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Smart Bowling Action Monitoring System Using WSN

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ABSTRACT: This system is to find the illegal bowling and knee movements to the cricketer. The knee moves are calculated using the real-time smart sensors. This sensor will find the values for illegal functioning and all values will send by what's app notification by using the internet. An Illegal Bowling Action is where a player is throwing rather than bowling the ball. This is defined by the ICC as being where the player's elbow extends by an amount of more than 15 degrees between their arm reaching the horizontal and the ball being released. Match Officials in international cricket use the naked eye and their cricketing experience to decide whether they believe a player may be using an Illegal Bowling Action and if so, they will submit a report. The player is then tested at an ICC Accredited Testing Centre, using state-of-the-art technology and supervised by experts in the science of human movement. The knee flexibility of the normal cricketer and that's pressure on that leg is 1.70 tons. Whenever the pressure with flexibility range or the hand bowling angle gets varied all the values will make notified to the concerned person or coach or a trainer via what's app message with the player's identity.

KEYWORDS: Kinematic Analysis, Human Gait Motion, Joint Angle Analysis, Linear Electric Actuator, Electromyography, Flex Sensor, Accelerometer

I. INTRODUCTION

Cricket as a sport derives its thrill from the battle between bat and bowl. An efficient bowling unit is every captain's dream which could run through the opponent's batting line-up. Bowling with a cricket ball is a perfect fusion of art and science wherein the bowler, limited by own biomechanics, exploits the physics governing motion of ball through air as well as deviation off the pitch surface to playing tricks on batter's mental template of the ball's trajectory. This is an attempt by batter's mind to predict the trajectories of the following deliveries based on release velocity and angle of preceding deliveries. Limited by reflexes, the batter has to depend more on this mental template as the release velocity of ball increases, leaving the batsman with shortened response time. Consequently, a ubiquitous motion exists in the cricketing world that batsmen find balls released at higher velocities difficult to play. Naturally, this has led cricket enthusiasts to believe that bowlers who release ball at higher velocities tend to outperform those releasing at lower velocities. Lower order batters, generally, do not specialize in batting techniques; based on this assumption many commentators believe lower order batters to be more vulnerable to pace, presenting them as defenseless hunt before faster bowlers. The present study attempts to justify/debunk these ubiquitous notions existing in cricketing world by statistically analyzing the performance of pace bowlers independently in three groups based on range of release velocities. The statistical variation in number of wickets taken by bowlers of different categories is studied for each stratum of batting line-up. Therefore, it is conceived that generating a knee motion close to able-bodied individuals leveraging the inertial motion can achieve active prostheses with safety and ease of walking.

