



# Wearable Computing for Physical Therapy

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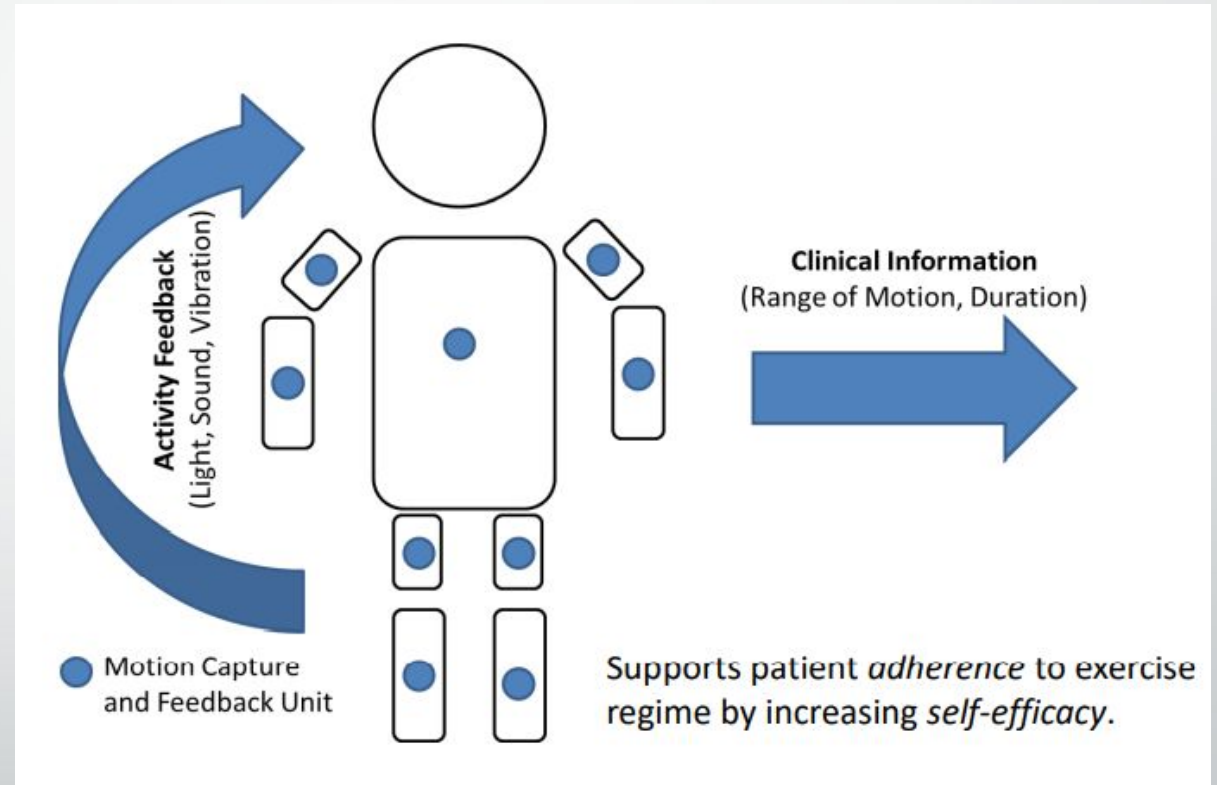
# Current Physical Therapy Concerns

- Your odds of becoming disabled before you retire are about 1 in 3 ([WebMD](#))
- Musculoskeletal conditions are the leading contributor to disability worldwide ([W.H.O.](#))
- [Research shows](#) that only 35% of physical therapy patients fully adhere to their plans of care
  - Forget to conduct exercises
  - Perform at-home exercises incorrectly



# How can we create a wearable computing system to help solve these problems?

- Activity detection
- Patient Feedback
- Physician Feedback



# Our focus: Patient Feedback

- How can a wearable computing system...
  - Guide exercise motions
  - Correct motions
- Types of feedback:
  - Haptic (vibration, force, etc.)
  - Light
  - Video
  - Augmented Reality
  - Virtual reality
  - Multimodal



