

Electrical and
Systems Engineering

MOTIONMEND

Personalized, Secure, and Portable Rehab Companion

Team I

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3.5k/day

knee replacement
surgeries in the US

134%

increase in surgeries
in the past decade

3.6M

patients affected
worldwide every year

10.6B

Knee Replacement
Market Valuation

**How many knee
replacement
surgeries
are there per day in
the US?**

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3.5k/day

knee replacement
surgeries in the US in

2024

3x/ week

physical therapy
session in person

>65%

patients do not follow
through their home
exercises

What does post-surgery look like for each patient?



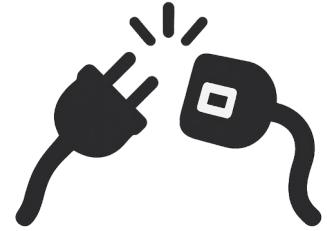
3x/week

sessions per week
after surgery

3 month

patient recovery
period

The Problem



Disconnect between

PT and patient

65 % non-compliance rate

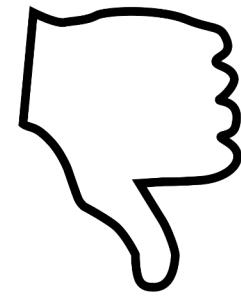
due to:

- Lack of direct feedback
- Inability to track progress



Inaccessibility

- 3x/week visits are infeasible
- Shortage of PT professionals



Current Solutions

Fall short

Camera based systems:

