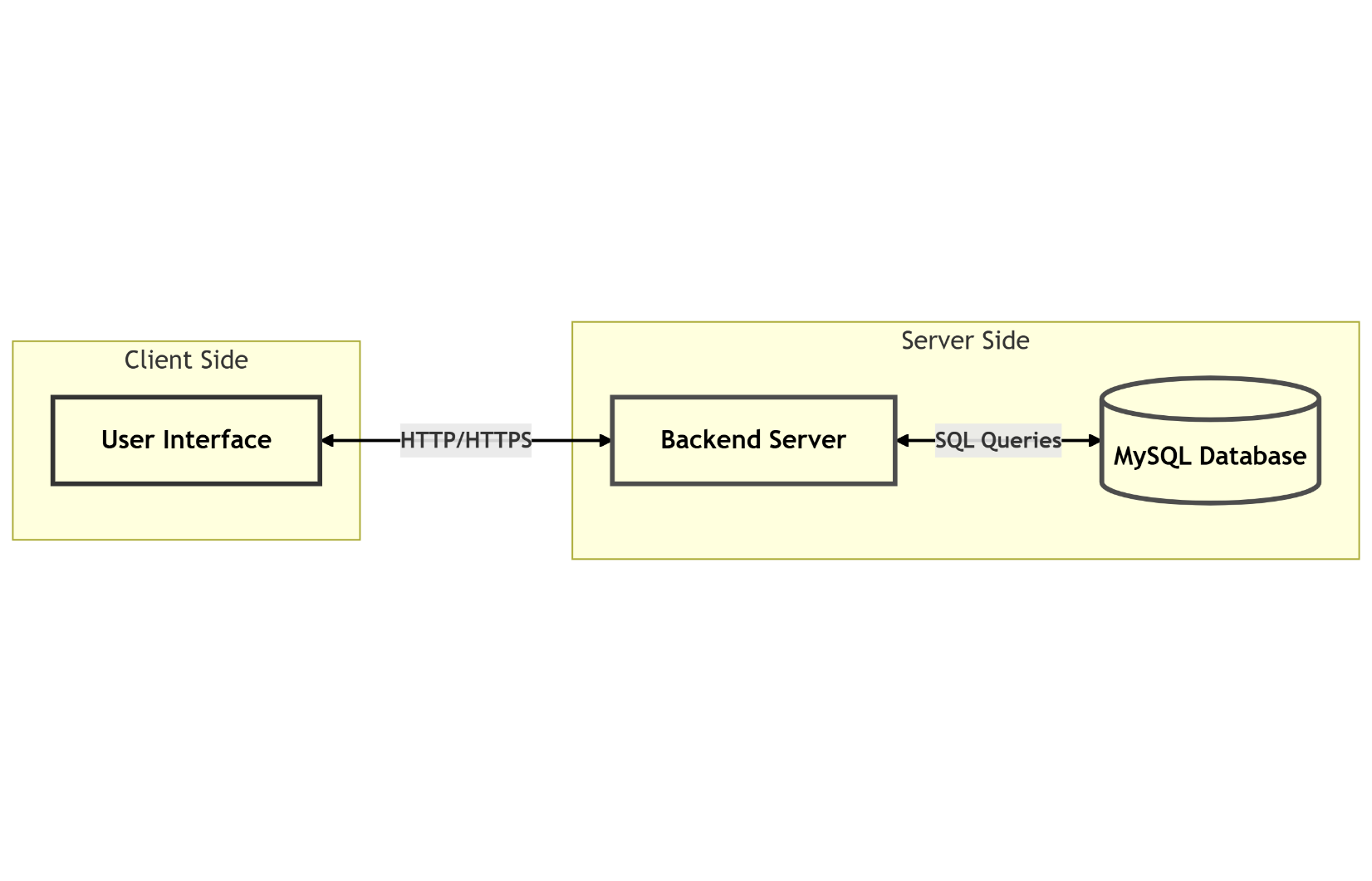
# Design Document – Firmware Installer

## 1. System Architecture Overview

**TekMedika Firmware Updater** is a comprehensive tool designed to simplify firmware installation for Arduino Mega and NodeMCU boards. The system is divided into three main components:

1. **Installer**: A Python-based Desktop GUI application that provides an intuitive interface for users to install firmware on master and slave boards.
2. **Backend Server**: A Node.js/Express-based server that records firmware installation details and provides APIs for interaction.
3. **Database**: A MySQL database that stores firmware installation records, including system UID, firmware version, and timestamps.