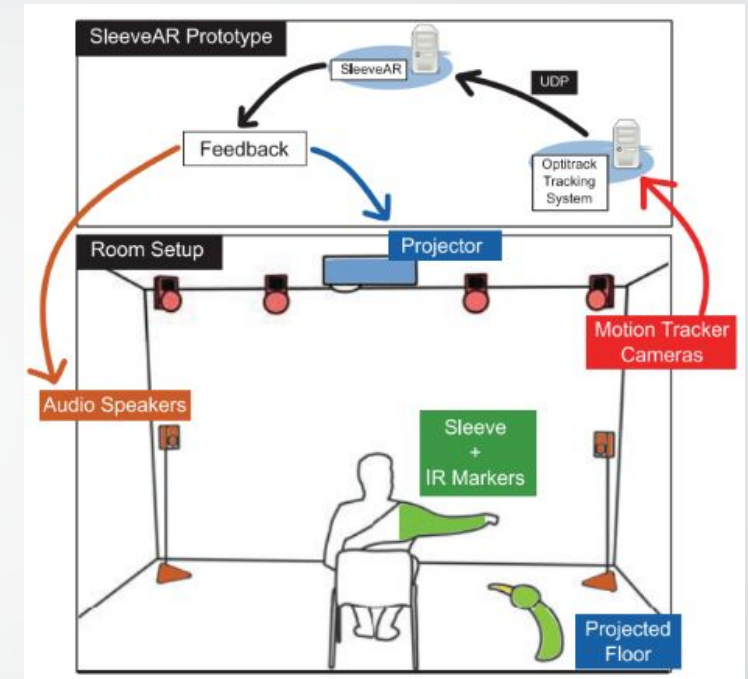
# Relevant Work



SoPhy : Video Feedback



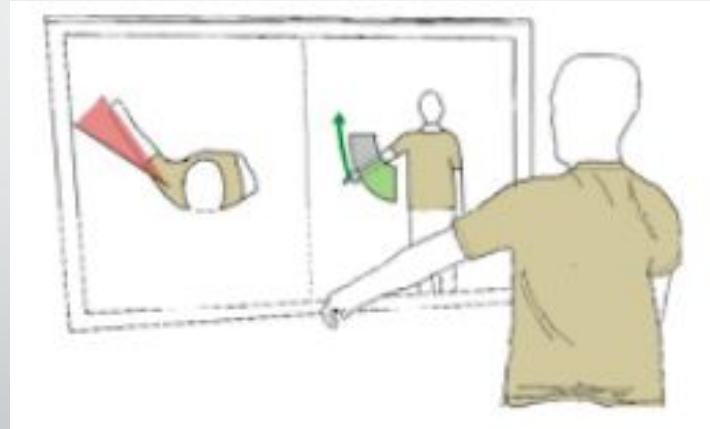
PT Viz : Light Feedback



SleeveAR : Augmented Reality Feedback



Study on Haptic Feedback



Physio@Home : Video Feedback

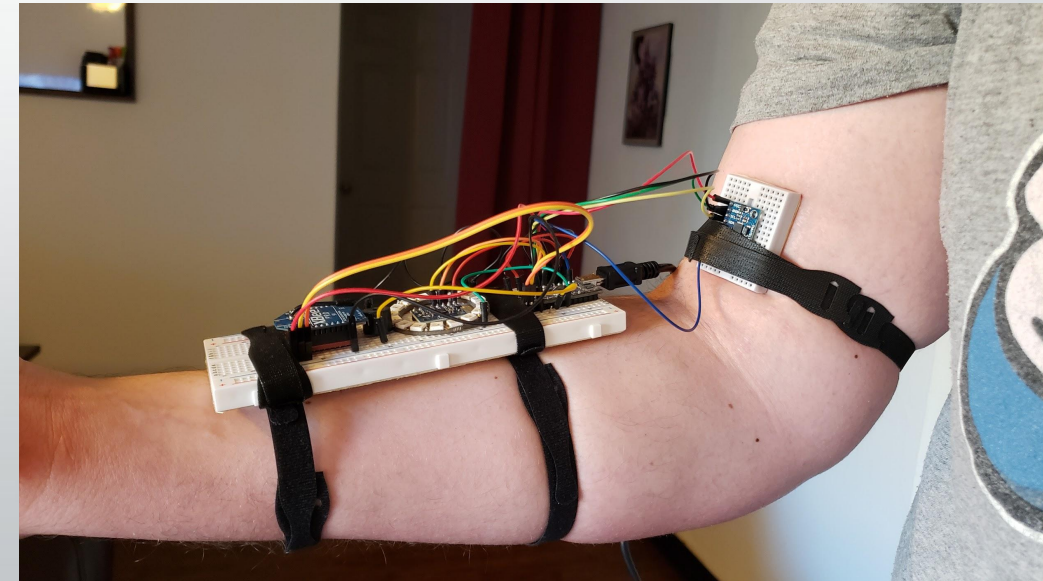
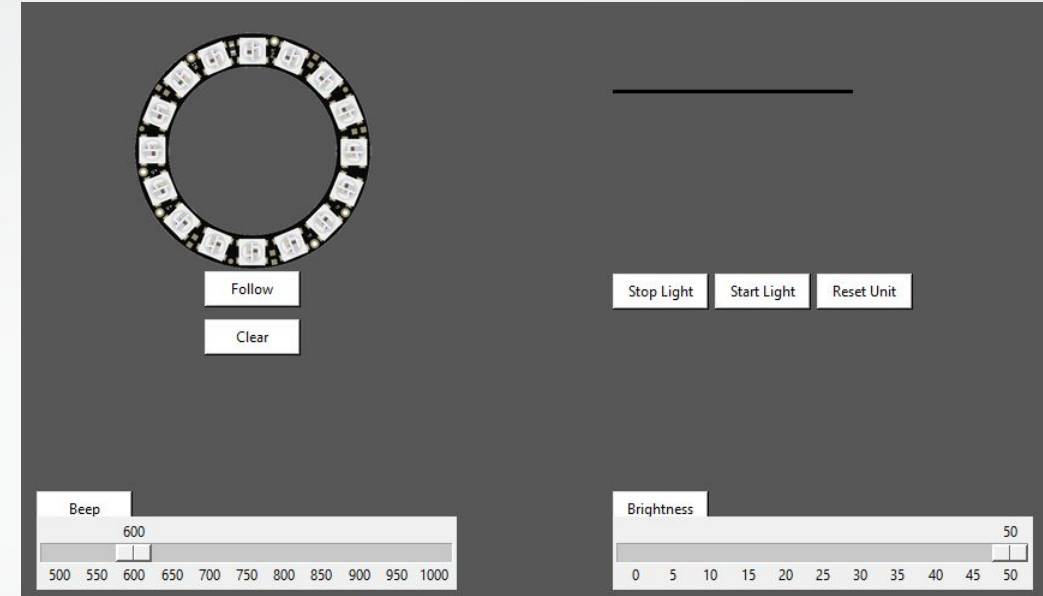
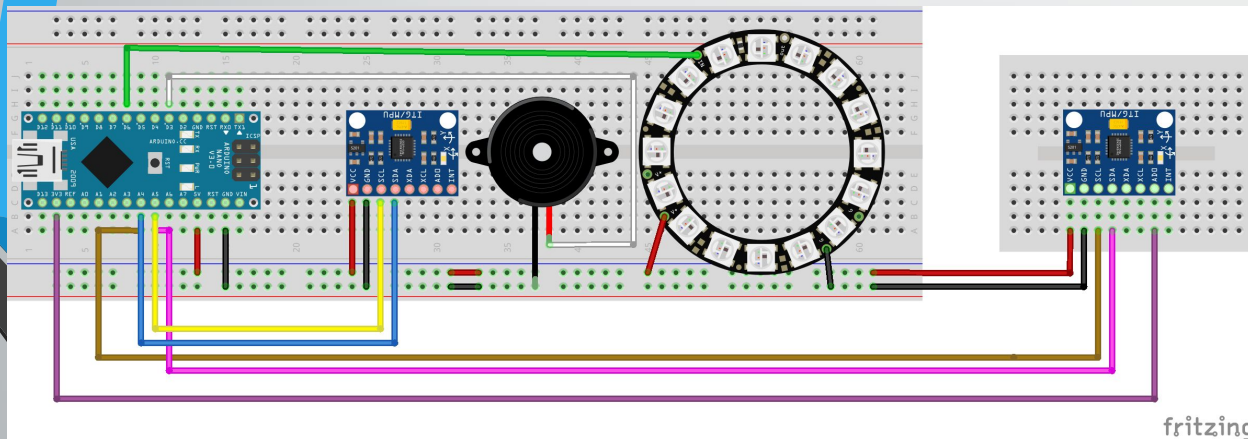
- focused on single limb or exercise routine
- Cannot be easily adapted for at-home use

# Why focus on Light?

- Provides guidance in an interactive and intuitive way
- Allows dynamic means of communicating both positive and negative feedback
- Communicates both direction and magnitude of intended motion

# Light Prototype

- Purpose:
  - Testing different colors, intensities, and positions of light
  - Assessing user interpretation of feedback



# Expected Results From Light

- Positive response to terminal feedback in the form of flashes
- Different preferences on “push” vs “pull” feedback
- General consensus on interpretation of different light colors

