

Developing an mHealth System for Rehabilitation Using Wearable Sensors and Machine Learning

AI & Public Health

Personalized Public Health Interventions

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Motivation - Lack of PT Accessibility/Adherence

- Following stroke, **over a third** receive no physical therapy and **nearly half** receive no occupational therapy [1].
- In back pain, one major issue is adherence, which can be as **low as 15% to 87%** [2]
- For osteoarthritis therapy, non-compliance is often due to the **difficulty patients face in integrating exercises** into their daily routines [3]
- **Prevalence of smartwatches:** 224.31 million smartwatch users worldwide as of 2024 [4]



- [1] <https://pubmed.ncbi.nlm.nih.gov/27679565/>
[2] <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0276326>
[3] <https://jech.bmj.com/content/55/2/132>
[4] <https://www.demandsage.com/smartwatch-statistics/>

Solution: Personalized Chatbot Nudges from Smartwatch Data!

Step 1: Activity Detection/Metrics Model



Step 2: Input Activity Data to LLM



Step 3: Send Tailored Message to Smartwatch



Case Study: Alice M. (68) – Hip Replacement Recovery

- **Weeks 1-4:** 500-2,000 daily steps using a walker/cane. Focused on mobility, pain management, and strength.
- **Weeks 5-8:** 4,000-5,000 daily steps. Improved endurance and balance, started walking independently indoors.
- **Weeks 9-12:** 7,000-8,000 daily steps. Resumed light activities like gardening.
- **Week 12+:** Achieved 10,000 daily steps, fully independent, returned to favorite activities.



Generated by Stable Diffusion

High-Level Implementation for Alice M. (68)

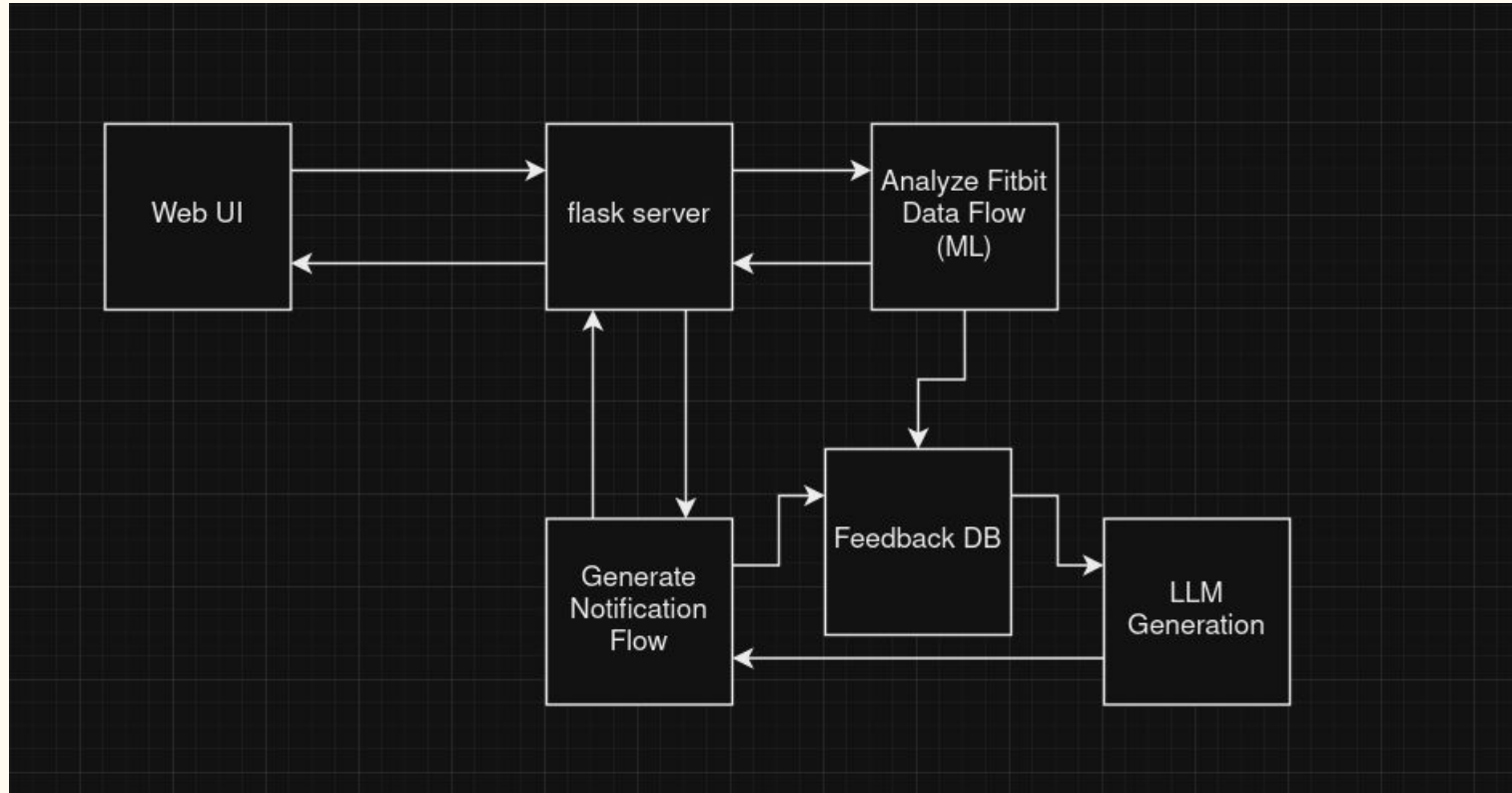
Step 1: How much is she moving? Did she improve from the past week?