- Raise privacy concerns
- No feedback loop
- High cost



Slower recovery, poorer outcomes, and patient frustration

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Meet the Ecosystem



Intuitive

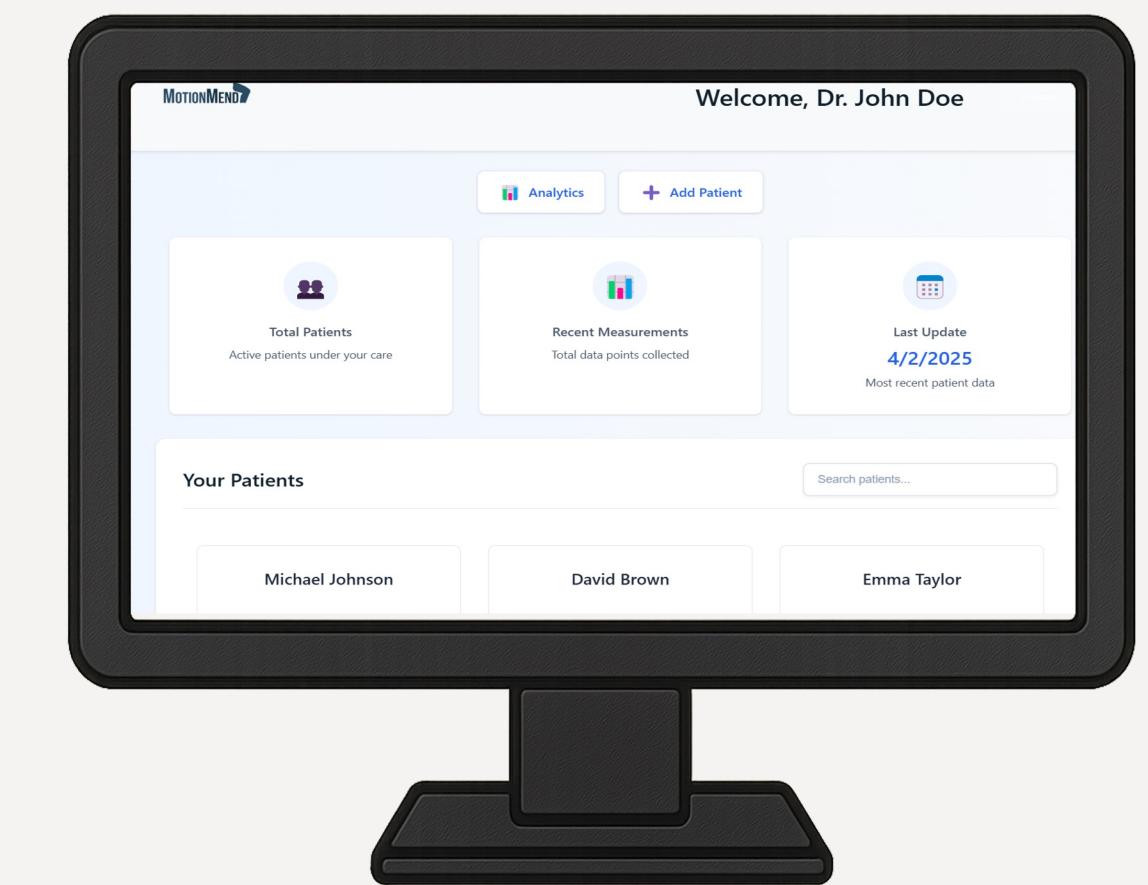