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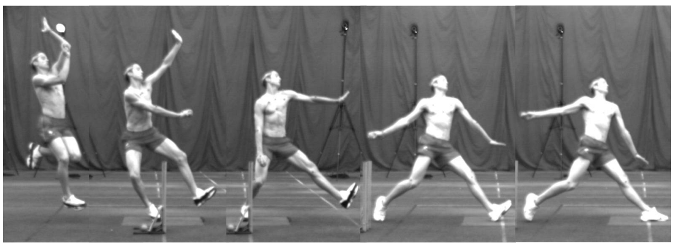
However, note that the mass of the Tran femoral prostheses is different from the biological counterparts of able-bodied individuals. Their inertial motions can be different from each other even with the same initial condition. Therefore, we developed a motion generation method of prosthetic knee that fits with the able-bodied individuals in mid-swing. However, this method could not be applied to situations where there are changes in the walking velocity because the proposed method generates timed trajectories. Therefore, the first purpose of the current study is to examine whether the kinematic synergy exists even during walking with a Tran femoral prosthesis using the inertial motion in the mid-swing, which is similar to that of an intact knee. The second purpose is to exploit this synergy to generate the motion of the prosthetic knee joint that can adapt to the walking velocity changes. First, the kinematic synergy between the intact limbs and the prosthetic knee employing the inertial motion is investigated. A method for generating the motion of the prosthetic knee joint is proposed based on an analysis of the kinematic synergy to adapt to the walking velocity changes. We found that the walking velocity could be estimated well from the initial motion. Hence, in the proposed method, the coefficients used to generate the knee motion from the biological joints are changed depending on the initial motion at each toe-off. Finally, numerical simulations are performed to evaluate the effectiveness of the proposed method. However, note that the mass of the Trans femoral prostheses is different from the biological counterparts of able-bodied individuals (e.g., most of the passive Tran femoral prostheses are lighter than the biological counterparts of able-bodied individuals). Their inertial motions can be.
different from each other even with the same initial condition. Therefore, we developed a motion generation method of prosthetic knee that fits with the able-bodied individuals in mid-swing. However, this method could not be applied to situations where there are changes in the walking velocity because the proposed method generates timed trajectories. Therefore, the first purpose of the current study is to examine whether the kinematic synergy exists even during walking with a Tran femoral prosthesis using the inertial motion in the mid-swing, which is similar to that of an intact knee. The second purpose is to exploit this synergy to generate the motion of the prosthetic knee joint that can adapt to the walking velocity changes. We found that the walking velocity could be estimated well from the initial motion. Hence, in the proposed method, the coefficients used to generate the knee motion from the biological joints are changed depending on the initial motion at each toe-off. Finally, numerical simulations are performed to evaluate the effectiveness of the proposed method.

THE AREA OF STUDY

The game of cricket can be described simply as a contest between bowlers, who deliver the ball, and batsmen who try to score runs by hitting the ball. Within a cricket team there can
be both fast bowlers (who deliver the ball at around 39 – 43 m.s-1) and spin bowlers (who can be one of two types: off-spin or leg-spin). Fast bowling is a dynamic activity requiring bowlers to run-up and repeatedly deliver the ball at high speeds (Figure 1.1). Ball release speed is a major contributor to fast bowling
success as it reduces the time the batsman has to interpret the path of the ball and make decisions regarding which shot to play. In international matches, bowlers may perform as many as 180 deliveries a day. Although cricket is generally considered a low-injury sport, fast bowlers have injury rates comparable to contact sports such as Australian rules football and the Rugby football codes (Orchard et al., 2006). Lower back injury is the most prevalent injury among fast bowlers, with lumbar stress fractures which occur predominantly on the non-dominant (non-bowling arm) side accounting for the most lost training and playing time (Gregory et al., 2004).



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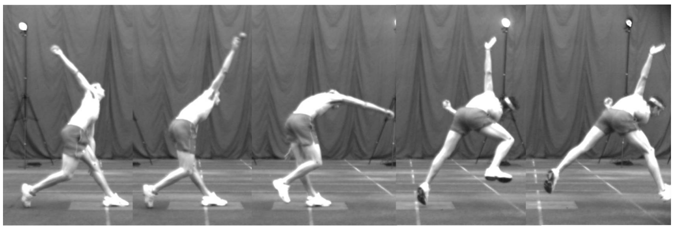

