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Correlation Between Archer's Hands Movement While Shooting and Its Score

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Abstract

In archery, the most critical time is a few seconds before the release of the arrow because the trajectory of the released arrow is dependent on the movement of the archer's arms in the release phase. An archer use's two hands while drawing a bow, one hand to push on the bow riser and the other to pull the string. The archer's performance can be quantified through the analysis of the movement of both the archer's arms while releasing the arrow. In this paper, a study of the arm movement of an archer while shooting using recurved bow is presented. In the experiments, university level archers shot six arrows per frame and each archer shot three frames each whilst wearing a dedicated small sized accelerometer in both arms. The generated data, in terms of linear acceleration, was streamed in real time to a computer wirelessly via Bluetooth. The sampling rate of the accelerometer was about 15Hz. The forward-reverse, up-down, left-right motion of both arms as well as the score and the position of the arrow of each shot were recorded. A high score category is when an archer shot ten, nine, and eight points while three, two, and one points score is a low score category. The analysis of the data showed a correlation between the archers' arm movement and their score. Although the arm movement generated a similar displacement pattern for a higher score and a lower score, a high bow arm's movement in transverse plane upon releasing the string may lead to a lower score.

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Keywords: archery; recurved bow; accelerometer; vibration;

1. Introduction

In archery, the most critical time is a few seconds before the release of the arrow. This time is the most critical because the trajectory of the released arrow is dependent on the movement of the archer's arm in the release phase. The World Archery Federation defines ten stages for shooting an arrow using recurved bow namely stance, setup, hooking, grip, drawing, anchor-ing, full draw, extending, release, and follow through [1]

Archers usually extend the drawing until the clicker on their bow fall then release the bow string to launch the arrow. During extending, the archer has to maintain the static balance of forces between the external tension of the bow and their muscular forces at the time of shooting [2]. Therefore, it is hypothesized that a severe movement of the arms during extending and release may influence the scores as it marks the point where the arrow acquires its initial trajectory and leaves the bow at a specific speed.

2. Related work

Several researchers had published several methods to monitor the forearm movement by an archer. Ertan et al. analyzed electromyography signals of extensor digitorum muscle and flexor digitorum superficialis of elite, beginner and non-archer [3].

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Their works showed that the release reactions of elite archers after the clicker fall were faster than beginner archers or non-archers. Thus, they concluded that the development of extensor digitorum muscle and flexor digitorum superficialis coordination were critical in order to react efficiently to the clicker fall.

Apart from the forearm muscles, Tinazci published a study, which correlate the forearm muscle activities with the postural sway of the archer [4]. He established that coordination of specific muscular strategy, aiming behavior and postural sway can increase the archer scoring performance. Their work showed that the acceleration of the arm caused by postural sway may contribute to an archer's scoring performance.

Ganter et al. developed three methods to monitor bow movement form three archers. They have used an optoelectronics system, a 3D video system and a 2D video system [5]. They concluded that optoelectronics device and 3D video system cannot be used in competition due the additional device mounted on the bow and time constraint to setup the 3D system. Both systems however were very useful in measuring individual techniques during training.

However, tracking human movement using wearable electronics devices is being researched across all sports disciplines. Sports, such as tennis [6], swimming, [7], cricket [8] have been using wearable electronics devices to assess athlete's performance. The wearable electronics devices typically consist of inertial measurement unit that is capable of measuring linear acceleration, radial acceleration as well as the orientation. The analysis from these inertial measurement units worn by an athlete usually gave the researcher insights on the athlete's technique during a training session or even the actual competition.

3. Method

In this paper, a simplified method is used to monitor the arm movement of the archer. Accelerometers were strapped to both, right and left arms of the archer. The hand, which handled the bow, is called the bow arm while the hand, which pulled the string, is called the string arm. The position of the accelerometers with its positive direction is shown in figure 1. For the bow hand, the measured acceleration in x-axis is positive in a leftward direction with respect to the archer and the measured acceleration in the z-axis is positive in a backward direction with respect to the archer. For the string hand, the measured acceleration in the x-axis and z-axis is positive in the opposite directions of the x-axis and z-axis acceleration of the bow hand respectively. However, the measured acceleration in y-axis for both hands is positive in the downward direction with respect to the archer.

The generated data was transferred wirelessly using Bluetooth. The device, as shown in figure 2, is programmed to take samples at about 15Hz rate. The measured acceleration data was integrated to calculate the velocity and the calculated velocity was integrated again to calculate the displacement of the archers' arm. This calculated displacement was used to analyze the movement of the archers' arm.

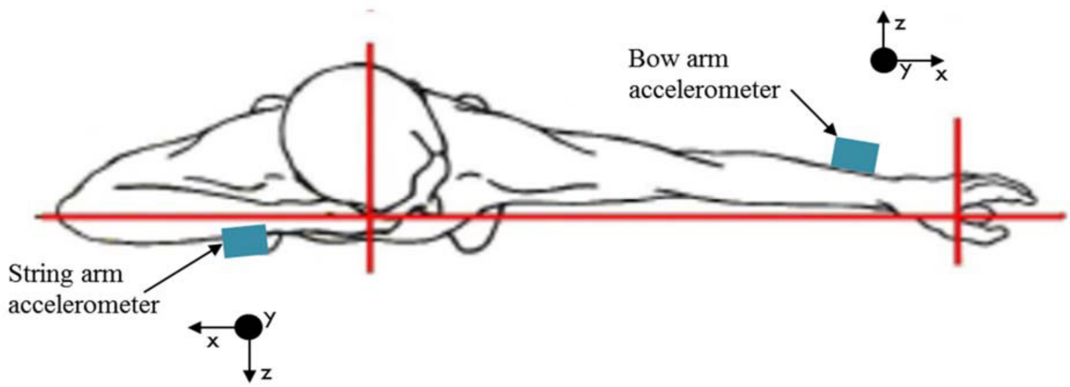

Fig. 1: The position of the accelerometers with its positive direction

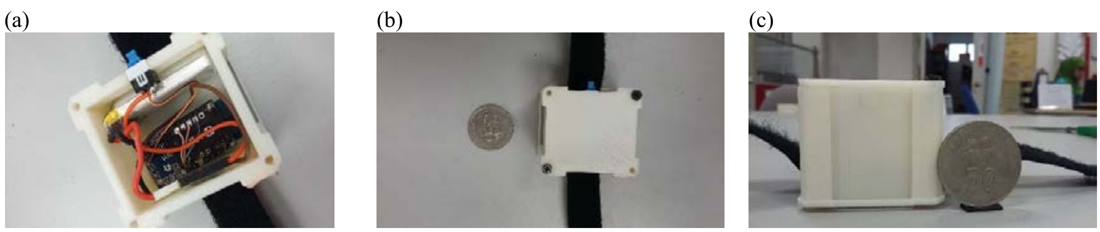

Fig. 2. The accelerometer used in this experiment. (a) Inside view. (b) Top view. (c) Side view.