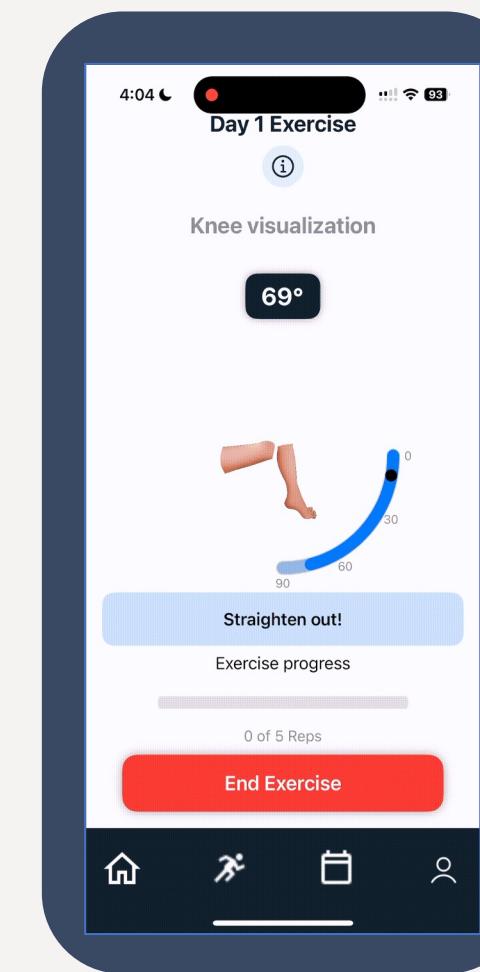
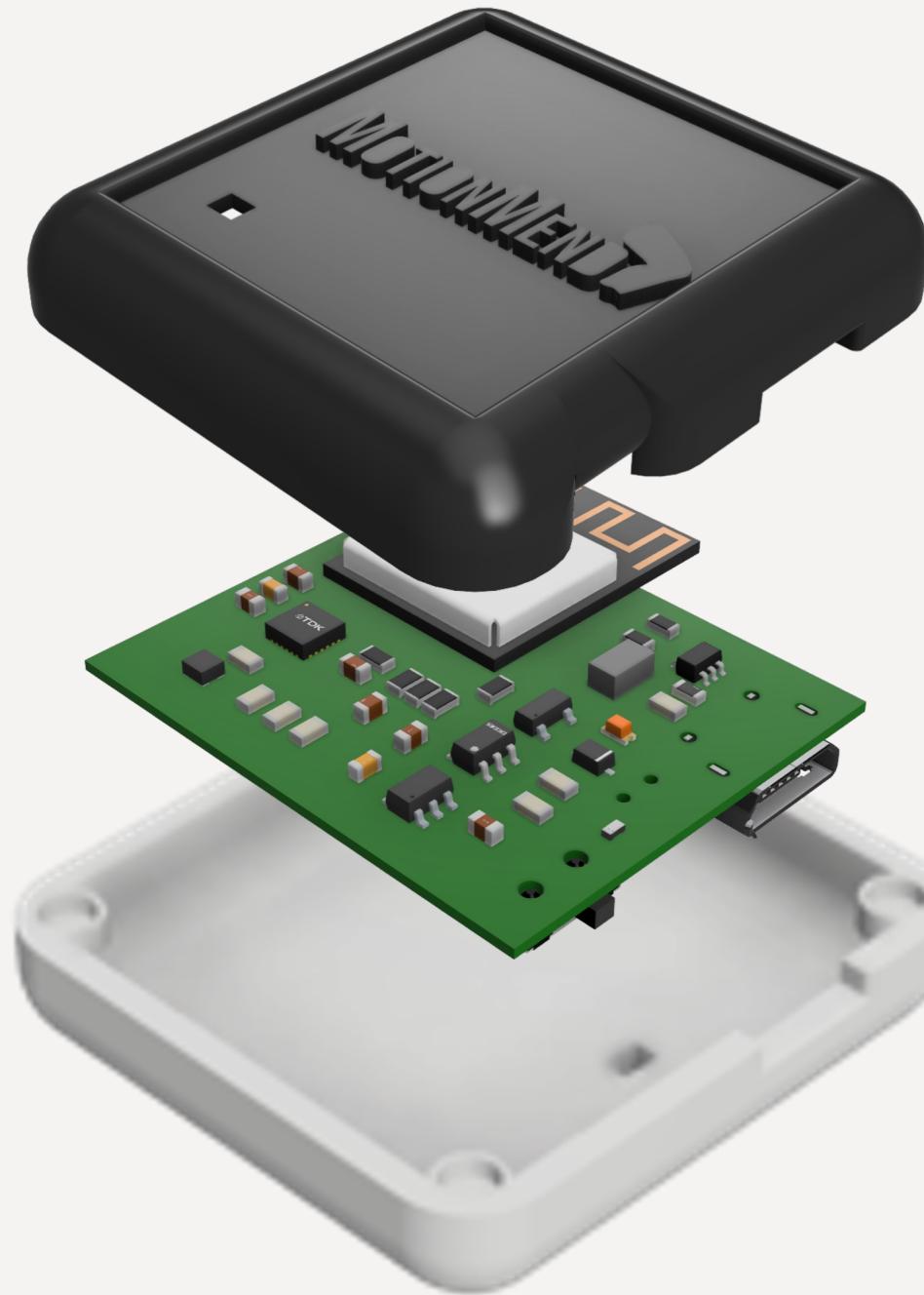
- **Effortless Setup** - Get started in minutes
- **Highly Accurate** - Precision motion tracking
- **Compact & Lightweight** - Designed for comfort