### High-Level Architecture



## 2. Components

### 2.1 Installer

* **Technology**: Python (Tkinter for GUI)
* **Purpose**: Provides a user-friendly interface for firmware installation, version selection, and board management.
* **Key Features**:
  + Detects connected boards (Master/Slave) via USB.
  + Downloads firmware files dynamically from a GitHub repository.
  + Installs firmware on the boards using arduino-cli and esptool.
  + Displays progress and logs for each step.
  + Registers firmware installation details with the backend server.

### 2.2 Backend Server

* **Technology**: Node.js with Express.js
* **Purpose**: Handles API requests from the installer and interacts with the database.
* **Key Features**:
  + Records firmware installation details (system UID, firmware version, timestamp).
  + Provides endpoints for retrieving installation history.
  + Secures API interactions using a hashed secret key.

### 2.3 Database

* **Technology**: MySQL
* **Purpose**: Stores firmware installation records.
* **Schema**:
  + **Table**: firmware\_installations

| **Field** | **Type** | **Description** |
| --- | --- | --- |
| id | INT (PK, AUTO\_INCREMENT) | Unique record ID |
| system\_uid | VARCHAR | Unique identifier for the system |
| firmware\_version | VARCHAR | Installed firmware version |
| installation\_timestamp | TIMESTAMP | Timestamp of the installation |
| verification\_status | BOOLEAN | Whether the installation was verified |

## ****3. Firmware Installation Flow****

### ****3.1 Home Page – Update Check****

1. When the application launches, users are directed to the **Home Page**.
2. The app automatically checks for the latest version using the firmware/appReleases API.
3. If a newer version is available:
   * A notification is shown to the user with a prompt to update.
4. After the update check, users are directed to the **Firmware Selection Page**.

### ****3.2 Admin Login****

1. On the **Firmware Selection Page**, an **"Login"** button is available.
2. Clicking the button opens a login prompt with the following credentials:
   * **Email:** admin
   * **Password:** admin
3. On successful login, the user enters **Admin Mode** with access to additional features:
   * Ability to select and install **any** firmware version.
   * Access to **Flash Erase** functionality for both boards.
   * Advanced options become visible in the UI.

### ****3.3 Firmware Selection****

1. On the **Firmware Selection Page**, users select the firmware version from a dropdown menu.
   * **Default User Mode:** Can only install the **latest** firmware version.
   * **Admin Mode:** Can select **any available** firmware version.
2. The selected firmware files are dynamically downloaded from the GitHub repository.

### ****3.4 Master Board (Arduino Mega) Installation****

1. The application detects the connected **Arduino Mega** board using serial.tools.list\_ports.
2. Using arduino-cli, the following actions are performed:
   * **Upload** the compiled firmware to the board.
3. After installation, the app verifies the operation by:
   * Extracting the **System UID** and **Firmware Version** via serial communication.
   * Displaying the verification status to the user.

### ****3.5 Slave Board (NodeMCU) Installation****

1. The application detects the connected **NodeMCU** board using serial.tools.list\_ports.
2. Using arduino-cli, the following actions are performed:
   * **Flash** the selected firmware file (.bin) to the board.
3. After installation, the app verifies the operation by:
   * Extracting the **System UID** and **Firmware Version** via serial communication.
   * Displaying the verification status to the user.

### ****3.6 Flash Erase (Admin Only)****

1. **Admin Mode** users can access the **Flash Erase** feature for both boards.
2. The process includes:
   * Uploading a Empty file to the **Master** and **Slave** boards to clear their flash memory.
   * Receiving confirmation of the **successful erase** operation from each board.

