Undergraduate Thesis Prospectus

Providing Weightlifters with Immediate Performance Feedback

(technical research project in Electrical Engineering)

Is Expertise Needed? The Practical Implications of a Flood of Health Data

(STS research project)

by

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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General Research Problem

How can individuals best be informed about their health?

To manage their own health, people need good, current information. Researchers have questioned the medical value of year checkups. Dr. Ezekiel Emanuel contends that "if you're healthy, there's every reason to believe these visits make no difference" (Heid, 2018). They are also too infrequent for those who are sick according to Krogsbøll (2012). Health literacy can help individuals better care for their own health and decide when to consult a doctor. Health wearables can also help. With the health data, wearers can develop training plans or detect early symptoms, thereby promoting health and saving money (Sortsø, 2018). Yet such effects can also compete with expert advice.

Providing Weightlifters with Immediate Performance Feedback

How can we provide immediate, critical feedback to weightlifters regarding their performance?

Professor Harry Powell of the department of Electrical and Computer Engineering supervises this project as part of the major capstone. The research team also includes Daniel Wu, David Ding, Hamza Kakeh, and Nathan Park.

The research team aims to create a small device, the Smart Barbell, capable of collecting and displaying weightlifting statistics to evaluate stance and physical performance. A correct stance while weightlifting can prevent injury and help muscle targeting (NFPT, 2014). Injury can also be prevented by lifting weights within one's physical capability. Lack of access to personal trainers result in experimenting with potentially dangerous ways (Gray, 2015). According to Frankel (2000), the best strategy

to avoid injury is to reinforce proper form and loads. A successful Smart Barbell should be accessible and will provide weightlifters with guidance on stance and performance summary statistics.

Most state-of-the-art wearables such as the Nexus only provides workout statistics and does not track stance (Sawh, 2018). The one that does, BaziFIT, costs $200 and only provides feedback at the end of a workout through an app that requires a subscription (BaziFIT, n.d.). Most weightlifting injuries are sustained due to imbalances during the lift which is why SmartBell aims to provide real-time stance feedback. However, the SmartBell can only provide immediate feedback on balance and whether correct posture was used for a repetition. It cannot immediately tell the user how to correct their form.

The SmartBell uses an accelerometer to track the relative movement of a Barbell during weightlifting, calculating speed and direction. This data can then be analyzed with an algorithm to determine whether the user had good, consistent form and report it through a screen at the end of the workout. For the more important information such as balance during a set of repetitions, an array of LEDs will provide immediate feedback to users, avoiding the possibility of unwanted twists and tears.

The hardware required for the SmartBell is relatively accessible and can also be replaced through the use of a smartphone when used in tandem with a mount. The novelty of the SmartBell will come from the ability for software to detect correct form using only accelerometer data without the use of sophisticated image recognition and cameras.

The research team will create a prototype of the SmartBell to test the methods of detecting correct form and gathering statistics. This prototype involves designing and

manufacturing a printed circuit board (PCB), soldering integrated circuits and circuit elements onto the PCB, and writing the software logic to detect and analyze form and statistics.

The physical and electrical components of the board will be tested by the research team using specialized equipment in a lab to ensure that it meets standards and specifications set out by various associations. Actual gym users and weightlifters will be asked to try the SmartBell in order to determine whether the stance detection algorithm works as designed.

At the end of the project, the team will deliver a working prototype that will be optimized for mass-production. We hope that the SmartBell will be simple and cheap enough for the masses, which should see an increase in form correctness, reducing injury.

Is Expertise Needed? The Practical Implications of a Flood of Health Data

How are wearables affecting individuals' health care?

Wearables have proliferated recently (Livingston, 2019). They can monitor the wearer's activity throughout the day, providing data that once required special medical devices and a visit to a health expert. Data from wearables, with information from the internet, can support self-diagnosis. But the convenience of self-diagnosis comes with the hazards of misdiagnosis and distrust.

Wearables can compete with professional advice. According to Landi (2019), individuals are more willing to adopt wearables if they can save them doctor visits. When someone self-diagnoses, they may neglect the implications of the diagnosis (Pillay, 2010). With more information, patients may be more likely to go to a professional with

conclusions instead of symptoms (Godman, 2018).

According to Ingrid Pipes, an individual with a chronic thyroid condition which affects weight, “doctors have refused to prescribe me the medication for my thyroid unless I lose weight, even though if my thyroid was working properly, I would lose weight.” Pipes asserts that her “numbers have never been ‘off’” but “doctors tend to see fatness before they listen.” Pipes therefore ignored professional advice (Keppler, 2018).

Many medical professionals warn that self-diagnosis from wearables can be dangerously inaccurate (Banks, 2019). According to one doctor, self-diagnosis can “miss a medical disease that masquerades as a psychiatric syndrome.” The patient may “think there is more wrong… than there actually is.” Finally, it “undermines the role of the doctor” (Pillay, 2010). Constant monitoring can cause overreactions to minor symptoms, such as a racing heart due to stress or too much coffee (McGrath, 2019).

Wearables can also save lives and complement the work of doctors. Fitbit data have helped doctors determine how long a patient’s heart had been racing. In another case, a Fitbit advised an individual to see a doctor, who diagnosed organ failure (Marshall, 2018). Dr. Dush Gunasekera believes that “the more accurate data we have on our patients, the better we can help with their health problems. Sometimes a snapshot can be just enough to give us the indications of a problem, or to prevent us missing one” (Heubl, 2014). Others, such as Dr. Ida Sim, see little benefit: “if you told a doctor, ‘We can run chemistry and liver panels on your patients every day for the rest of their lives… they would look at you like your crazy” (Sukel, 2019). Haghi (2017), however, contends that “sensors have made investigation of a full range of parameters closer to realization.” Wearables data can help researchers investigate patterns of rare diseases (Dias, 2018).

To sell wearables, manufacturers claim that they will make users more health-conscious (Fitbit, n.d.). Apple even calls its Apple Watch "the ultimate device for a healthy life" (Apple, n.d.). To users with medical conditions, wearables offer increased self-efficacy (Gualtieri, 2016). For healthy users, wearables can promote exercise and goal setting (Dove, 2015). "At the end of the day I can look at my activity tracker, and if it's low I can go for a walk around the block before I go to bed or I can dance around my living room" (Project Catalyst, 2016). Health professionals such as doctors and fitness trainers generally welcome wearables for the information they report (Trent, 2015). According to one trainer, Steven Dieltz, people striving to improve their fitness need "a slow progression… staying consistent." A heart rate monitor can help them pace the progress accordingly (Kollmorgen, 2019). Yet wearables are no replacement for experts. "Even the most popular trackers see a drop-off rate of 50% within 2 weeks of use" (Asimakopoulos, 2017). Experts do warn that wearers may ignore professional advice and take health into their own, untrained hands (Felde, 2019). Nevertheless, Britain's NHS and insurance companies are evaluating and subsidizing wearables to promote health consciousness and reduce long-term insurance costs (Best, 2018).

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