Bouldering Pathfinding

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Our Mission

The primary goal of our application is to provide personalized climbing paths to users, helping beginner boulderers improve their climbing technique by following optimized move sequences. With an intuitive and user-friendly interface, our project enhances the indoor climbing experience, making it more accessible and enjoyable for all.

Intellectual Merits

HOW OPTIMAL PATHS ARE GENERATED

1. USER PROFILE DATA
Users can enter their data under the profile section, which is used to individualize routes. This includes height, wingspan, difficulty level, and desired hold type rankings.

2. DETECTING HOLDS
After uploading images, users are prompted to select the color of the holds corresponding to the route they want to generate a path for.

3. HOLD ANNOTATION
Users are given the option to edit the detected holds. This includes assigning hold types and selecting start and end holds.

4. CUSTOM A* ALGORITHM
Hold annotations and user data are sent to the pathfinding algorithm, which searches for an optimal path using every limb.
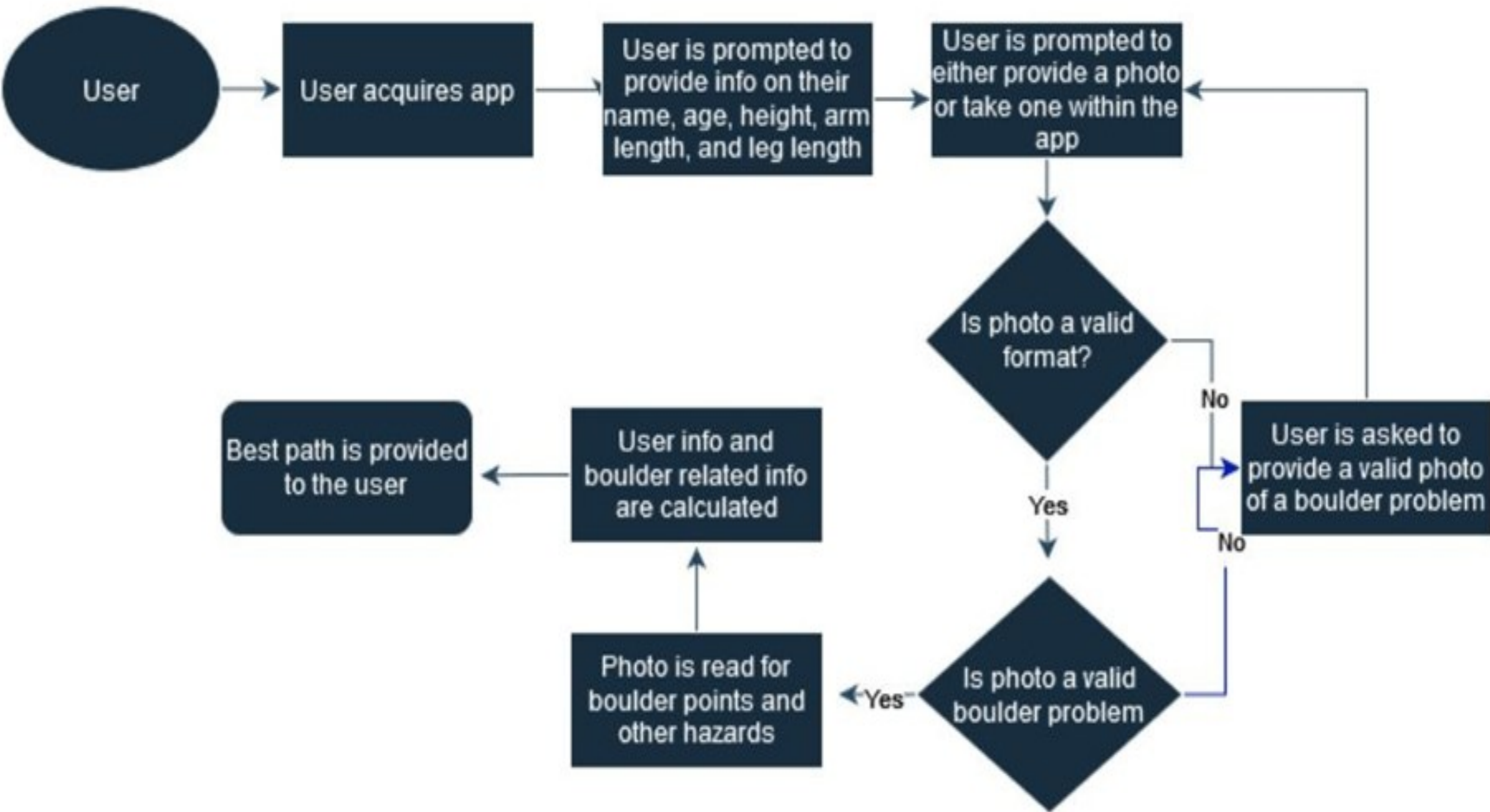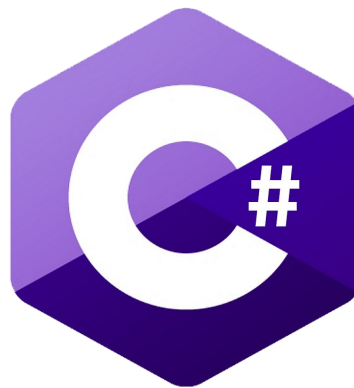
Challenges

Blob Detection

- **Problem:** One of our primary challenges was identifying climbing holds by both color and type. Many open-source tools either did not support .NET android development or lacked necessary functionality.
- **Solution:** We integrated Emgu CV, a .NET wrapper for OpenCV that allowed us to detect holds by color. We decided automatic detection of holds may be too unreliable, so we added an option for users to manually change hold types from the annotation screen.

Pathfinding

- **Problem:** We initially considered using evolutionary computing to generate multiple paths, allowing users to choose the one that best suits them. However, with mobile processing limitations and time constraints we decided this approach was impractical.
- **Solution:** We instead opted to use A* pathfinding as an efficient and reliable alternative.

User Interface

- **Problem:** Designing a clear and intuitive UI was challenging. Displaying an entire climbing route, including hand and foot placements, often resulted in a cluttered and difficult-to-read interface.
- **Solution:** Instead of showing the full path at once, we implemented a step-by-step visualization. This approach highlights individual moves sequentially, indicating which hand or foot to move next, making the path easier to follow.

Design Diagram

User → User acquires app → User is prompted to provide info on their name, age, height, arm length, and leg length → User is prompted to either provide a photo or take one within the app

Is photo a valid format? — No → User is asked to provide a valid photo of a boulder problem

Yes → Is photo a valid boulder problem — No → User is asked to provide a valid photo of a boulder problem

Yes → Photo is read for boulder points and other hazards → User info and boulder related info are calculated → Best path is provided to the user

Developed Using:

C#

Result

- User Profiles added for personal information.
- The app processes an uploaded image using blob detection and selects routes by color.
- The annotation page allows users to change inputs such as start holds, finish holds, hold types, and route length.
- The pathfinding picks the most efficient move for each limb until the finish is reached