Figure 1.1 – The fast bowling action

The rationale for this research study is to analyse the fast bowling action to gain an understanding of the effect of interactions between aspects of fast bowling technique on ball release speed and the forces exerted on the bowler. While previous research has looked to identify links between fast bowling technique and ball release speed, none have considered the effects of interactions between elements of technique. Some studies have considered the contribution of run-up length or run-up speed (Davis and Blanksby, 1976a;
Elliott et al., 1986) on release speeds. Others have considered individual aspects of front leg technique (Elliott et al., 1986; Burden and Bartlett, 1990b; Portus et al., 2004), the motion of the thorax (Davis and Blanksby, 1976b; Elliott et al., 1986; Burden and Bartlett, 1990a; Portus et al., 2004), or the position of the arm at ball release (Davis and Blanksby, 1976b; Elliott et al., 1986; Burden and Bartlett, 1989; Foster et al., 1989; Burden, 1990). There is currently no consensus regarding the effect of these elements of technique on ball 3 release speed, it seems likely that these contradictory results may be due to interactions between technique variables which have not been addressed.
A number of studies have reported ground reaction forces during the front foot contact phase of the bowling action (Elliott et al., 1986, 1992, 1993; Foster et al., 1989; Mason et al., 1989; Saunders and Coleman, 1991; Hurrion et al., 1997a, 1997b, 2000; Portus et al., 2004). However, no studies have considered these forces in conjunction with three dimensional kinematic data of the bowling action. Currently, no studies have attempted to calculate the forces experienced in the lower back of fast bowlers. A three-dimensional inverse-dynamics analysis of the fast bowling action has the potential to provide a more thorough understanding of the mechanics of fast bowling, in addition to
the effect of technique on ground reaction forces and loading in the lower back. This will allow current coaching practises to be better informed and also help identify those bowlers who are likely to have higher forces in their back and may be at higher risk of injury.

II. RELATED WORKS

A computational investigation is performed to evaluate the effects of piston bowl geometry on fuel-air mixing and engine performance in a high-intensified diesel engine. Fourteen different shapes of diesel engine piston bowl are selected and simulated by CFD FIRE. The main results suggest that an optimal value exist to maximize indicated power, respectively, of piston bowl diameter, re-entrant angle and bowl bottom radius. Piston bowl diameter and bowl bottom radius are found to have a more significant impact on performance than re-entrant angle. Because variations of piston bowl diameter and bowl bottom radius are found to have a bigger effect on piston bowl geometry, which mainly affect fuel-air mixing process near bowl side-wall and bottom of central convexity, resulting in marked effects on combustion process and performance. This study underlines the need to carefully consider fuel-air mixing process induced by piston bowl geometry. In recent past, the research about control methods for complex machines and robots has been developed rapidly. The main objective is to establish a non-linear model of cricket bowling arm in Biomechanics and implementation of optimal control based for different bowling actions. Continuous Passive Motion (CPM) device is commonly used for knee rehabilitation to recover the range of motion or to lessen edema and swelling of the knee following injuries or surgeries. The objectives of this work are to design and develop a touch screen based CPM device for knee rehabilitation.

STATEMENT OF PURPOSE

Full-body three-dimensional kinematics and ground reaction force characteristics will be calculated to enable the analysis of fast bowling techniques. In particular, the effect of interactions between aspects of fast bowling technique on ball r elease speed and ground reaction forces. A full-body inverse-dynamics analysis will be developed, enabling forces in the lower back to be estimated and their link with bowling technique to be addressed.

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The fast bowlers will be represented as a system of 18 rigid segments linked by pin joints. Kinematic, kinetic and anthropometric data will be collected for a group of 20 elite fast bowlers. The analysis will be customised for each bowler, using subject-specific segmental parameters determined using the geometric model of Yeadon (1990). The inverse-dynamics analysis will be used to calculate parameters describing elements of fast bowling technique as well as characteristics of the ground reaction forces and the forces in the lower back. The output from the analysis will be used to address correlations between technique, ball speed and ground reaction forces which have previously been reported / proposed in the literature. The interactions between aspects of fast bowling technique which determine 4 ball release speed will be identified. The effect of front leg technique on ground reaction forces and forces in the lower back, during the front foot contact phase of the bowling action, will also be addressed.

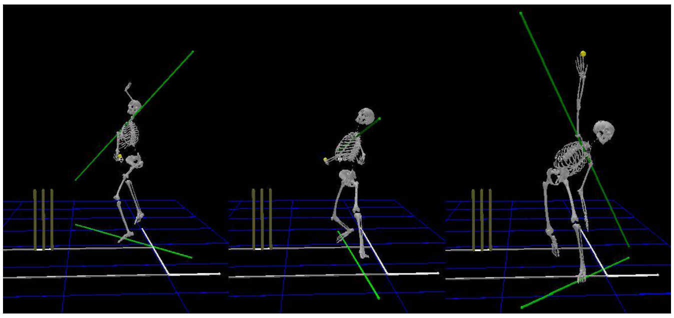

Figure 2 An illustration of: (A) the front-on action; and (B) the more closed, mid-way action.

