TJHSST Computer Systems Lab Senior Research Project
Analysis of Runner Biomechanics Through Edge Detection and Image Processing
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Abstract

The biomechanical features of a runner in an image can be analyzed by using certain image processing techniques, the primary method being edge detection. By constructing an accurate, two-dimensional model of a runners lower body from a rear angle, it is possible to extrapolate the underlying qualities of that runners biomechanics. This is done by creating an outline of a runner's lower leg and feet. An edge detection algorithim is applied on an image to create this outline. In this type of situation, algorithim speed is not a very relevant issue; accuracty is far more important, the reason being that you only need to analyze a few images to create a two dimensional model of the lower body, as well as the fact that the time it takes to analyze a runner does not directly affect his performace as a runner.

Keywords: Biomechanics, Running, Edge Detection, Image Processing

1 Introduction - Elaboration on the problem statement, purpose, and project scope

1.1 Scope of Study

The goal of this project is to analyze images of a runner and extract biomechanical information about the runner from the images. Among runners, a major cause of injury is over pronation. Pronation is the natural inward rolling of the ankle to absorb impact. 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. Using only images, the project will determine the degree of pronation of a runner, which could be instrumental in determining the proper shoe type and diagnosing injuries. The project will strictly be involved in analyzing images from a controled environment and determining biomechanical features from analysis of images. This means that the project will not be concerned with selecting images from a video feed or trying to analyize images taken in random and widely variying situations. The images used in the project will be taken from the back of a runner running on a treadmill, not from a runner running in stormy weather in an urban environment, taken at an awkward camera angle. There is very little purpose in trying to determine the biomechanics of random people walking in the street, so focusing on controled environments makes the project much more feasible at almost no cost to applicability in the real word.

1.2 Expected results

The expected goal of this project is create a system that can acurately determine the biomechanical features of a runner and come up with a verdict concernign the efficiency and proper shoe type of the runner. The system is not designed to totally replace human analysis of runner biomechanics, but rather to assist human analysis and eliminate at least partially mistakes made in the human biomechancis analysis process.

1.3 Type of research

This project is pure applied research. The fundamentals of human biomechanics are already known. A lack of knowledge is not a problem that this

project is proposing to address, rather, the project is addressing the problem of automatically determining variables in different situations and assisting current methods of a process that is already being conducted by humans.

2 Background and review of current literature and research

The aim of this project is largely unique in the acadmic world. However, the commercial sector has tackled this problem, but only because of motivation to sell more running shoes and increase profits. Fundamentally, this project is venturing into unknown territory. It is a melding of known information about biomechanics and edge detection and image processing techniques. Consiquently, the background of this project lies in two, distinctly different areas.

3 Procedures and Methodology

The first step in the process is to get an outline of the lower leg and feet from an image. Using gausian blurring, noise removing techniques, and outlier removal algorithims, and edge detection program creates this outline. Once an outline is made, there are two possible methods for determining the degree of pronation. The first method is will find the degree of pronation by determining the general angle of the lower ankle and foot and comparing it to the angle of the leg. Disparities in the two angles will conclude either pronation or supernation, depending on the sign of the angle difference. The second method is probably the one that will be further developed in the later stages of the project. This method requires two images, an image of the runner right before and right after impact. An algorithim is applied to both images that extracts an outline and the average x value of the outline. These two values are compared between each image, and the higher the value, the higher the degree of pronation. However, the output of this method, the pixel difference between the two values, is relative to the distance between the runner and the camera. Thus, it is important to standardize this distance. To determine this relative factor, the program will be tested and analyzed on a multitude of neutral runners, runners with a correct amount of pronation. After storing the outputs of all the neutral runners, the outlier outputs will be discarded,

and the remaining range of output values will be designated as the neutral output range. Output values above the neutral range will be over pronators and output values below this range will be superantors.

4 Expected Results

This project is expected to create an overall algorithim that can analyze images of a runner under a controled environment and come up with a biomechanical fingerprint for the runner, namely, the degree of pronation of the runner. The implication of the project is a new precedent for accurately determining proper shoe type for runners and preventing common injuries.