CricketCoach: Towards Creating a Better Awareness of Gripping Forces for Cricketers

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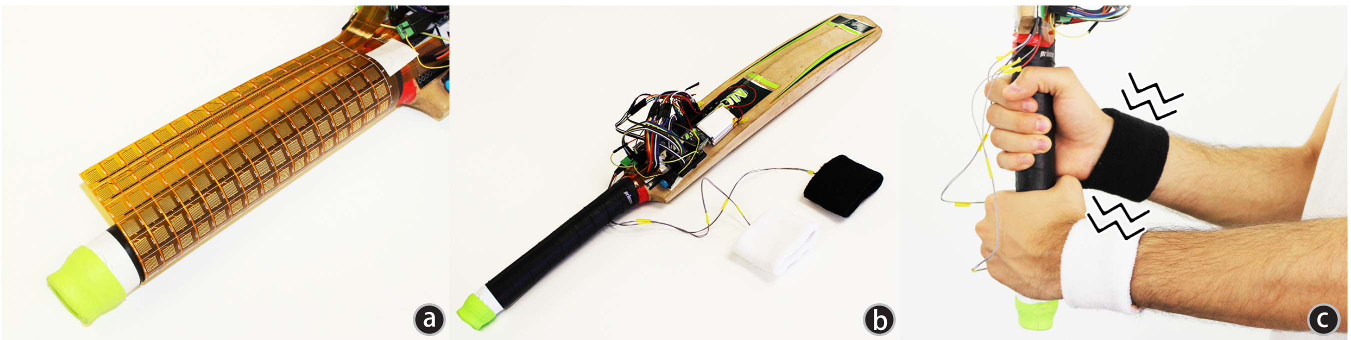

Figure 1: CricketCoach Prototype. a) Underlying force sensitive resistor grid. b) The overall system integrated with a cricket bat. c) Wrist bands that provide vibrotactile feedback.

ABSTRACT
In this paper, we demonstrate a smart system that creates awareness of the hand-grip force for cricket players. A custom Force-Sensitive Resistor (FSR) matrix is attached to the bat's handle to sense the gripping. Two wrist bands, incorporating vibration motors, provide feedback that helps non-expert users to understand the relative forces exerted by each hand while performing a stroke. A preliminary user study was conducted to collect first insights.

CCS CONCEPTS
• **Human-centered computing → Ubiquitous and mobile computing systems and tools**;

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1 INTRODUCTION
Cricket is a complex sport that employs various strategies and dynamic tactics. Apparently, the correct execution of batting is fundamental to the game. Especially in batting, the grip of the batsman plays a key role in the proper execution of a stroke. This is supported by the three expert cricket coaches we spoke to. They stated that each specific type of batting stroke has an optimal way of holding the bat. Thereby, the proportional applied force from both hands on the bat's grip is essential. Coaches suggest that especially beginners find it difficult to maintain the correct hand posture and to apply the correct force. Although the hand posture can be assessed visually, the force exerted by hands remains invisible for the coach. To overcome this, we augment a cricket bat grip with a force sensitive resistor matrix and visualize these forces using vibrotactile feedback at the wrist.

Previous research by Kahn et al. [3] suggested augmenting the cricket player's limbs with Inertial Measurement Units (IMU) to assess the quality of batting shots and to generally sense the current activity. We aim to go a step further by demonstrating methods to improve one's batting shots, while visualizing this information using vibrotactile feedback. Attaching vibration motors and IMUs at different body positions other than the wrist has successfully assisted with activities such as swimming [1]. Other researchers implemented pressure sensitive sensors into the shoe [4] to

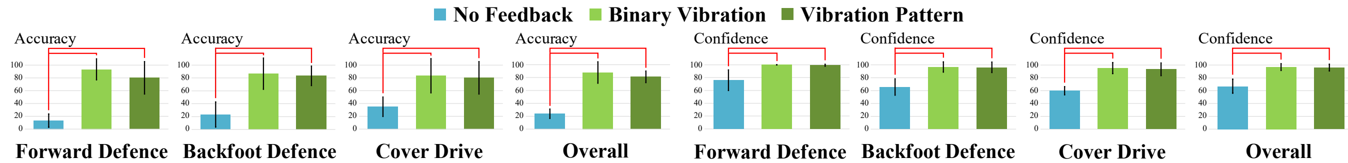

Figure 2: Accuracy of relative force awareness and the confidence of the participants in 3 condition: No Feedback (NF), Binary Vibration (BV) and Vibration Pattern (VP) for three batting strokes, which are Forward Defence (FD), Back-foot Defence (BD), Cover Drive (CD), and Overall (the average among all three strokes).

analyze football shots. A pressure-sensitive insole plus vibrational feedback at the foot has also shown to significantly improve body posture for dead lifts and squats [2].

