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Cyclist's Knee Alignment Adjusting Aid Application Using Computer Vision

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ABSTRACT

This study examined behavior of knee alignment during simulated distance cycling. The non-proper knee alignment with overuse activity can caught cycling's injury from knee pain syndrome. Machine vision was used to track object/marker which attached at knees and forefoot in purpose to compute knee angle. If knees to forefoot are not vertical plane, it means resultant lateral force, undesirable stresses at the joint, pushing at knee. This injury is usually called iliotibial band (ITB). A method and system are provided including hue value and saturation (HSV), morphological and moment method. The result shows knee angle in real time and address a problem that knee is jutting collect, outward or inward. If knee alignment is not proper, cyclists need to change behavior of cycling to avoid suffer and improve performance.

Author Keywords

cyclists' performance; lateral movement; knee pain; bike fitting.

INTRODUCTION

Nowadays, many people are more concerned about health, thus sport is one of the solution to provide them a better health. As happened with every kinds of sport, some people got an injury from workout. Cycling is one of the famous sports. The number of cyclists who suffer has risen, with the majority caused by overuse [1]. Bike aches and pains are normally happen at knee, back, foot, hip, neck and shoulder [4].

The knee injury is one of the issues that usually happen with cyclists. Several researches have study about injury at the knee.

Several research studies on force and repetition during cycling by using 3D motion analysis system [2]. Some research study on iliotibial band (ITB) during cycling [3].

A number of people go bike fitting is rising. It is good and recommended because it will help rider to sit more comfortably and more efficiently. But this option is not available for everyone because it is quite expensive. In this research we are implementing knee alignment detected program to aid cyclist in properly adjusting their knees while doing activity in purpose to get good performance and less injury.

METHODOLOGY

The purpose of this program is to measure the knee alignment base on image processing. Before getting started, cyclist needs to attach the marker at the knee and the fore foot of both two legs.

The system has two main functions which can be either online or off line.

The system start with loading an image then converts from RGB to HSV. After that, HSV threshold is applied to filter color of interest by using minimum color, maximum color and also filter size of object. Then dilation and erosion are applied to get the better result. Finding contours is the next step. Using moment method to compute angle of knee reference with y-axis then display result. Overall system diagram shows in Figure 1.

On the display shows the result of knee angle (angle of knee with reference with y-axis), average angle, average deviation, maximum angle, minimum angle and tracking percentage of both sides.
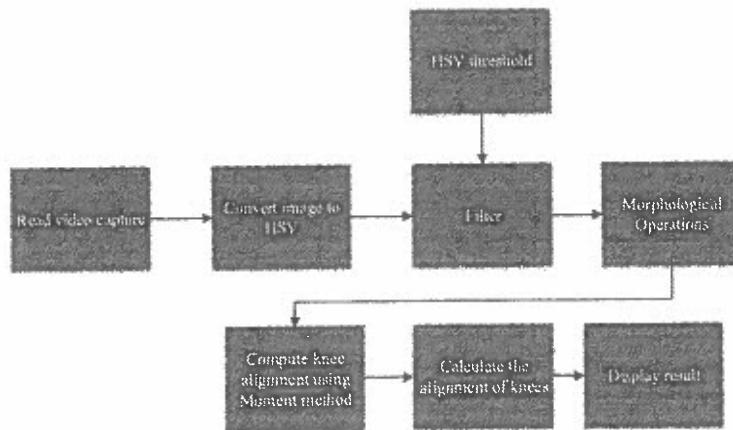
Figure 1. Overall system diagram.

Calculation of the result shows as below

Knee angle $= \tan^{-1}\dfrac{\Delta x}{\Delta y}$

average angle $= \dfrac{angle}{numTrack}$

average deviation $= \dfrac{\sqrt{\dfrac{\sum(angle - average\ angle)^2}{numTrack}}}{numTrack}$

tracking percentage $= \dfrac{numTrack}{numFram}$

where Δx is the difference between center point in x-axis.

Δy is the difference between center point in y-axis.

numTrack is number of frame that can track.

numFram is number of total frame.

RESULT

In this program, object of interest will be tracked as the contour and the red line is drawn between object. Angle of knee with reference with y-axis is displayed in term of degree. If value (knee angle, θ) is minus, it means knee is jutting outward. On the other hand, knee is jutting inward. The example of display shows in figure2. Average knee angle of left and right legs have small degree with plus term. It means all two legs have knee jutting outward.

CONCLUSION

In this work is focus on knee alignment base on image processing. The program can compute knee alignment which is onward or inward in off line and online. The result will show angle, average angle, average deviation, maximum angle, minimum angle and tracking percentage on both two legs. In order to get good performance and less hurt of cycling, the knee alignment should be aligned along the vertical.
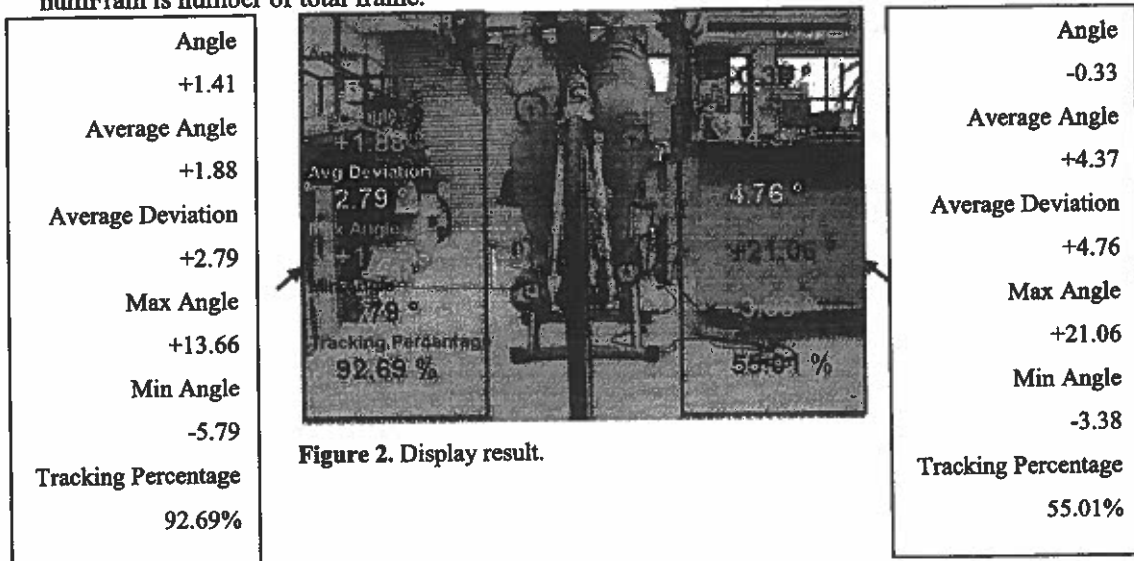
Angle
+1.41
Average Angle
+1.88
Average Deviation
+2.79
Max Angle
+13.66
Min Angle
-5.79
Tracking Percentage
92.69%

Figure 2. Display result.

Angle
-0.33
Average Angle
+4.37
Average Deviation
+4.76
Max Angle
+21.06
Min Angle
-3.38
Tracking Percentage
55.01%

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