Data-Driven

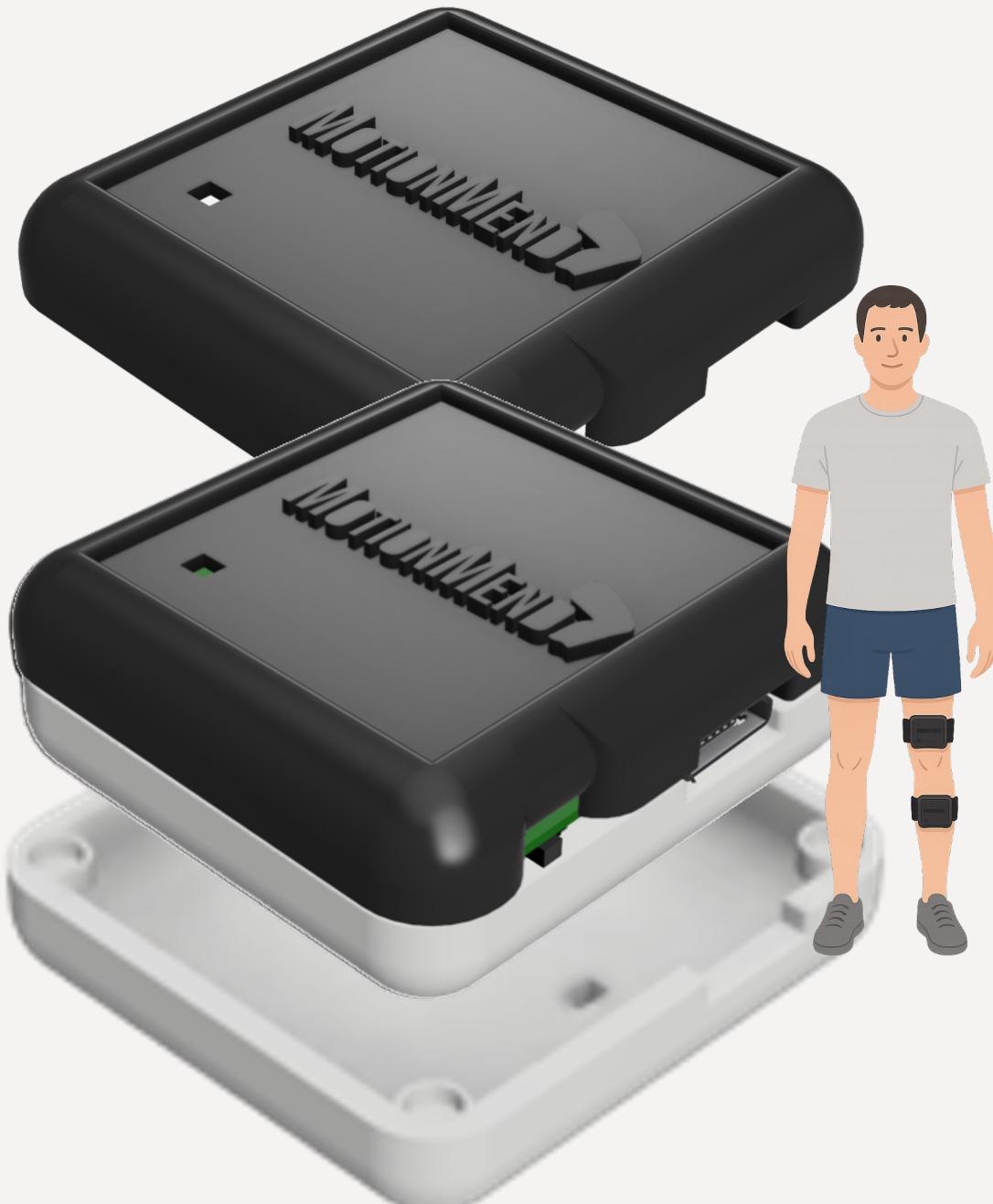
- **Real-Time Feedback** - Track progress and stay motivated
- **User-Friendly Interface** - Simple and intuitive design
- **Physician Analytics** - Track patient progress over time

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Meet the Ecosystem



Solution - Hardware



Modular

- Knee replacement: 2 modules
- Adaptable to different exercises

Custom PCB

- ESP32 C3 Mini
- 9-DoF IMU
- Charger IC & 1 hour battery life
- Indicator lights

Signal Processing & Communication

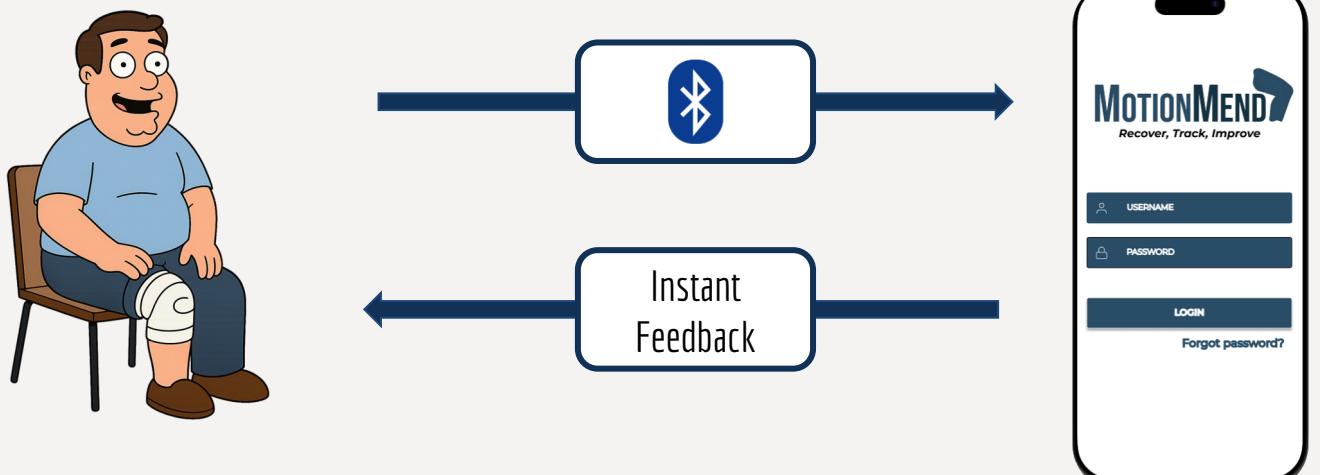
- On-Device Kalman filtering
- Bluetooth Low-Energy protocol

