASPebt6uw?si=N-i_R8BNAHHwSp1x

## REFERENCES


1. https://randomnerdtutorials.com/esp32-microsd-card-arduino/
2. https://wokwi.com/projects/new/esp32
3. https://www.espressif.com/sites/default/files/documentation/esp32_technical_reference_manual_en.pdf