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Web application for setting up an ergonomic position on a bicycle

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Abstract

Cycling is a massively popular activity that requires a well-fitted bike to be enjoyable. However, setting up a bike is not a trivial task and often requires expert help. This work aims to create a web application that helps cyclists set up their bikes from the comfort of their home, without relying on expensive equipment or expert help.
The application uses a lightweight pose estimation model to detect the rider's key points from a video. The model runs directly in the browser, which means the user's video is not uploaded to any server. The key points are then used to calculate the angles between the rider's joints. The app tracks the angles at different phases of the pedal stroke and compares them to the recommended angles for the selected fit goal and bike type. The user is then provided with recommendations on how to adjust their bike.
To evaluate and improve the accuracy of pose estimation models, a custom dataset of cyclists was created. The dataset was then used to fine-tune the RTMPose-m model. The model performance significantly improved after fine-tuning, with the average Normalized Mean Error (NME) decreasing from 21.2 % to 12.6 % (40% improvement).

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1. Introduction

Cycling is a massively popular activity around the world. People of all ages and skill levels enjoy it, from commuters to professional athletes. To enjoy cycling, it is important to have a bike that fits the rider. Having a bike that does not fit the rider can lead to unnecessary pain or over time even injuries. Having a bike that does not fit the can also have detrimental effect on performance. Therefore, a well fitted bike is important for professional athletes and amateurs alike.

Unfortunately, the setup of one's bike is not a trivial task. Information on how to setup the bike is often comprised of general guidelines and rules of thumb. These guidelines are often contradictory and can cause confusion. The setup of the bike is also highly individual and depends on the rider's flexibility, riding style, goals, etc. Similarly, each bike is different and requires different setup.

This led to the creation of a new profession called bikefitting. Bikefitters are experts who help cyclists set up their bikes. This was traditionally done in person and relied solely on the bikefitter's experience and rudimentary tools such as plumb bobs, goniometers, etc. However, in recent years, to make it more accessible, bikefitting has been increasingly relying on technology, mainly motion capture systems. This means bikefitters do not have to rely solely on their experience and can use data to make more informed decisions. However, these in-person bikefitting sessions are often not available in all areas and can be too costly for amateur cyclists.

To make bikefitting even more accessible, there has been a rise in bikefitting applications that aim to automate some of the bikefitting process. Despite the success of these applications, they are often limited to a single platform, provide only very basic information to the user, or are too costly.

This work aims to create a bikefitting application that does not suffer from these limitations. The application is available in the browser, provides the user with detailed information, while being easy to use and uses lightweight SOTA pose estimation models, that run directly in the browser to keep the cost of the application low.

2. Video Filming

At first, the user is asked to film themselves on the bike. An indoor bike trainer is recommended, but leaning the bike against a wall is also possible. The user is asked to film themselves from the side. The camera should be placed square to the rider and roughly in the height of the seat to minimize perspective distortion. The video should have a few pedal strokes to capture the rider in motion. Figure 1 shows and example of a good video angle.

3. Video Upload and Fit Goal Selection

After the video is filmed, the user is asked to upload the video to the application. The user is then asked to select their fit goal and their type of bike. The application supports three fit goals: comfort, performance, and balanced and three types of bikes: road, mountain, and time gravel. The fit goal and bike type change the recommendations the application provides.

4. Pose Estimation and Angle Calculation

The video is then processed by a pose estimation model. The model outputs the rider's key points, such as the shoulders, hips, knees, etc. The model is based on the RTMPose-m [1] model, which is an accurate but lightweight pose estimation model. It was trained on the Body8-Halpe26 dataset, which combines 8 pose estimation datasets and contains 26 full body keypoints as defined in the Halpe [2] dataset. These keypoints include feet keypoints which are very valuable for bikefitting. COCO [3] and similar datasets usually contain only 17 keypoints.

The model was then fine-tuned on a custom dataset of cyclists to improve the accuracy of the key points. The dataset consists of 21 videos of the author cycling on a bike trainer. The videos were annotated by first marking the key points by a colored sticker and then tracking these stickers in the video.

The model runs directly in the browser using TensorFlow.js, which means the user's video is not uploaded to any server and the application is fast and responsive. Model uses WebGPU or WebGL backends to run on the user's GPU, which makes the model run faster and more efficiently. Figure 2 shows an example of a video processed by the model, with joint angles drawn on the video using canvas.

5. Angle Analysis

The key points are then used to calculate the angles between the rider's joints. The app tracks how the angles change at different phases of the pedal stroke (top, bottom and front). After gathering the angles for each measurement at each phase, the app aggregates the data and compares it to the recommended angles for the selected fit goal and bike type. The user can easily see how the angles change at in different pedal strokes and if they are within the recommended range in a chart. Figure 3 shows an example of an analysis for knee to extension angle at the bottom of the pedal stroke.

6. Recommendations

Based on the angle analysis, the application provides the user with recommendations on how to adjust their bike. The recommendations are tailored to the user's fit goal and bike type. The app provides a list of adjustments for saddle height, saddle fore/aft, handlebar height and handlebar reach. Figure 4 shows an example of recommendations for saddle height and handlebar height.

References

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