Step 2: Input Change in Activity to LLM

Aim 3: Send the most effective encouragement for her movement



Low-Level Implementation

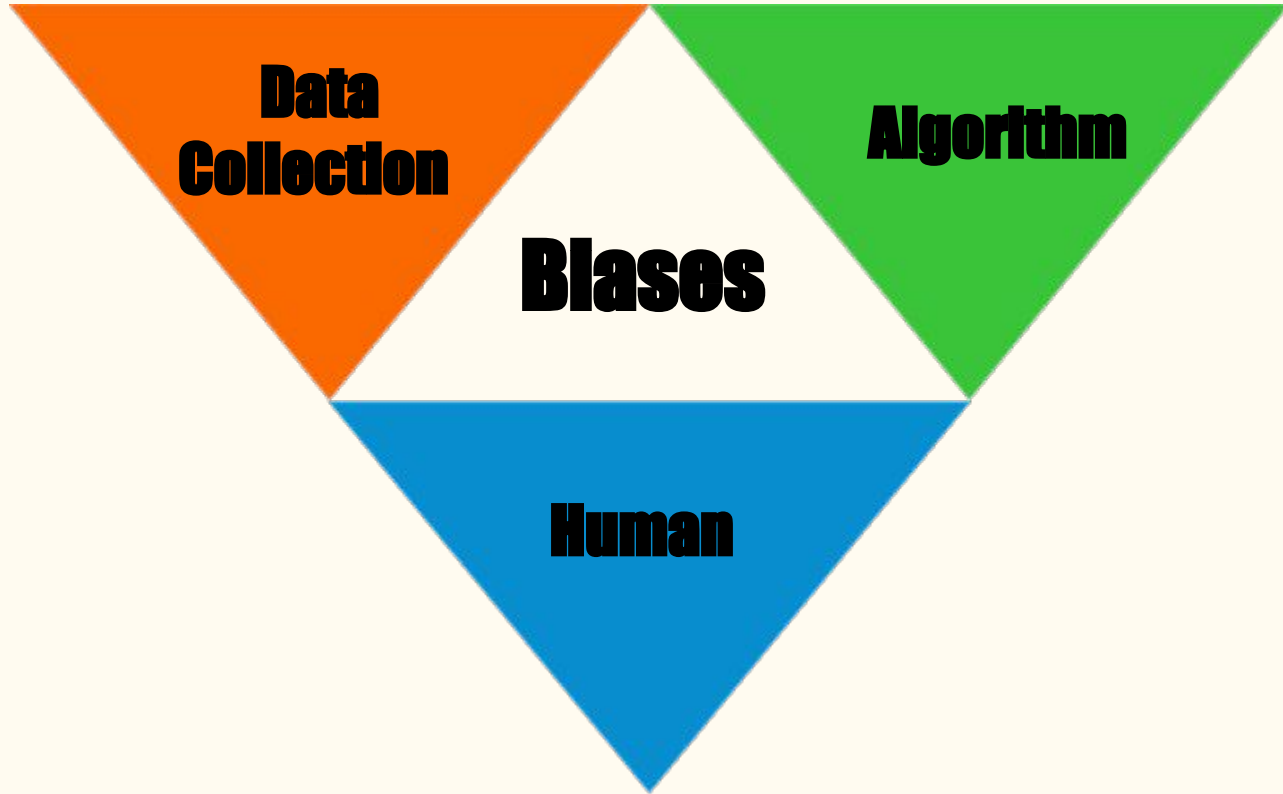


Demo

Ethics

- **Data Concerns**
 - Complying with HIPPA
 - Local solution
- **Accessible Product**
- **AI Safety Concerns**
 - Low function tool
- **Developer Obligations**
 - Post-deployment performance monitoring

Ethics



Scalability and Distribution



- **Cloud-Based Machine Learning**

- Centralized algorithms allow for real-time analysis without the need for high-end local hardware.
- Easy updates and improvements to ML models can be deployed universally.

