# Just-In-Time Adaptive Intervention to Motivate Physical Activity for Wheelchair Users with Spinal Cord Injury

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## 1. Abstract

Lack of regular physical activity in the general population is a top public health concern, and this problem is even more acute among the 300,000 individuals with spinal cord injuries in the US.[1,2]

In prior work, our team developed pattern recognition techniques to automatically detect physical activity and energy expenditure for people in wheelchairs.[3,4]

The aim of this study is to develop and evaluate a just-in-time adaptive intervention (JITAI) using wireless sensors for assessing activity and providing feedback about physical activity levels in individuals with spinal cord injury.

## 2. System Development

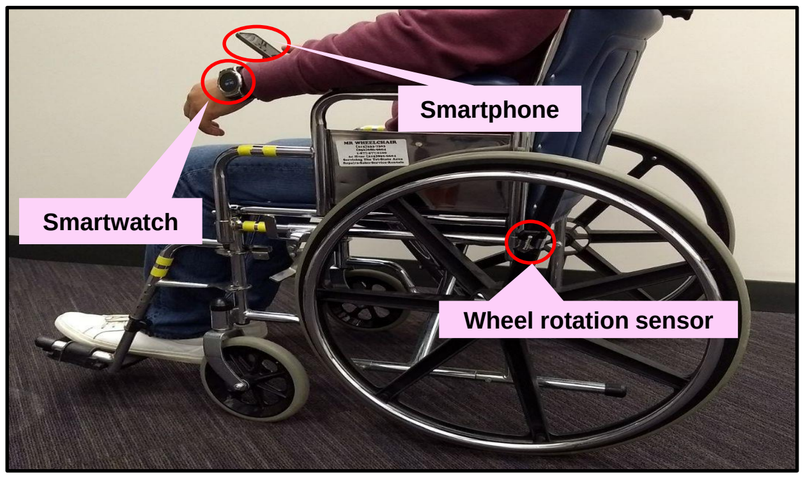



Fig. 1. Device setup for just-in-time adaptive intervention system

A commercial, Bluetooth-based wheel rotation monitor (Panobike) and a wrist worn smartwatch stream data to an Android smartphone.

We are adapting machine learning models to detect wheelchair-based physical activity that we developed in our previous research[3,4].

The smartphone computes **energy expenditure (kCal)** and **distance travelled (miles)** in real time.

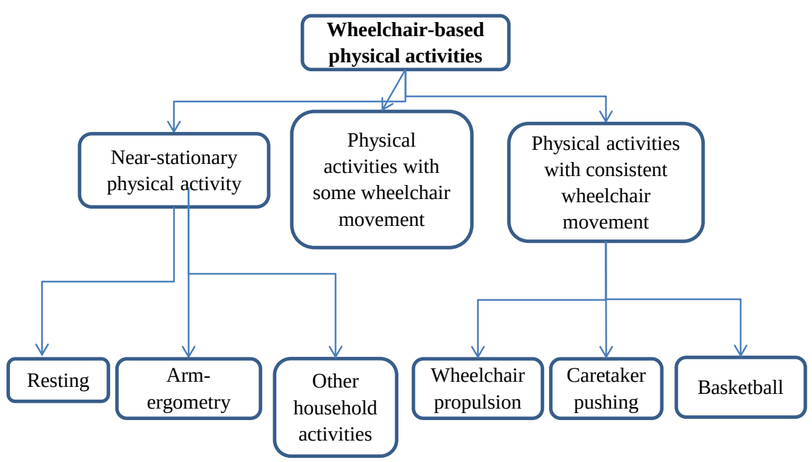



Fig. 2. A two-step process for classifying various wheelchair-based physical activities.

## 3. Data Collection

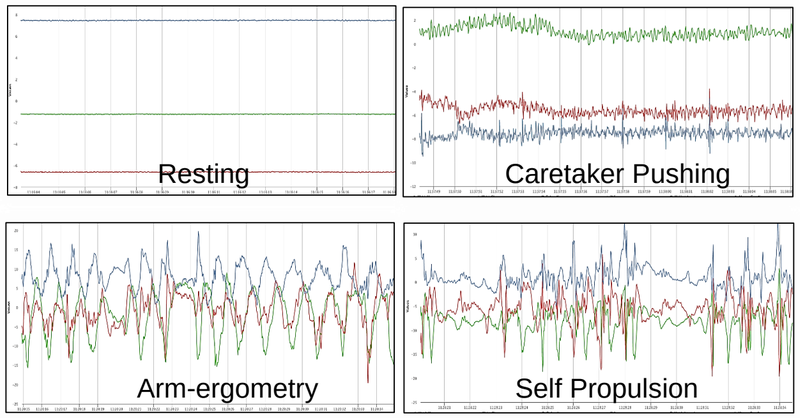



Table 1: Raw accelerometer data from smartwatch for pattern recognition for various physical activities

## 4. Intervention

FIRST MONTH

Physical activity monitoring

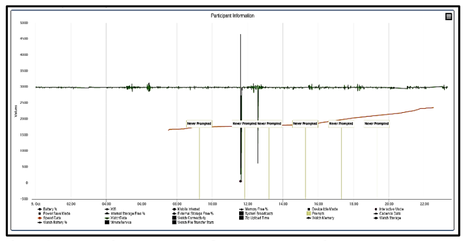
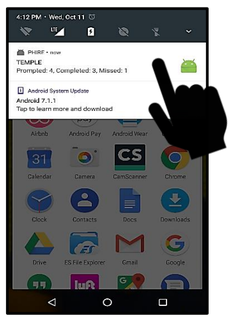


Fig. 3. Desktop app for researchers to monitor participants' activity and compliance

SECOND MONTH



Passive (user-initiated) feedback

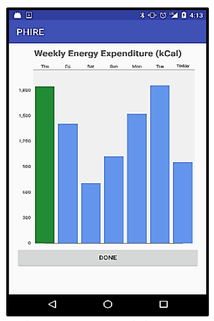



Fig. 4. Participant actively presses app's notification bar

Fig. 5. Weekly energy expenditure summary

THIRD MONTH

Just-in-time (adaptive/ personalized) feedback

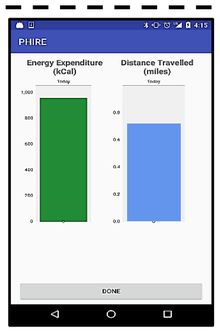




Fig. 6. Watch notification shown to participants while they are physically active

Fig. 7. Real-time energy expenditure and distance

## 5. Results and Conclusions

We have deployed an offline-trained algorithm in **a real-time PA monitoring** system using commercial wearable technologies.

Just-in-time adaptive interface system provides:

- **Passive feedback in the form of daily and weekly summary** of energy expenditure and distance travelled, and
- **Active feedback in the form of watch notifications that are both adaptive and personalized** to individuals while they are physically active.

## 6. Validation study

A pilot test is being conducted in 20 wheelchair users with spinal cord injuries (SCI) in the Philadelphia area.

- Hypothesis 1: **Physical activity (PA) level of individuals with SCI in community settings will be low** (only 20% of the participants will be performing regular PA compared to the PA level recommended for individuals with disabilities in general.
- Hypothesis 2: **PA levels of the participants, when obtaining passive feedback about their PA levels during the second month of the study, will not be significantly different** compared to Month 1 without any intervention.
- Hypothesis 3: **PA levels of the participants will be significantly higher for the third month of the study** (light-level PAs by 25% and moderate-level PAs by 7%) compared to their own Month 1 without any intervention.

## Acknowledgement

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## References

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