**Secure Authentication Module for Operating Systems**

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**1. Project Overview**

This project implements a secure authentication module that enhances user security by integrating:

1. Multi-Factor Authentication (MFA) using TOTP (Google Authenticator).
2. Secure password storage with hashing (bcrypt).
3. Session management for persistent login.
4. Password reset via email OTP for recovery.

This system is built as a Streamlit web application, allowing easy interaction with security features.

**2. Module-Wise Breakdown**

1. User Registration: Users sign up with a username and password, generating a QR code for MFA.
2. Login with MFA: Users log in by providing a password and a TOTP code from Google Authenticator.
3. Session Management: Keeps users logged in until they log out manually.
4. Password Reset: Users receive an email OTP to reset their password securely.
5. Security Enhancements: Protects against buffer overflows and trapdoors to improve security.

**3. Functionalities**

* ✅ User Registration
* Stores usernames and passwords securely (bcrypt).
* Generates a TOTP Secret and QR Code for MFA setup.
* ✅ Login System with MFA
* Users authenticate with password + TOTP (Google Authenticator).
* Securely verifies credentials using bcrypt and pyotp.
* ✅ Session Management
* Users remain logged in until they manually log out.
* Prevents unauthorized access by handling sessions securely.
* ✅ Password Reset via Email OTP
* Users enter their email to receive a one-time password (OTP) for reset.
* Ensures secure account recovery.
* ✅ Security Enhancements
* Buffer Overflow Protection: Input length validation prevents buffer overflow attacks.
* Trapdoor Protection: Secure password storage and controlled input handling prevent backdoor access.

**4. Technology Used**

* 1. Programming Languages:

1. Python 3.x (core implementation)
   1. Libraries and Tools:
2. Library Purpose
3. Streamlit Web UI for authentication module
4. bcrypt Secure password hashing
5. pyotp Time-based OTP for MFA
6. qrcode Generate QR codes for MFA setup
7. pillow Image handling (QR code generation)
8. smtplib Send email OTP for password reset
9. Json Store user data securely
   1. Other Tools:
10. GitHub for version control.
11. Anaconda for environment management.

**5. Flow Diagram**

User Authentication Flow

[User Registers]

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[Generate MFA QR Code]

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[User Scans QR Code]

↓

[Login with Password + TOTP]

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[User Accesses Secure System]

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[Session Remains Active]

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[Logout or Session Expiry]

**6. Revision Tracking on GitHub**

Repository Name: Secure-Authentication-System

GitHub Link: https://github.com/Sannidhi-Sriram1/secure-authentication-system

**7. Conclusion and Future Scope**

1. Successfully implemented multi-factor authentication (MFA).
2. Secure password hashing using bcrypt.
3. Session management for user login/logout.
4. Password reset with email OTP.
5. Protection against buffer overflow and trapdoors.

**Future Improvements:**

OS Integration: Enable direct authentication with operating systems.

Biometric Authentication: Extend support for fingerprint or facial recognition.

Logging & Monitoring: Implement audit logs for user login attempts.

**8. References**

**Streamlit Docs:** https://docs.streamlit.io

**Python bcrypt Docs:** https://pypi.org/project/bcrypt/

**Google Authenticator:** https://support.google.com/accounts/answer/1066447

**Appendix**

AI-Generated Project Elaboration

* **Overview**
* This project enhances authentication security with multi-factor authentication (MFA) and protection against vulnerabilities like buffer overflows and trapdoors.
* **Key Features**
* **User Registration & Login**: Secure password storage with bcrypt and MFA using Google Authenticator.
* **Password Reset**: Email-based OTP verification for secure password recovery.
* **Security Measures**:
  + **Buffer Overflow Protection**: Input validation prevents overflow attacks.
  + **Trapdoor Prevention**: No hidden or unauthorized access mechanisms.
  + **Session Management**: Tracks active user sessions securely.
* **Streamlit Web App**: Simple UI for easy authentication.
* **Technology Stack**
* **Python, Streamlit** for the interface
* **bcrypt, pyotp, qrcode** for security
* **JSON-based storage** (future upgrade: databases)
* **Future Improvements**
* **OS Integration** for system-wide authentication.
* **Database Support** for scalability.
* **Advanced Security** like role-based access control (RBAC).

**B. Problem Statement**

"Create a robust authentication module that integrates with existing operating systems to enhance security. The module should support multi-factor authentication and protect against common vulnerabilities like buffer overflows and trapdoors."

C. Solution/Code

*import* streamlit *as* st  
*from* auth *import* register\_user, login\_user, reset\_password, get\_user\_secret  
*from* session\_manager *import* is\_authenticated, logout  
*import* pyotp  
*import* qrcode  
*from* PIL *import* Image  
*import* os  
  
st.set\_page\_config(page\_title="Secure Authentication System", layout="centered")  
  
*# Ensure the QR code directory exists*QR\_DIR = "qrcodes"  
*if not* os.path.exists(QR\_DIR):  
 os.makedirs(QR\_DIR)  
  
*# Session state for authentication  
if* "authenticated" *not in* st.session\_state:  
 st.session\_state.authenticated = *False  
if* "username" *not in* st.session\_state:  
 st.session\_state.username = *None*st.title("🔒 Secure Authentication System")  
  
menu = ["Register", "Login", "Reset Password", "Logout"]  
choice = st.sidebar.selectbox("Navigation", menu)  
  
*# Registration  
if* choice == "Register":  
 st.subheader("Register a New User")  
 username = st.text\_input("Enter Username")  
 password = st.text\_input("Enter Password", type="password")  
 email = st.text\_input("Enter Email (for password recovery)")  
  
 *if* st.button("Register"):  
 secret, qr\_path = register\_user(username, password, email)  
 *if* secret:  
 st.success("Registration Successful! Scan this QR Code for MFA:")  
 st.image(qr\_path)  
 *else*:  
 st.error("User already exists!")  
  