App

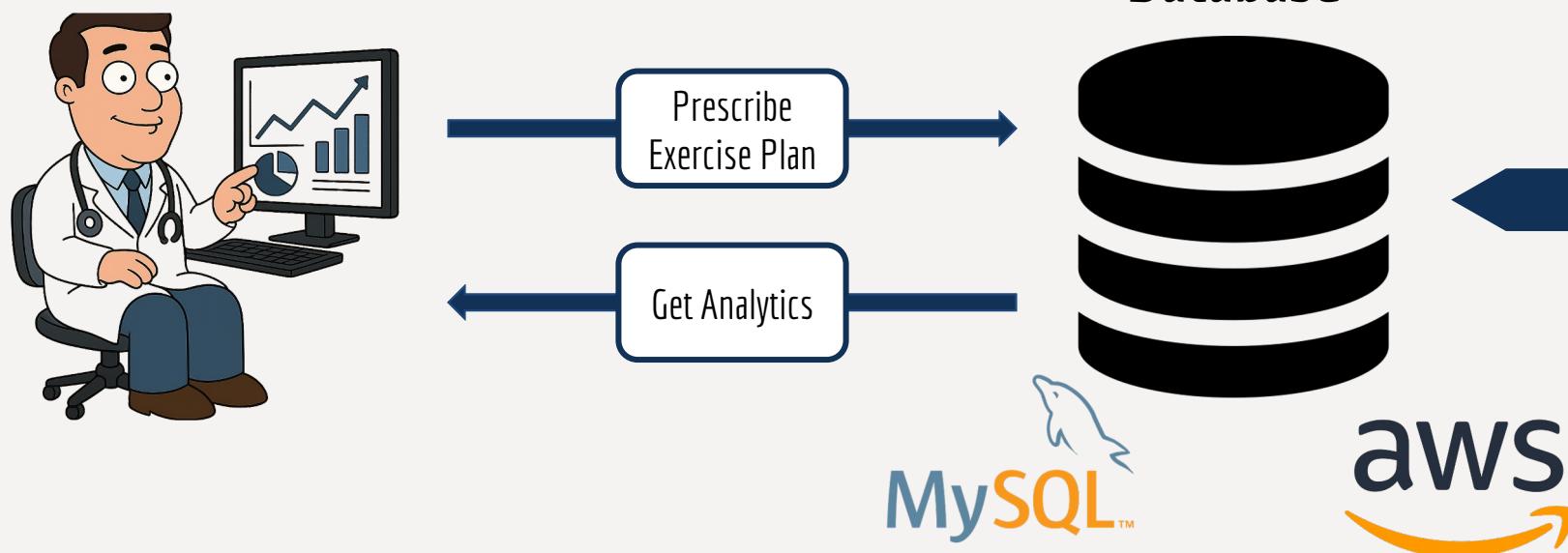
- Collects data from MotionMend modules
- Gives instant feedback
- Uploads to MotionMend database

