Project Description

Student: Asa Kusuma, Computer Systems Lab 2007-2008, Period 3
Title: Analysis of Runner Biomechanics Through Image Processing

Background:
The purpose of this project was to develop a computer-based system for determining the biomechanics of runners. By analyzing images of a runner, the system can determine the level of pronation in a runner. Pronation is one of the most important aspects of the biomechanics of any runner. Pronation is the natural inward rolling of the ankle to absorb impact. Among runners, a major cause of injury is overpronation. All runners should pronate to a degree, but many runners pronate to much, causing misalignment, knee problems, and problems with the muscles and ligaments around the ankle. Even worse, overpronation puts abnormal stress on the inside shin bone, the Tibia. This can lead to shin splits and even stress fractures. Conversely, many runners don't pronate enough. This situation is called supination--such runners are called supinators. Supination can cause problems similar to those stemming from overpronation, but instead, the problems are usually with the outside of the leg.

Like most biomechanical features in the human body, pronation is a visible phenomenon, but hard to reconzie to the un-trained eye. Pronation happens very quickly, and the movement is miniscule. This type of movement is hard for humans to see, but much easier for a computer, armed with a 20 fram-per-second camera. Using only images from a camera, the project will determine the degree of pronation of a runner. Such an ability could be instrumental in determining the proper shoe type and diagnosing injuries.

Description:
For the actual program, a programming language had to be decided on. Originally, C++ was going to be used, but after further though, Python was chosen. Because the nature of the project concerned developing, testing, and trial-by-error coding of algorithms, Python, a very easy to code and simple language, was chosen. The downside is that Python is slightly slower than C++. The program was written as a python script that can be run on any computer that has python installed.

The first step in the process is to acquire the right images, namely, images of a runner's leg in motion, before and after foot impact with the ground. In order to increase the accuracy of the algorithm, it is important to develop a proper and uniform setup for capturing images. To capture the images, the camera is placed behind the treadmill, with the lens placed just above the treadmill running surface.

Within the program, the images are prepared for edge detection using Gaussian blurring, noise removing techniques, and outlier removal algorithms. After preparation, an edge detection program creates an outline of the inner leg. Once the two edges from the two images are derived, the edges need to be aligned properly so that they can be properly compared. Then an algorithm is applied to both edges, in order to find the average x values of the outlines. These two values are compared, producing a pixel gap, or the difference in pixels between the two edges. The larger the pixel gap, the higher the degree of pronation. In order to produce a practical program that can be used by others, it is imperative to develop some kind of graphic user interface that the average person can use. A graphical user interface was implemented within the python terminal program. In other words, the user must open a terminal and run the program using the python command, but once that step has been completed, the rest of the user experience has a graphical user interface.