SEGMENT DEFINITIONS
Within BodyLanguage, each segment was represented by a right-handed coordinate system. These were positioned at the lower joint centre of the segment when standing in an anatomical position. Segments were defined such that when in an anatomical position, the z-axis pointed upwards along the longitudinal axis of the segment, the x-axis pointed to the subject's right (representing the flexion-extension axis of the joint) and the y-axis pointed forwards, representing the frontal axis The longitudinal axis was typically defined to join the proximal and distal joint centres of the segment, exceptions to this are described below.

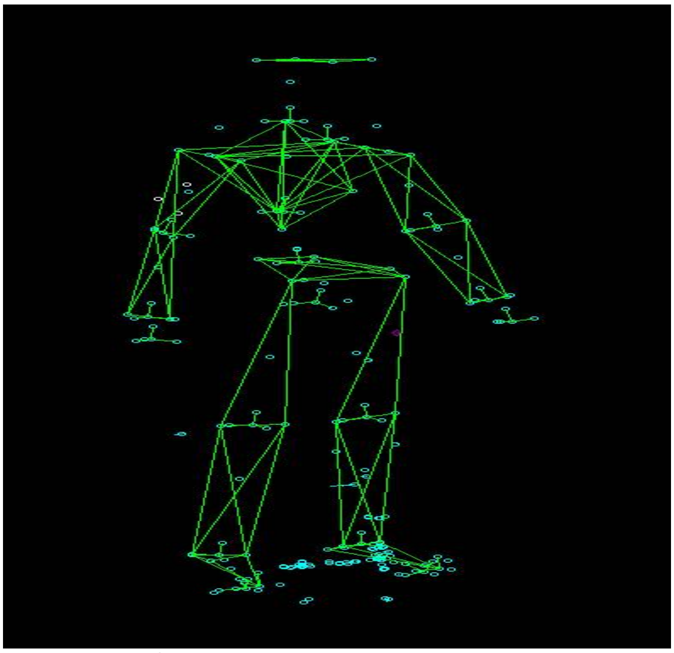

Figure 3. Illustration of the orientation of the 18 segments' coordinate axes (with and without an outline of the body drawn).

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ANGLE DEFINITIONS

Joint angles were calculated using Cardan angles, defining the rotation applied to the parent coordinate system (proximal segment) to bring it into coincidence with the child segment (distal segment). The pelvis segment was defined to be the only segment without a parent; rotation of the femur and lower back were both defined with the pelvis as the parent segment. Rotation angles were calculated using an xyz sequence - representing an initial rotation about the x-axis of the parent, followed by rotation about a floating y-axis of the parent and finally the z-axis of the child. These rotations correspond to flexion extension, abduction-adduction or valgus varus rotation, and longitudinal rotation, respectively.

III. CONCLUSION AND FUTUREWORK

Some form of elbow-axis to sensor orientation calibration process was necessary and this exercise appeared beneficial. Sensor mounting location, muscle loading and longitudinal rotation of the forearm all influenced the data generated from the inertial sensors during functional movements and the cricket bowling action. Work is ongoing to minimize the effect of these factors to allow inertial sensors to be used as a bowling training aid and illegal action assessment tool. Work is also ongoing to understand which aspects of the movement are individual or generic so on-field monitoring with inertial sensors is effective in cricket. Future studies will include the implementation of the proposed method in an actual prosthesis and an evaluation of the method from a biomechanics perspective. The robustness of the proposed method to the changes in the input signals for a wider variety of signals, such as a larger hip joint motion, should be investigated. Investigating the ease of walking with the proposed method is also an important future work to validate our hypothesis that leveraging the inertial motion in the prosthetic knee control would increase the ease of walking.

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