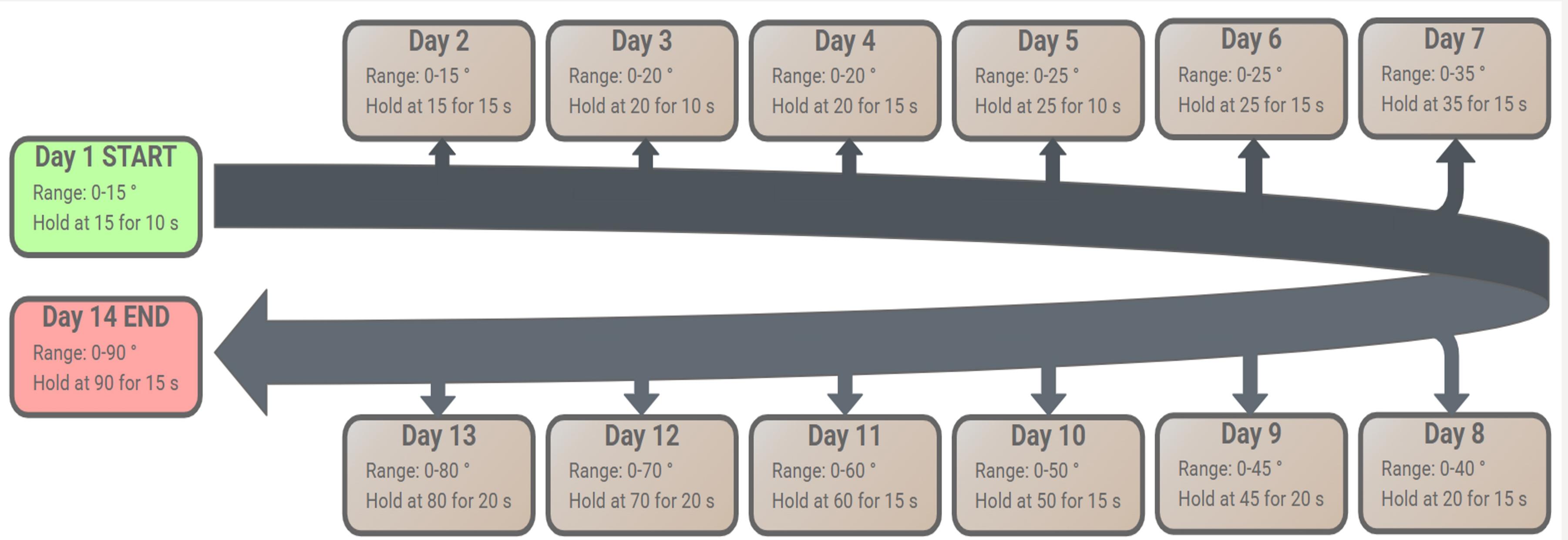
Solution - Software

Patient + Wearable



Doctor + Dashboard





An example of a 14-day plan, prescribable by a physician through MotionMend



1. Patient Info 2. Treatment Plan

Initial Treatment Plan

Starting Angle (degrees)

