

DYNAMIC MODEL OF GOLF CLUB FOR THE CLUB HEAD TRAJECTORY ESTIMATION FROM THE IMU MEASUREMENT FOR CUSTOM CLUB FITTING

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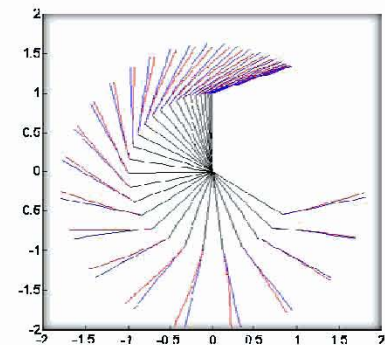
KEY WORDS: golf, golf club, custom club fitting, dynamic model, IMU, MEMS sensor.

INTRODUCTION: A novel way to analyze the golfer's full swing motion for custom golf club fitting process is proposed using the idea of the personalized inertial measurement unit with the sensors strap-down onto the golf club. It has been developed by the research team, led by Perkins, the University of Michigan. To make the best club choice, not only the golfer's swing motion but also the club's motion needs carefully deliberated because it is the golf club head that contacts the ball. However because of the extremely severe impact, it is not practical to measure the head motion directly with sensors attached to it. This research proposes the method to estimate the golfer's swing and golf club's deformation using the dynamic golf club model to acquire the thorough information for the golfer's personal swing.



METHOD: The IMU shown on right side measures the motion of the golf club at the butt in 6 DoF. Assuming that the club is exposed the base excitation, rotation and translation motion, the deformation of the club is calculated from the equation of motion. Superposing those two motions, the motion of the butt and the deformation of the golf club, the full swing information is completed. The IMU comprises the angular rate sensors in 3 axes and accelerometers in 3 axes. The data sampling rate is up to 500Hz with 10bit AD converter transmitting the data to the personal computer for the post data processing. The golf club head is assumed to be rigid and the golf club shaft is considered as flexible matching the natural frequency, deflection, torsion and physical dimension to the published data.

RESULTS and DISCUSSION: The IMU and the dynamic model are examined separately. The estimated deformation, as shown in the figure on right, which includes bending in two direction and torsion in one direction, is calculated using the two-link motion as the input motion, where black, blue and red lines mean arm, rigid club and flexible club respectively, not from the measured swing motion. It shows the characteristic bending feature that the grip lead at the early stage of the down swing but it lags at impact. The amount of the bending is up to 10 centimetres and the torsion is up to 8 degree. From this calculation the equation of motion for the golf club can be considered that it is properly formulated for the purpose.



CONCLUSION: This study introduces a very practical method to collect all the information from the golf swing using the personalized IMU and the dynamic model of golf club, which may equip the club maker more thoroughly to provide a better custom golf club fitting service. It is expected the full calculation experiment that uses the measurement data from the IMU will be carried out soon. This system can be applied to the area of golf swing training, entertainment and rehabilitation, as well.

REFERENCES:

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