**Milestone Two**

**Enhancement 1 Narrative**

**Software Design and Engineering**

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# Briefly describe the artifact. What is it? When was it created?

The artifact central to my enhancements is the "RGB LED Cube Control Software," a project initiated during my Electrical Engineering Technology Associate degree program's capstone in 2015. Initially, I constructed a 4x4x4 LED Cube with RGB LEDs, shown below, integrating it with an FPGA development board and crafting custom firmware to manipulate the 52 control lines governing the 64 LEDs.

A green box with wires

Description automatically generated

In a recent pursuit of rekindling my enthusiasm for the project, I designed additional circuitry to interface my RGB LED Cube Control Software with an Arduino Uno, facilitating control over the RGB LEDs. Prior to the start of this course, I had developed a simple functional user interface (UI), shown below, establishing communication with the Arduino Uno through a COM Port. This initial UI empowered me to illuminate one color of one LED based on user-defined color, X, Y, and Z values.

A screenshot of a computer screen

Description automatically generated

Having accomplished the hardware integration and circuitry enhancements, the focus of my Computer Science Capstone project pivots decisively to the evolution of the RGB LED Cube Control Software. With the foundational hardware components in place and the initial user interface demonstrating functional control over individual LEDs, my aim is to delve into advanced features and optimizations within the software realm. This shift marks the latest chapter in the ongoing development of a project that seamlessly marries my technical skills in both hardware and software domains.

# Justify the inclusion of the artifact in your ePortfolio. Why did you select this item? What specific components of the artifact showcase your skills and abilities in software development? How was the artifact improved?

I selected the RGB LED Cube Control Software as a pivotal artifact for my ePortfolio due to its unique blend of hardware and software components, offering a comprehensive showcase of my skills in software development. The initial iteration of the project was hardware-centric, focusing on establishing control over the RGB LED Cube. However, my attention shifted towards the software aspects during this enhancement phase.

## UI Overhaul:

The decision to overhaul the user interface (UI) exemplifies my proficiency in graphical user interface design. In creating a new project within QT Creator, I demonstrated the ability to construct an intuitive and visually appealing UI. The transition from a singular view to a multi-tab interface comprised of Login, Hardware Init, Cube Control, and Database tabs, reflects my capacity to architect complex UI structures.

## Login Tab Functionality:

A screenshot of a computer

Description automatically generated

The implementation of the Login tab introduces elements of software security and user authentication to the project. The creation of a userCredentials class, complete with functions to check and verify user credentials, showcases my expertise in implementing secure software practices. The seamless integration of login functionality, including feedback mechanisms for successful and failed attempts, underscores my attention to both usability and security aspects.

## Dynamic Hardware Initialization Tab Functionality:

A screenshot of a computer

Description automatically generated

The Dynamic Hardware Initialization functionality further highlights my skills in software development. The addition of a QSerialPort object demonstrates my ability to integrate external communication protocols into the software architecture. The implementation of error handling mechanisms, such as checking for valid COM port entries and securing against repeated initialization attempts, showcases my commitment to robust and reliable software design.

In summary, the RGB LED Cube Control Software is a compelling addition to my ePortfolio as it not only represents the evolution of a hardware project but also serves as a testament to my growth in software development. The enhancements made in the UI, security features, and dynamic hardware initialization underscore my ability to conceive and implement sophisticated software solutions. The ongoing refinement of this artifact aligns with my commitment to advancing and showcasing my software development skills throughout my academic and professional journey.

## Video:

A visual walkthrough encapsulated in the video linked below provides a dynamic exploration of these updates. The video not only discusses the intricacies of the software enhancements but also showcases the live functionality of the RGB LED Cube Control Software.

Link to video hosted on YouTube - [Enhancement 1](https://www.youtube.com/watch?v=-KXExONsFV8)

# Did you meet the course objectives you planned to meet with this enhancement in Module One? Do you have any updates to your outcome-coverage plans?

## Outcome One:

The first outcome I met in this enhancement was, "Demonstrate and ability to use well-founded and innovative techniques, skills, and tools in computing practices for the purpose of implementing computer solutions that deliver value and accomplish industry-specific goals".

### QT Library Usage:

In achieving this, I strategically utilized QT's UI framework and QTSerialPort library, demonstrating a proficiency in integrating innovative tools into my work. This choice not only highlighted my technical skills but also emphasized the importance of leveraging external APIs and libraries in professional development, showcasing my capacity to expand capabilities without starting from scratch. My proficiency in navigating documentation pertaining to these libraries further underscored my understanding of this crucial aspect.

### Full Stack Application Development:

The development of an efficient UI with streamlined user interaction and robust exception handling was pivotal in realizing the broader goal of creating a full-stack application. This enhancement serves as a visible starting point for the top layer of the stack, the UI, and the intermediary layer, which comprises the code responsible for enabling login and serial port functionality. This meticulous attention to the UI's design and functionality not only aligns with the project's goals but also reinforces my commitment to delivering solutions that meet industry standards and user expectations.

## Outcome Two:

The second outcome I met with this enhancement was, “Develop a security mindset that anticipates adversarial exploits in software architecture and designs to expose potential vulnerabilities, mitigate design flaws, and ensure privacy and enhanced security of data resources”.

### Class Creation - userCredentials:

This approach involved the creation of a dedicated userCredentials class, emphasizing the importance of safeguarding sensitive login information. The instantiation of this class during program startup, with username and password variables initialized from static const QString variables, systemUserName, and systemPassword, establishes a secure foundation for user authentication.

### Secure UI Design:

The UI design reflects a security-conscious strategy by initially granting access solely to the login tab at startup. Successful authentication is required for progression within the system. A systematic control mechanism, triggered upon successful login, secures the login button and grants access to subsequent tabs.

This approach ensures that the software not only meets functional objectives but also embodies a proactive stance in addressing potential security vulnerabilities. The emphasis on a secure user authentication process and controlled system progression underscores a commitment to robust software architecture and data security.

# Reflect on the process of enhancing and/or modifying the artifact. What did you learn as you were creating it and improving it? What challenges did you face?

## Stepping Back from Relying on QT Designer for UI Interactions:

In working on this enhancement, my previous experience largely revolved around utilizing QT Designer for crafting user interfaces and linking UI events to underlying software functionality. However, the specific requirements of this project required me to take a step back from relying on the built-in functionality of QT Designer. It lacked the capability to implement dynamic features, such as locking individual tabs or buttons based on other system actions. Initially, this shift posed a challenge, requiring a transition to manipulating widget properties directly in the code. This adjustment proved to be very rewarding as it offered a newfound level of flexibility within the QT UI Framework.

## Security-Centric Mindset:

Another noteworthy learning curve involved adopting a security-centric mindset, stepping back from my typical approach in school assignments where functionality took precedence. In professional software development experience, security concerns often fall within a dedicated sector, and private networks provide an additional layer of defense. However, this enhancement required a more comprehensive consideration of security aspects within my project. While initially unfamiliar, addressing security concerns became a welcomed challenge. It prompted a shift in perspective, allowing me to analyze my project through a new lens and integrate security measures seamlessly into the development process.

## Conclusion:

This dual learning experience not only expanded my technical skills but also enriched my approach to software development by incorporating a heightened awareness of security considerations.