Optimization of Free Throw Technique

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Correctly performing a free throw in the game of basketball requires a complex motion by an athlete. In order to be successful free throw shooters, athletes need to perform their shooting motion in a way that can be repeated consistently many times. This project seeks to mathematically prove whether or not the accepted "perfect form" for free throw shooting is correct.

This can be done by first finding motions that are within the realm of human possibility that will result in a successful free throw. These motions can then be evaluated for muscle activation levels and sensitivity to small errors by the athlete. Optimization techniques will be used at various stages of this project. Finding possible motions involves setting constraints that relate to human anatomical limits and solving the indeterminate system for muscle forces. This process is commonly done in the field of biomechanics when the motion of joints is already known. This project will expand on what is commonly done in human kinematic studies by determining possible combinations of motions and muscle forces that result in a successful free throw. Optimization techniques will also be implemented to evaluate which motion is best. This will be done by evaluating the sensitivity of the results (how much do muscle forces have to change in order for the free throw to be unsuccessful), as well as the muscle activation required for the motion.

The optimization process will rely on several significant factors including the location of the most prevalent arm/hand joints involved in the desired arm motions and the energy required by relevant active muscles. Prior to conducting the optimization study, preliminary research on arm dimensions, the roles of different muscles in shooting a basketball, along with other key information will be gathered. It is expected that this project will produce results that align closely to what is considered perfect form. However, this project will be beneficial because it will provide a quantitative explanation for why some basketball players struggle so much with their free throw shooting.