

**INVESTIGATING NOVEL PROXIMITY MONITORING TECHNIQUES USING  
UBIQUITOUS SENSOR TECHNOLOGY**

**THE PHYSICAL AND PSYCHOLOGICAL IMPACTS OF WEARABLE  
TECHNOLOGIES ON PERSONAL HEALTH**

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By

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## SOCIOTECHNICAL SYNTHESIS

The evolution of wearable and user-friendly personal fitness tracking devices has allowed such technologies to become affordable and reliable tools for people to monitor their physical well-being. Due to the onset of the coronavirus disease 2019 (COVID-19) pandemic, scientists and researchers have begun to question whether or not these devices could be used to accurately monitor or detect COVID-19 related metrics. This led to the technical project which focused on investigating novel proximity detection techniques by researching and testing various sensor technologies and determining their feasibility in an athletic context. The three sensor technologies that we investigated and compared were Bluetooth, ultrasound, and ultra-wideband (UWB). The STS scholarly article outlines the positive and negative physical and psychological impacts that wearable devices have on their users as well as potential solutions to problems that each social group faces in adopting wearable technology. The technical project and tightly coupled STS project analyze both the current usages and potential capabilities of wearable devices as well as their effects on the stakeholders in their network.

Since the start of the COVID-19 pandemic, sports teams have been challenged to find feasible ways to monitor social distancing and contact tracing among athletes so that they could continue to train and play together. This led to the technical project which outlines a comparison of the accuracy and feasibility of the three technologies in regards to measuring the distance between athletes in real-time. In order to test and compare the three modalities, we ran controlled experiments in which we set the devices at various distances apart from each other and recorded the timestamps of when the devices were at each specified distance.

For analysis, we used a power regression model with RSSI (received signal strength intensity) values as the predictors for Bluetooth and a regression model for ultrasound that both

gave predicted distance values that we then compared to the distances given by the UWB system. We found that RMSE (root mean square error) has a positive relationship with distance, meaning that the models yield higher error at increasing distances. The UWB model yielded an accuracy of about 96%, while ultrasound had an accuracy of about 81%, and Bluetooth had an accuracy of about 48%. After analyzing the results, Bluetooth was ruled out as a potential solution and although UWB outperformed ultrasound in accuracy and precision, there are important tradeoffs to consider such as ultrasound having better privacy, limitation of false positives, and widespread availability.

In order to understand how wearable devices could be used to help various social groups, the STS research aimed to answer the questions of how the negative impacts of using fitness trackers can be minimized, how the technology can become more accessible and attractive to all social groups, and how various social groups can be motivated to use them correctly. To further analyze the impacts that wearables have on users, Pinch and Bijker's Social Construction of Technology (SCOT) framework was used to categorize the relevant social groups and to highlight the major problems each group faces in their adoption of wearable fitness devices. Additionally, several ethical tests were applied to wearables and the relevant social groups involved to further understand where improvements could be made.

While there are several positive impacts that wearable devices have, such as helping people monitor their vitals for health conditions, there are also negative effects that have to be recognized as well, including promoting unhealthy behaviors. In addition to the negative effects, there is also user concern about the privacy and protection of biometric data since there is currently no federal regulation in the U.S. concerning the subject. Another problem that the research identified with wearable technologies is the differences in how older and younger users

adopt and interact with new devices. The SCOT analysis was used to develop potential solutions to these problems which include technology companies developing alternative options to ease the learning process for consumers who may be discouraged, making sure that healthcare professionals who are prescribing wearables to their patients address mental health concerns in addition to physical health concerns, and having healthcare professionals provide necessary resources about specialized workout plans to ensure that patients set realistic goals for themselves based on their capabilities.

Wearable technologies have proved to be useful in a variety of situations for both athletes and members of the general public. Their increasing capabilities with the additions of new sensors have opened up several potential ways in which they could continue to revolutionize the sports analytics and healthcare industries. However, understanding the feasibility and the impacts that these devices have on users is integral in improving the integration of wearables into sports programs and healthcare systems.

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