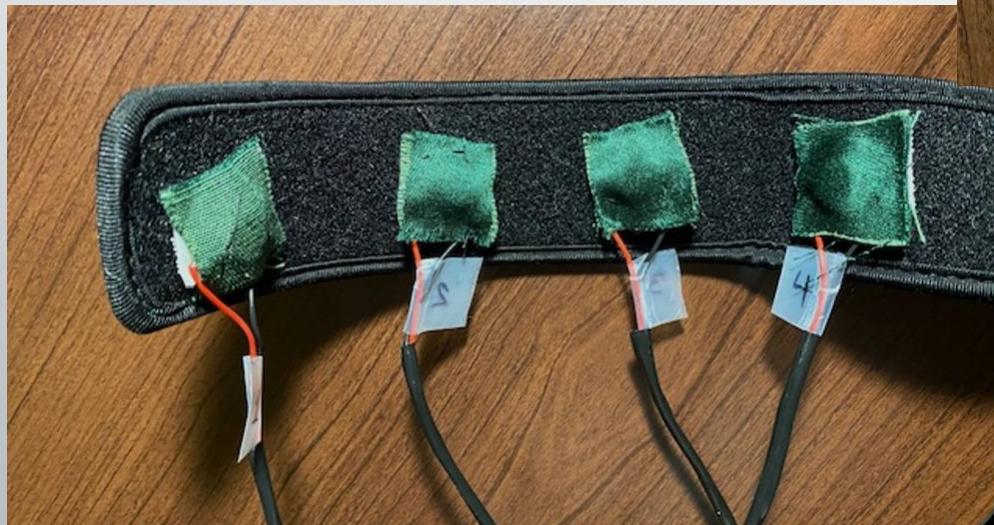
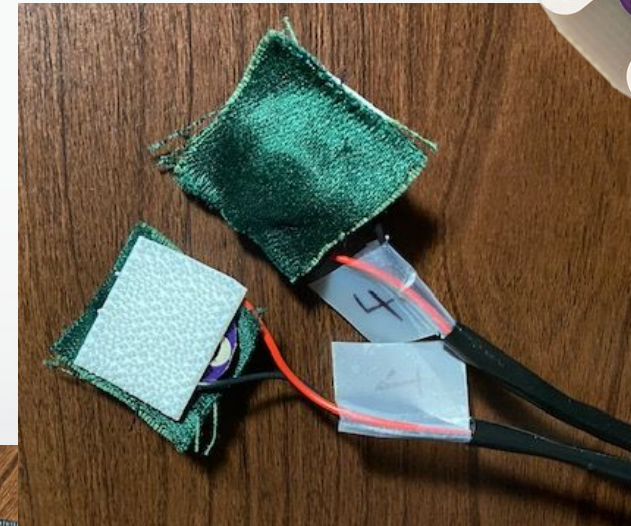
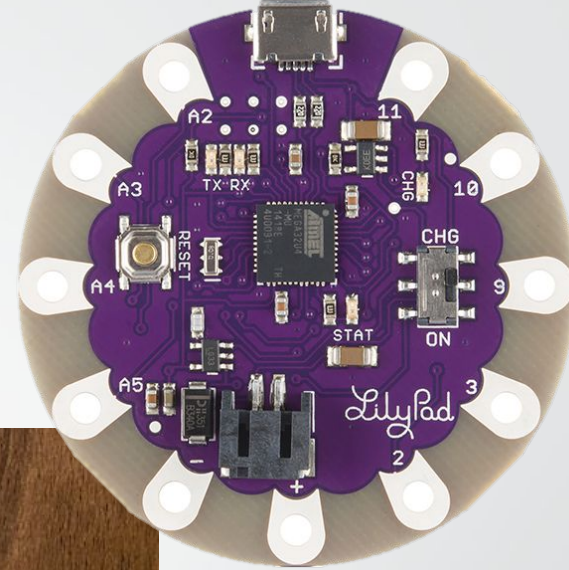
# Why focus on Haptic?