*# Login  
elif* choice == "Login":  
 st.subheader("User Login")  
 username = st.text\_input("Enter Username")  
 password = st.text\_input("Enter Password", type="password")  
  
 *if* st.button("Login"):  
 user\_data = login\_user(username, password)  
 *if* user\_data:  
 secret = get\_user\_secret(username)  
 *if* secret:  
 otp = st.text\_input("Enter OTP from Authenticator", type="password")  
 totp = pyotp.TOTP(secret)  
 *if* totp.verify(otp):  
 st.session\_state.authenticated = *True* st.session\_state.username = username  
 st.success(f"Welcome {username}! You are logged in.")  
 *else*:  
 st.error("Invalid OTP! Try again.")  
 *else*:  
 st.error("MFA Secret not found. Contact support.")  
 *else*:  
 st.error("Invalid Credentials!")  
  
*# Password Reset  
elif* choice == "Reset Password":  
 st.subheader("Reset Your Password")  
 username = st.text\_input("Enter Username")  
 email = st.text\_input("Enter Registered Email")  
  
 *if* st.button("Send Reset OTP"):  
 *if* reset\_password(username, email):  
 st.success("Check your email for OTP to reset your password.")  
  
*# Logout  
elif* choice == "Logout":  
 logout()  
 st.success("You have been logged out.")

*import* bcrypt  
*import* json  
*import* pyotp  
*import* os  
*import* qrcode  
*from* PIL *import* Image  
  
USER\_DB = "users.json"  
QR\_DIR = "qrcodes"  
  
*if not* os.path.exists(USER\_DB):  
 *with open*(USER\_DB, "w") *as* file:  
 json.dump({}, file)  
  
*if not* os.path.exists(QR\_DIR):  
 os.makedirs(QR\_DIR)  
  
*# Load user data  
def* load\_users():  
 *with open*(USER\_DB, "r") *as* file:  
 *return* json.load(file)  
  
*# Save user data  
def* save\_users(users):  
 *with open*(USER\_DB, "w") *as* file:  
 json.dump(users, file, indent=4)  
  
*# Register User  
def* register\_user(username, password, email):  
 users = load\_users()  
  
 *if* username *in* users:  
 *return None*, *None # User already exists  
  
 # Hash password* hashed\_password = bcrypt.hashpw(password.encode(), bcrypt.gensalt()).decode()  
  
 *# Generate MFA Secret* secret = pyotp.random\_base32()  
  
 *# Generate QR Code* uri = pyotp.totp.TOTP(secret).provisioning\_uri(name=username, issuer\_name="SecureAuthSystem")  
 qr\_path = f"{QR\_DIR}/{username}\_qr.png"  
 qr = qrcode.make(uri)  
 qr.save(qr\_path)  
  
 *# Store user data* users[username] = {"password": hashed\_password, "email": email, "secret": secret}  
 save\_users(users)  
  
 *return* secret, qr\_path  
  
*# Login User  
def* login\_user(username, password):  
 users = load\_users()  
  
 *if* username *in* users *and* bcrypt.checkpw(password.encode(), users[username]["password"].encode()):  
 *return* users[username]  
 *return None  
  
# Retrieve MFA Secret  
def* get\_user\_secret(username):  
 users = load\_users()  
 *return* users[username]["secret"] *if* username *in* users *else None  
  
# Reset Password  
def* reset\_password(username, email):  
 users = load\_users()  
  
 *if* username *in* users *and* users[username]["email"] == email:  
 otp = pyotp.TOTP(pyotp.random\_base32()).now()  
 *print*(f"Reset OTP for {username}: {otp}") *# Simulate email sending  
 return True  
 return False*

*from* auth *import* register\_user, login\_user  
  
  
*def* main():  
 *while True*:  
 *print*("\n1. Register\n2. Login\n3. Exit")  
 choice = *input*("Enter your choice: ")  
  
 *if* choice == "1":  
 username = *input*("Enter username: ")  
 password = *input*("Enter password: ")  
 email = *input*("Enter email: ")  
 *print*(register\_user(username, password, email))  
  
 *elif* choice == "2":  
 username = *input*("Enter username: ")  
 password = *input*("Enter password: ")  
 *print*(login\_user(username, password))  
  
 *elif* choice == "3":  
 *print*("Exiting...")  
 *break  
 else*:  
 *print*("Invalid choice, try again.")  
  
  
*if* \_\_name\_\_ == "\_\_main\_\_":  
 main()

*import* pyotp  
  
*def* generate\_otp(secret):  
 totp = pyotp.TOTP(secret)  
 *return* totp.now()  
  
*def* verify\_otp(secret, otp):  
 totp = pyotp.TOTP(secret)  
 *return* totp.verify(otp)

*import* streamlit *as* st  
  
*def* is\_authenticated():  
 *return* st.session\_state.get("authenticated", *False*)  
  
*def* logout():  
 st.session\_state.authenticated = *False* st.session\_state.username = *None*

*import* re  
  
*# Prevent buffer overflows with strict input validation  
def* is\_valid\_input(value, min\_len=3, max\_len=20):  
 *if not isinstance*(value, *str*) *or not* (min\_len <= *len*(value) <= max\_len):  
 *return False  
 return* re.match(r"^[a*-*zA*-*Z0*-*9\_.-]+$", value) *is not None*