## 4. UID & Version Extraction Logic

* **Purpose**: To uniquely identify the system and verify the installed firmware version.
* **Process**:
  + Establish a serial connection with the board.
  + Send specific commands:
    - H: Handshake to ensure communication.
    - U: Retrieve the system UID.
    - V: Retrieve the firmware version.
  + Parse the responses and return the extracted values.
* **Implementation**: The logic is implemented in the get\_device\_info function in api.py.

## 5. API Flow and Database Interaction

### 5.1 API Endpoints

1. **POST /api/firmware-installation**

* **Purpose**: Record firmware installation details.
* **Request Body**:
  + {  
     "system\_uid": "unique-system-id",  
     "firmware\_version": "x.x.x",  
     "verification\_status": true,   
    }
  + **Response**: Success or error message.

1. **GET /api/firmware-installation/:system\_uid**
   * **Purpose**: Retrieve firmware installation history for a specific system UID.
   * **Response**: List of installation records.
2. **GET /download-excel**
   * **Purpose:** Downloads all firmware installation records in **Excel format**.
   * **Response:** File: firmware\_installations.xlsx
   * **Excel Columns:**

|  |
| --- |
| ID |
| System UID |
| Firmware Versio |
| Installation Timestamp |
| Verification Status (shown as **Verified** or **Not Verified**) |

### 5.2 ****Backend GUI****

#### /view-installations

* **Purpose:** Renders an HTML table view of all firmware installation records.
* **Displayed Columns:**
  + ID
  + System UID
  + Firmware Version
  + Installation Timestamp
  + Verification Status

### 5.3 Database Interaction

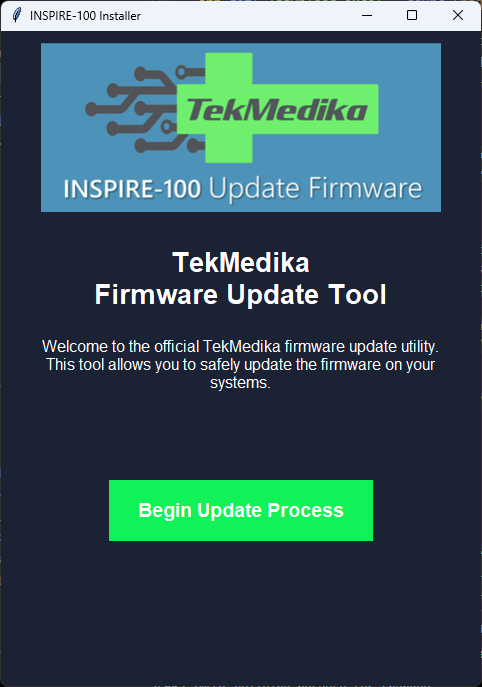
* **Insert Operation**: When a firmware installation is completed, the installer sends a POST request to the backend, which inserts the details into the firmware\_installations table.
* **Query Operation**: The backend retrieves installation history for a given system UID using a SELECT query.