- Mimics the guidance of a Physical therapist
- Notifies errors instead of position control
  - Position control makes patients dependent
- Reinforcement through repetition



# Haptic Prototype

- Purpose:
  - Testing different locations and success of identifying vibrations
  - Testing different types of vibrations



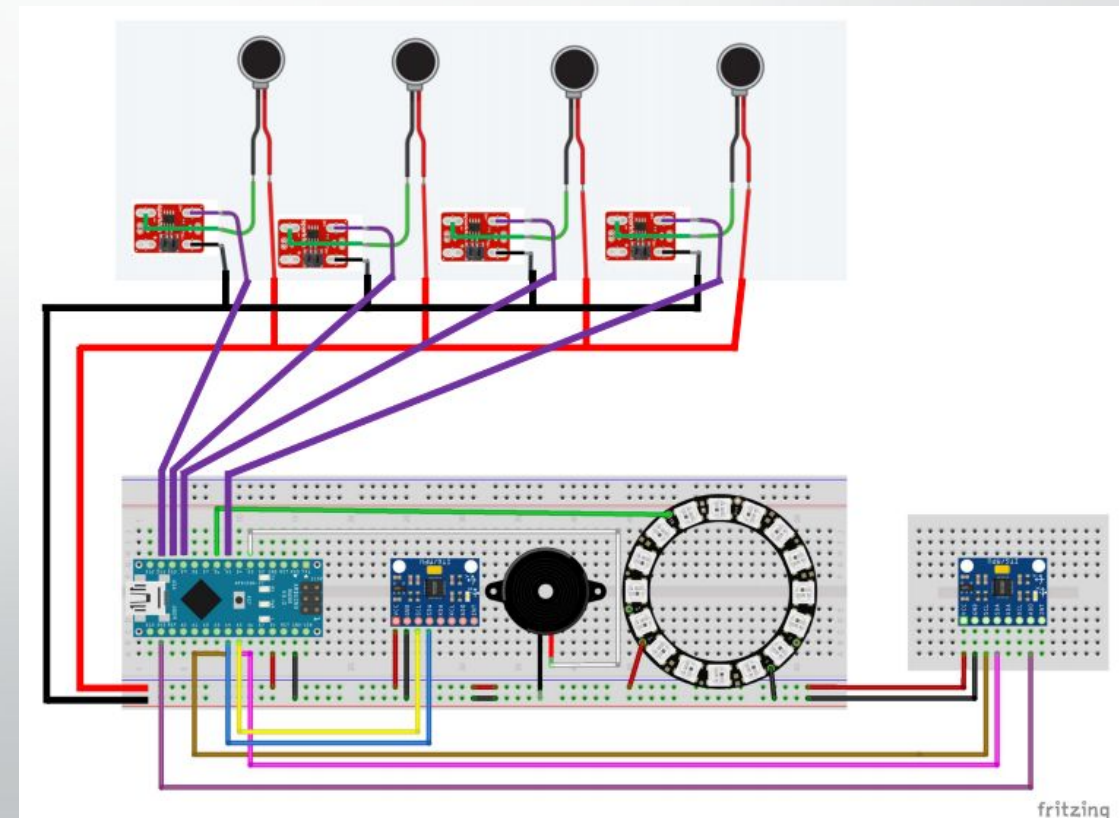
# Results From Haptic

- Small size of Test group
- Most subjects were reliable in identifying motor location
  - Subjects with smaller arms had difficulty identifying motor locations when four motors were used
- Received various feedback on preferred vibration type

|                                | Instant  | Continuous  |
|--------------------------------|--|---|
| How many people preferred it?  | 3  | 5   |
| Reasons why it's better (Pros) | <ul style="list-style-type: none"><li>• didn't have to think as much about the buzzing and could focus more on the curl itself</li><li>• Gets the point across</li></ul>   | <ul style="list-style-type: none"><li>• felt like it guided her better by telling her when to start and when to stop buzzing</li><li>• it continued to guide the subject and it was easy to follow because they knew when to move and when to stop</li><li>• it was clear when he was supposed to stop and he can tell lot better when it's the side buzzer that begins to buzz</li></ul> |
| Reasons why it's worse (Cons)  | <ul style="list-style-type: none"><li>• Instant buzz tells you to move in a certain direction but doesn't tell you how far to move in that direction (e.g. if an instant buzz is signaled from the left then the patient could end up moving too far to the right)</li></ul> | <ul style="list-style-type: none"><li>• "I feel like I'm doing something wrong"</li><li>• With the continuous buzz, she confused the top and the bottom. Felt as if the whole thing is buzzing</li></ul>  |

# Next steps

- Build combined Light and Haptic Feedback Prototype
- Conduct Public Study
- Combine with Activity recognition team





# Questions?

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# References

- <https://www.webmd.com/healthy-aging/features/top-causes-disability#1>
- <https://www.who.int/news-room/fact-sheets/detail/musculoskeletal-conditions>
- <https://pubmed.ncbi.nlm.nih.gov/8234458/>