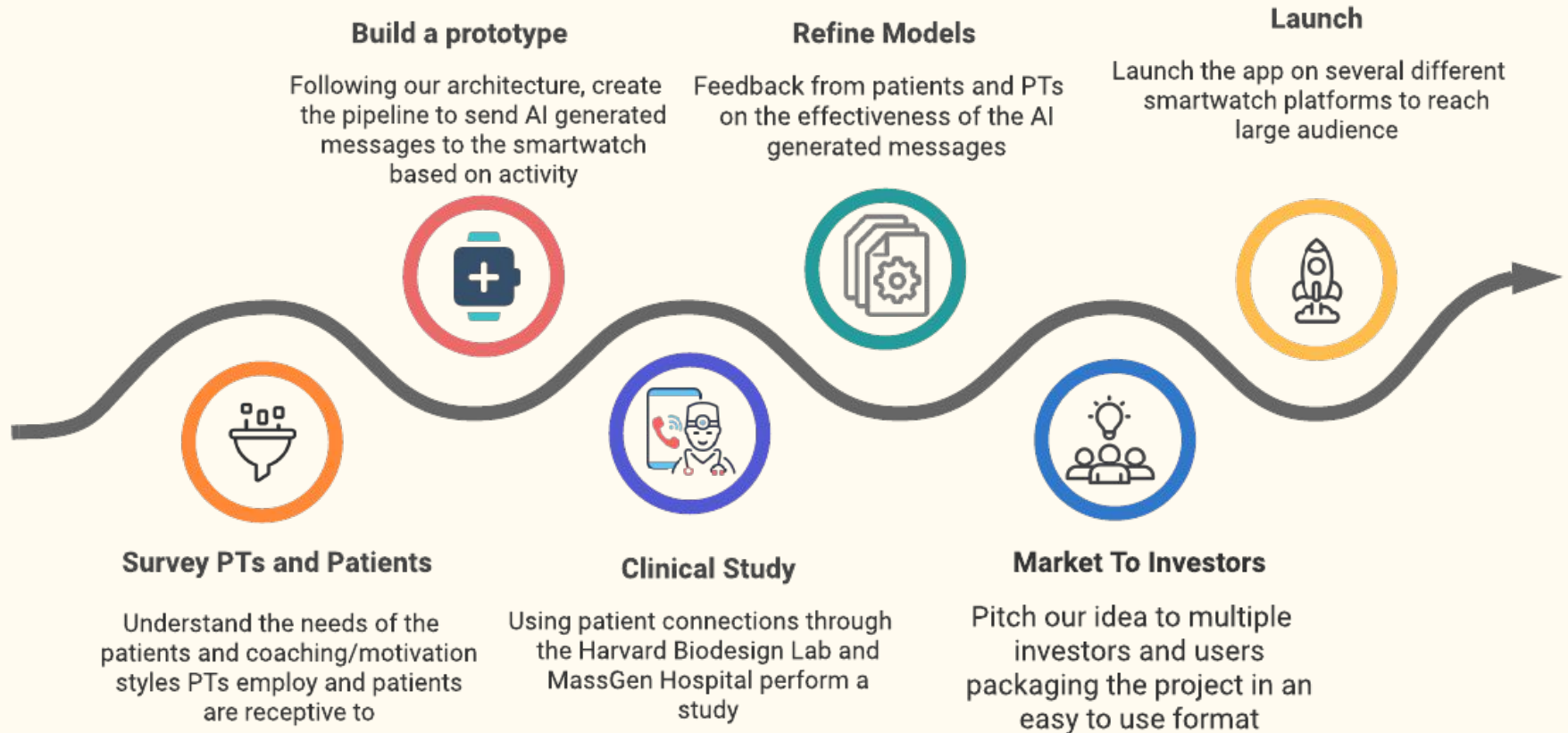
- **Ease of Deployment**

- Smartwatches are increasingly becoming more popular
- Minimal setup required—patients can easily attach a smartwatch
- Can be distributed through app stores and integrated with telehealth services.

- **Benefits for Underserved Communities**

- Scalable to large populations due to low cost and simplicity.
- Remote monitoring reaches patients in rural or low-resource areas.

Implementation Timeline



Gaps in Existing Products

- Exer AI
 - Relies on camera-based devices for tracking exercises—our solution eliminates extra devices by providing tailored feedback through a single smartwatch based on daily activity usage
- Zerapy
 - Requires frequent virtual therapist check-ins—our solution offers fully automated, real-time feedback on everyday activities without the need for therapist involvement
- Sword
 - Focuses primarily on structured physical therapy sessions—our solution tracks spontaneous movements throughout the day, ensuring continuous engagement and arm usage in real-world activities