## 6. Project Structure

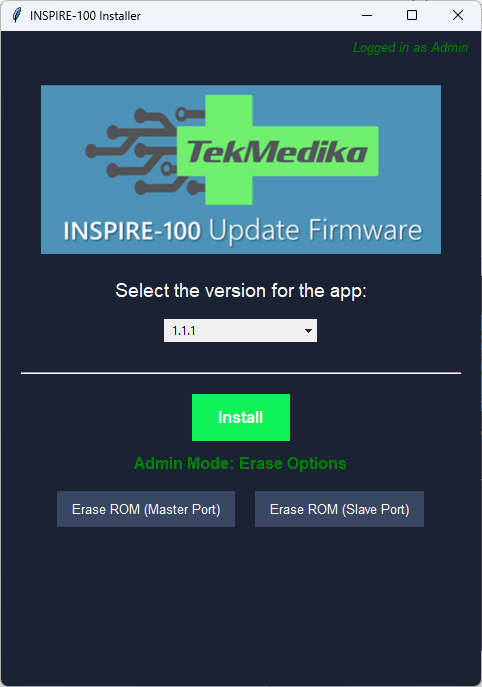
TekMedika-Firmware-Updater/  
│── main.py # Main entry point of the application  
│── src/  
│ ├── arduino/ # Arduino-specific scripts  
│ │ ├── arduino.py  
│ ├── nodemcu/ # NodeMCU-specific scripts  
│ │ ├── nodemcu.py  
│ ├── ui/ # UI components  
│ │ ├── home\_page.py  
│ │ ├── login\_page.py  
│ │ ├── version\_selection\_page.py  
│ │ ├── download\_screen.py  
│ │ ├── run\_installation.py  
│ │ ├── erasing\_pages.py  
│ │ ├── utils.py  
│ │ ├── assets/ # UI assets  
│ ├── backend/ # Backend API logic  
│ │ ├── api.py  
│ ├── config/ # Configuration files  
│ │ ├── config.py  
│ │ ├── color.py  
│ ├── utils/ # Utility functions  
│ │ ├── utils.py  
│── backend/ # Node.js backend server  
│ ├── app.js  
│ ├── package.json  
│── requirements.txt # Python dependencies  
│── setup\_script.iss # Setup script for installer

## 7. UI Flow

### 7.1 Home Page

* **Purpose**: Welcome screen with a brief description of the tool.
* **Actions**: Navigate to the login page.
*  Home Page when the app is Latest
*  Home Page when the app is not Latest

### 7.2 Version Selection Page

* **Purpose**: Allow users to select the firmware version to install.
* **Actions**:
  + Admins can access additional erase options.
  + Users can proceed to download the selected firmware.
*  Default Version Selection Page
*  *Version Selection Page after admin login*

### 7.3 Login Page

* **Purpose**: Authenticate users (Admin).
* **Actions**: Validate credentials and navigate to the version selection page.
* 

### 7.4 Download Screen

* **Purpose**: Display download progress for firmware files.
* **Actions**: Proceed to connection instructions after download completion.
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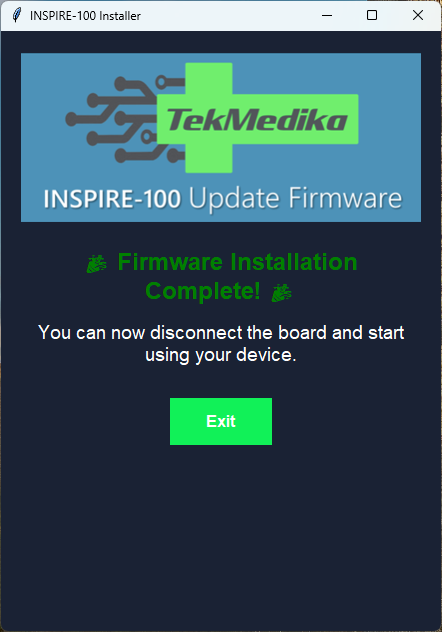
### 7.5 Connection Instructions

* **Purpose**: Guide users to connect the appropriate board (Master/Slave).
* **Actions**: Start the installation process.
* 

### 7.6 Installation Progress

* **Purpose**: Show progress of firmware installation.
* **Actions**: Display logs and progress bar.
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### 7.7 Completion Screen

* **Purpose**: Confirm successful installation.
* **Actions**: Exit the application or restart the process.
* 

## 8. ****Python Dependencies (with Versions)****

altgraph==0.17.4

certifi==2025.1.31

charset-normalizer==3.4.1

future==1.0.0

idna==3.10

iso8601==2.1.0

packaging==24.2

pefile==2023.2.7

pillow==11.1.0

psutil==7.0.0

pyinstaller==6.12.0

pyinstaller-hooks-contrib==2025.2

pyserial==3.5

pywin32-ctypes==0.2.3

PyYAML==6.0.2

requests==2.32.3

setuptools==78.1.0

urllib3==2.3.0