In this paper, we augmented a cricket bat with a customized grip using FSR and an IMU. We provide vibrotactile feedback at the wrist, aiming to assist novice cricket players to learn to maintain correct hand gripping forces to improve their batting technique. We conducted a preliminary user study with six participants and found that the perceived awareness of relative hand grip forces were significantly more accurate with vibration feedback compared to no feedback. There was no preference of vibration type. A post-questionnaire indicated that visualizing the correct grasping force to the players in an unobtrusive way is desired.

2 PROTOTYPE

As depicted in *Figure 1*, our prototype includes 1) a force sensitive grid which can distinguish the force distribution throughout the grip surface, 2) an IMU that measures the orientation of the bat, and 3) two wristbands which provide vibrotactile feedback to the user in real-time.

Force Sensing Grid: Since off-the-shelf FSRs are difficult to customize for a bat handle, we designed a custom force sensing grid which could be well-hidden underneath the grip. The FSRs are fabricated from a semi-flexible PCB which $10cm \times 22cm$ in size. It has 128 sensing nodes (16×8) and each sensor node covers an area of $1cm \times 1cm$. On top of the flexible PCB layer, we included a pressure sensitive conductive sheet (Velostat). Depending on the force applied, the velostat changes the conductivity and thus the connectivity of the non-attached copper nodes increases with applied pressure. This is sensed using a voltage divider circuit with a $180k\Omega$ resistor. Sixteen digital outputs of the Arduino Mega enabled the sensing of one row of sensor nodes (8 nodes) at a time. We then switched between several rows to reach an overall sampling rate of $40Hz$. The data stream was transmitted to a PC using a Bluetooth Transceiver Module HC-06. A $400mAh$ LiPo battery powers the system.

Vibrotactile Feedback: We developed two wristbands incorporating a vibration motor (ERM Motor, model 307-103 from precisionmicrodrives) for each, being triggered by two controllers (DRV2605L). We provided the feedback right after the stroke. Either by just visualizing a single vibration at the force-dominating side, or a pattern at both sides, also visualizing the relative difference by a number of $2Hz$ pulses.

3 PRELIMINARY EVALUATION

Data Collection: We collected and analyzed data from six participants, who were asked to perform three batting strokes: Forward defence (FD), Back-foot defence (BD), and Cover drive (CD) like executing batting drills. We tested 3 conditions: No feedback (NF), Binary Vibration (BV), and a Vibration pattern (VP). For each condition, we asked the participant to identify the hand they perceived applied more pressure during the stroke. We compared their answer with the recording of the actual pressure distribution of the bat grip. In addition to this, we also asked the users to rate their confidence levels while performing the stroke execution as well as collect qualitative feedback. In total, each user performed 45 strokes ($3stroke \times 3conditions \times 5repetitions$).

Results: Comparing the accuracy; a *one-way ANOVA* showed a significant main effect for: FD ($F_{2,15}$=32.63, p<.001), BD ($F_{2,15}$=19.05, p<.001), CD ($F_{2,15}$=8.32, p=.003), and for the overall accuracy ($F_{2,15}$=54.45, p<.001) as shown in Figure 2. Thus, using feedback increases accuracy. In terms of confidence, a *one-way ANOVA* showed a significant main effect for: FD ($F_{2,15}$=13, p<.001), BD ($F_{2,15}$=19.66, p<.001), CD ($F_{2,15}$=33.07, p<.001), and for the overall confidence ($F_{2,15}$=29.61, p<.001). It is evident that visualizing the force also increases confidence.

4 FUTURE DIRECTIONS

We understand the current system to be still in a work-in-progress stage. Sensors needs to be integrated, the connection to wristbands needs to be wireless, and overall the system needs to be miniaturized.The generalization of Cricket-Coach is desirable and would enable other sports that use devices with a handle, such as Tennis, Golf, Rowing, Javelin etc. to benefit from this technology.

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