User Login System Project
ATmega32 with External EEPROM

Project Overview

This project implements a secure and persistent **user login and authentication system** using an ATmega32 microcontroller, an external EEPROM (via I²C), UART for user input, and an LCD for user interaction. The system supports **username/password creation**, **login verification**, and a **settings menu** to modify user credentials. EEPROM ensures data persistence even after power loss.

Key Functional Features

• **Persistent User Credentials Storage** using external EEPROM
• **Initial User Setup** when EEPROM is empty
• **UART-based username/password input** from PC terminal
• **LCD-based notifications and user guidance**
• **Settings Menu** to change username/password after successful login
• **Secure comparison of entered and stored credentials**

System Components

1. **ATmega32 Microcontroller** – central controller managing EEPROM, LCD, and UART communication.
2. **External EEPROM (AT24Cxx)** – stores username, password, and system status using I²C protocol.
3. **LCD Display (16×2 or 20×4)** – provides messages and instructions.
4. **UART Communication** – enables user input from terminal software such as PuTTY or Arduino Serial Monitor.
5. **I²C Communication** – connects ATmega32 to EEPROM for read/write operations.

I²C Communication Overview

I²C is a two-wire serial communication protocol used to interface the ATmega32 and external EEPROM.

How it works:
• Master (ATmega32) initiates communication using **Start Condition**.
• Sends **7-bit EEPROM address + Read/Write bit**.
• EEPROM acknowledges (ACK).
• Data bytes are transferred in both directions with ACK after each byte.
• Communication ends with **Stop Condition**.

I²C allows reliable and fast data transfer with minimal wiring, crucial for storing and retrieving login credentials.

UART Communication Overview

UART enables communication between the microcontroller and PC for entering the username and password.

Data Transfer Steps:
• TX line goes low to start a frame (Start Bit).
• Data bits are transmitted (LSB first).
• Optional **parity bit** verifies data integrity.
• Frame ends with 1 or 2 **Stop Bits**.

UART requires only TX and RX lines and is ideal for debugging and testing login systems.

EEPROM Memory Usage

The external EEPROM stores:
• **Username (fixed-length storage)**
• **Password (fixed-length storage)**
• **System Status Byte** (0xFF = uninitialized, other = initialized)

EEPROM ensures **non-volatile storage**, making credentials available even after system reset or power loss.

System Workflow

1. **Initialization Phase**:
• Initialize LCD, I²C, UART.
• Check EEPROM status byte.

2. **User Setup Phase (if EEPROM default)**:
• Prompt for username and password via UART.
• Save credentials to EEPROM.
• Update EEPROM status to 'initialized'.

3. **Login Phase**:
• Ask user to enter username and password over UART.
• Read stored values from EEPROM.
• Compare and verify credentials.

4. **Settings Menu**:
• User can choose:
– Change Password
– Change Username

• Updated credentials are written to EEPROM.

Applications

• **Secure Access Control System** for labs and rooms
• **Prototype User Authentication Unit**
• **Embedded Configuration Storage** for devices requiring persistent login

- **IoT and embedded products needing user identity management**