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FSR MOTOR CONTROL AND LEARNING LAB: TRACING THE MICROSCOPIC MOVEMENTS

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Picture 1: Motor Control and Learning Laboratory

Human movement is a complex phenomenon that involves the interaction of various body systems, such as the skeletal, muscular, nervous, and cardiovascular systems. Depending on the type and purpose of the movement, different patterns of coordination, control, and adaptation can be observed. Researchers have developed various models and methods to describe and analyze human movement, ranging from theory-driven to data-driven approaches. Theory-driven models incorporate anatomical and physiological aspects of movement generation, while data-driven models focus on specific aspects or outcomes of movement performance. Both types of models have advantages and limitations, depending on the research question and the available data [1]. Some examples of human movement types are flexion, extension, abduction, adduction, rotation, pronation, supination, circumduction, deviation, opposition, repositioning, inversion, and eversion. These terms describe the direction or orientation of a body part or segment relative to a reference axis or plane [2].

Researchers measure human movement using various techniques and instruments, depending on the analysis's type, purpose, and accuracy. Some of the common methods are electrical linkage methods, stereometric methods, biplanar roentgenographic methods, and accelerometric methods [3]. Electrical linkage methods use potentiometers or encoders attached to the joints or segments of interest to measure angular displacements or velocities. Stereometric methods use cameras or other optical devices to capture the position of markers or landmarks on the body and reconstruct the three-dimensional coordinates of the movement. Biplanar roentgenographic methods use X-ray images from two different views to measure internal skeletal motion and joint kinematics. Accelerometric methods use accelerometers or gyroscopes attached to the body segments to measure linear or angular accelerations [3]. Each method has its advantages and limitations in terms of accuracy, precision, reliability, validity, cost, complexity, and invasiveness. Researchers need to consider these factors when choosing the appropriate method for measuring human movement.

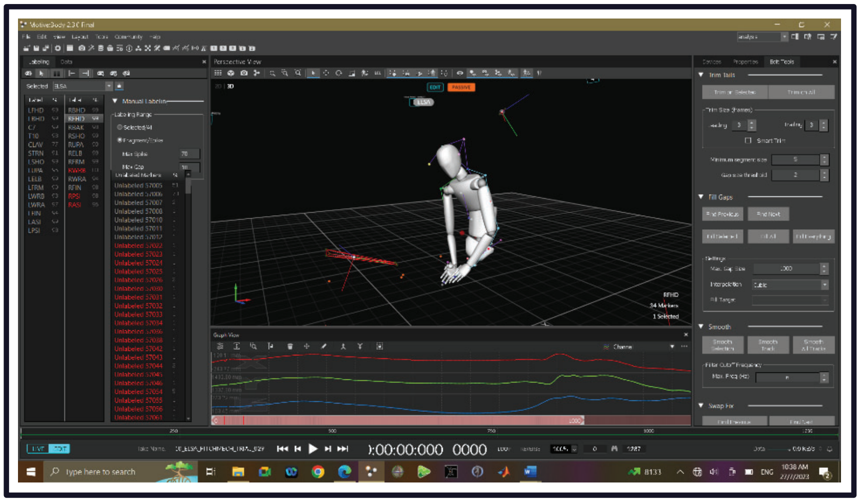
In FSR Seremban, we utilize the Stereometric MOCAP (Motion Capture) methods with the aid of eight (8) optical cameras from OptiTrack. The OptiTrack Prime x13 is a motion capture camera that offers high-speed, precise tracking for medium-sized areas. It has a resolution of 1.3 megapixels and a native frame rate of 240 frames per second, which can capture movement speeds above 125 mph with an accuracy of +/- 0.20 mm and rotational errors less than 0.5 degrees. The camera features a custom-designed, low-distortion lens with a wide-band anti-reflective coating, which increases light transmission and improves 3D data quality. The camera also has a filter switcher technology that allows switching between infrared and visible spectrum imaging and onboard image processing that identifies markers and marker centers. The camera can be used with passive and active markers and can be mixed and matched with any other camera in the Prime and Prime X family to create the optimal configuration for any use case. The camera has a small footprint, a lightweight design, and an invisible 850nm IR illumination, making it ideal for applications that require a discreet tracking system. [4][5][6].

Picture 2: OptiTrack Prime X13 MOCAP Camera

We recently conducted a post-graduate project that utilized this system involving Malaysian softball players as the participants. The aim of the project was to examine the batter's performance in hitting a softball that was thrown at different speeds ranging from 70 to 120 km/h under various scenarios. The scenarios included having a national pitcher or a pitching machine as the source of the softball, as well as having a static pitching pole as a control condition. The height of the pole was adjusted according to the height of the batter.

Picture 3: Data Quantification and Advance Analysis

Softball pitching is a complex skill that requires coordination, strength, speed, and accuracy. Pitching performance can be influenced by various factors, such as biomechanics, fatigue, injury, psychological state, and environmental conditions. One of the most important aspects of pitching performance is the velocity of the ball, which can determine the outcome of the game. According to a study [7], the average ball velocity for collegiate softball pitchers ranges from 24.1 to 30.5 m/s, depending on the type of pitch. The study also found that ball velocity was positively correlated with elbow extension velocity, shoulder internal rotation velocity and wrist flexion velocity. These findings suggest that pitchers should focus on improving these joint movements to enhance their pitching performance. In contrast to this, softball batting performance is influenced by various factors, such as the type of pitch, the speed of the ball, the stance of the batter, and the swing mechanics. According to a study [8], the optimal bat weight for maximizing bat speed and batted ball velocity is about 12% of the batter's body mass. The study also found that increasing the moment of inertia of the bat by adding weight to the barrel end reduced bat speed and batted ball velocity. The authors suggest that softball players should select a bat that is comfortable for them and allows them to generate high bat speed and batted ball velocity. Later this year, a new project will be conducted towards Malaysian professional golfers to enlighten the kinematics, and golfing prowess towards difference lengths of golf clubs.



Picture 4: Kinematics properties of softball swing

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