Climbing Log Information Management Bundle (CLIMB)

with

Linux, Apache, MySQL, and PHP (LAMP)

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What is CLIMB?

Climbing is a sport that is becoming more popular, as evidenced by its recent appearance in the 2020 Olympics. Since the popularity is relatively new compared to most sports, there are many opportunities for technological advances. The goal of this project was to develop technology that could be used with modern climbing walls. With CLIMB, users can keep track of their climbing sessions and interact with their climbing environment from a single spot, presented to them as a webpage.

Users will have a log of their climbing information stored in a database. The information, once in the database, can then be managed to extract pertinent information like how many routes they have completed, the difficult of the routes, and when they climbed the routes. Also, since the database stores information about the routes, users can search for what routes are available to climb and filter them by their difficulty. The result is that the climber can have a more fluid climbing experience by spending more time climbing and less time searching for or guessing about information of routes they have climbed or want to climb.

Additionally, some modern climbing walls allow for their angle to be adjusted. Users of CLIMB, if it's incorporated into the climbing wall's angle controlling mechanism, can signal the climbing wall to move up or down to the user-selected angle from a webpage. First the program will use the Raspberry Pi to capture bitmap images with its camera. Then the image will be analyzed and manipulated to determine if the climbing wall is at the correct angle. If it isn't at the correct angle, the program will send a signal to move the wall in the correct direction.

What is LAMP?

For the features of CLIMB to work correctly, a server must be setup to provide services that can interact with itself, users, and a small programmable computer (Raspberry Pi). Services are provided from what is referred to as a LAMP stack [1]. This setup is broken down into its open-source components as follows:

- (L) Linux: Operating system that is run on the server
- (A) Apache: Web hosting service that provides users with a webpage
- (M) MySQL: Database used to store user and route information
- (P) PHP: Dynamically makes webpages for users

With all the components of LAMP together on a computer, the host can receive a user request. Process the request, resulting in the execution of a PHP file and subsequent database queries. Then HTML output from the PHP script will be sent to the user, which they view as a regular webpage.

Code

The primary programming languages used in this project are PHP, HTML, MySQL, and C++. There are also some existing Application Programming Interfaces (API)s that were used that contain code for operating the Raspberry Pi's relays, camera, and display. Those APIs are primarily written in C or C++. All the code for this project can be found on the GitHub repository:

- https://github.com/Paul-Kummer/seniorSeminar

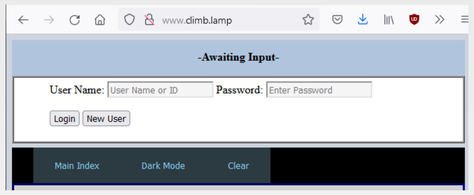
The Raspberry Pi's APIs used in this project are as follows:

- raspicam: Allows the capturing of Bitmap images [2]
  License: BSD
- usb-relay-hid: Allows USB relays to be controlled programmatically [3]
  License: GNU GPL v3
- SSD1306_OLED_RPI: Allows the Raspberry Pi to output to a physical organic light-emitting display (OLED) display [4]
  License: GNU GPL v3

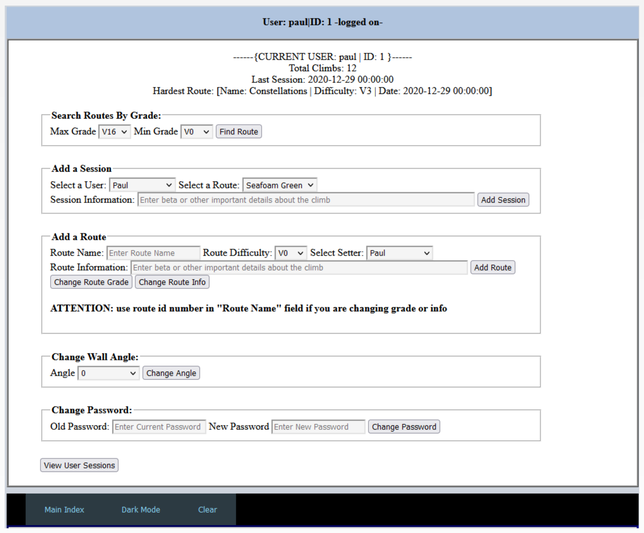
How it Works

1. The user connects to the local wireless network.
   - SSID: CLIMBwithLAMP
   - Password: PaulKummer
2. The user accesses their internet browser to navigate to the webpage.
   - www.climb.lamp OR 192.168.1.37

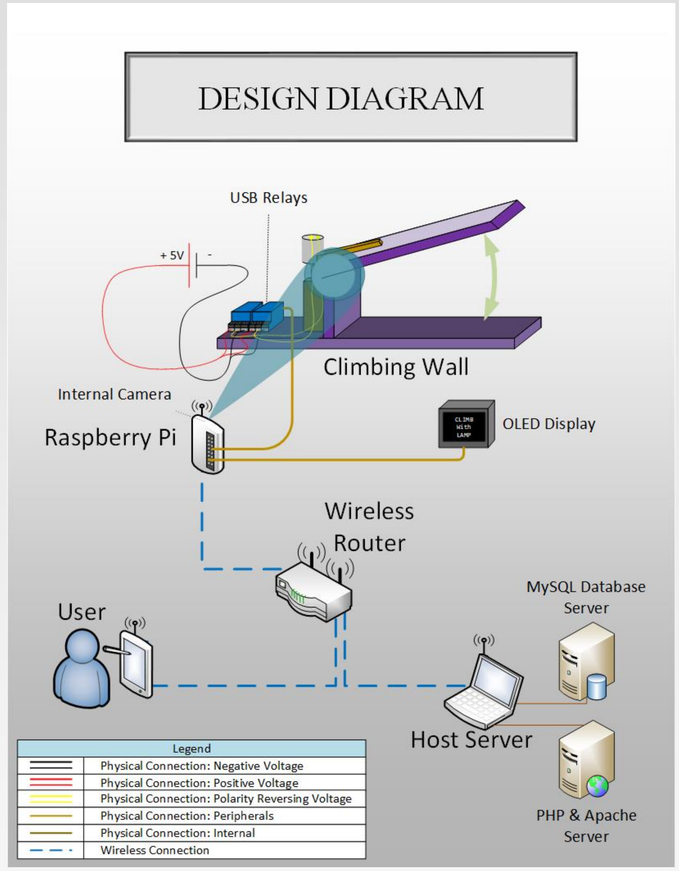
   By doing this, the user will communicate with the LAMP stack. The server will get a request from the client and in turn run the PHP file that delivers a login page in the form of HTML to the user's machine, the client.
3. The user creates an account or logs into an existing account. When this is done, a similar action will occur like when the login page is loaded. However, this time the PHP server will communicate with the database server to either add a new user or to authenticate that an existing username and password is valid. All passwords are securely stored using SHA2, a cryptographic hashing algorithm.



4. Once logged in, the user can then use the buttons and text fields to perform actions with the server that will either respond by delivering a webpage or issuing a command to the Raspberry Pi. The process for retrieving a new webpage is similar to when the login page is loaded, except the database has different queries executed, delivering different information.



5. If the Raspberry Pi is issued a command to change the angle, it will begin capturing and analyzing images with its camera [2] and a linear regression algorithm [5]. Based on the result of the algorithm, the climbing wall will be directed to move up, stop, or move down by controlling a USB relay [3]. The wall will move until it gets within two degrees of the requested angle. Also, the status of what direction the wall is moving, and its angle will be displayed on the OLED display [4].



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