Max: 90°

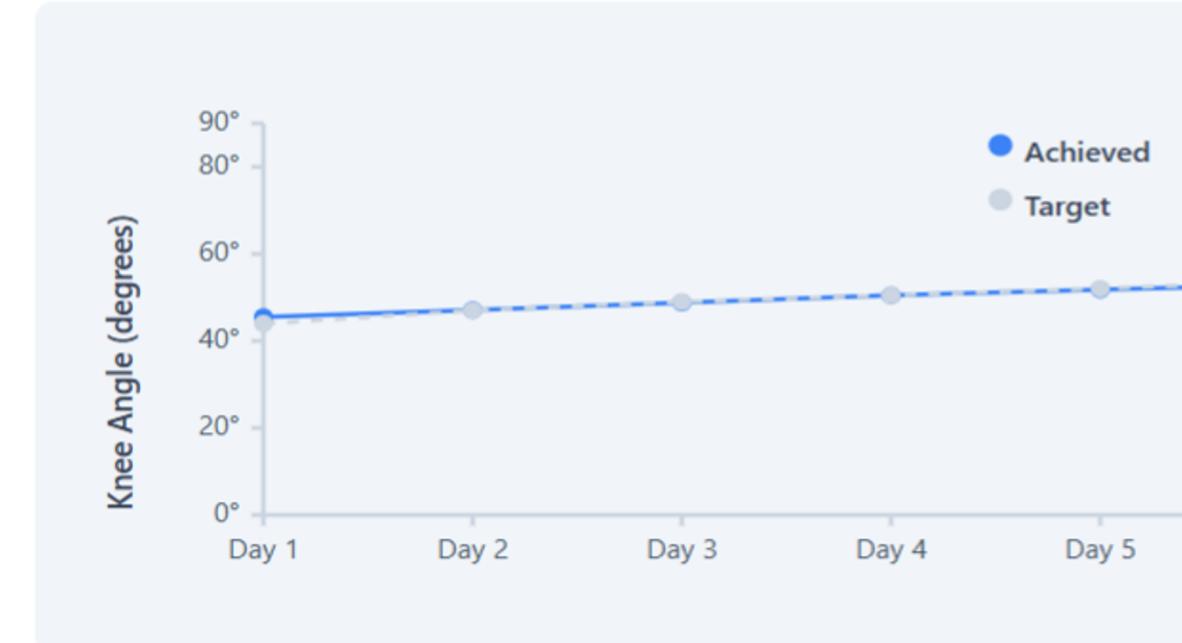
Hold Time (seconds)

Daily Angle Goals

Default progression adds 2° per day. Adjust if needed.

Day 1	Day 2	Day 3	Day 4
45	47	49	51
Day 5	Day 6	Day 7	Day 8
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An example of adding a patient on MotionMend's Dashboard and providing an initial treatment plan

**Emma Taylor****Adjust Plan****Emma Taylor's Angle Progress****Daily Exercise Duration****Emma Taylor's Sessions**

An example of patient progress for angle progression and exercise duration

Adjust Treatment Plan

Hold Time (seconds):

10

Daily Angle Goals (°):

Day 1

44

Day 2

47

Day 3

49

Day 4

50.5

Day 5

52

Day 6

54

Day 7

55

Day 8

57

Day 9

59

Day 10

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Day 11

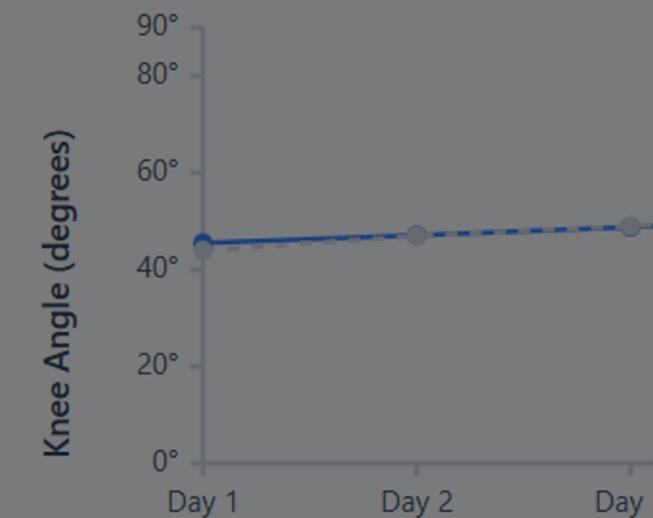
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Day 12

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Adjust Plan

Emma Taylor's Angle Progress



Emma Taylor's Sessions

An example of modifying a patient's treatment plan

Engineering Standards

HIPAA

Ensures that patient data is stored, transmitted, and processed securely and with strict privacy controls.

FDA SiMD

Outlines requirements for software that operates as part of a medical device.

IEEE 802.15.1

Covers the specifications for Bluetooth and, by extension, Bluetooth Low Energy (BLE) communication

Apple App Store

These guidelines ensure that the mobile app, as the user interface for the device, meets strict usability, privacy, and security standards, which is important for both patient and provider trust.

UL 2054

Provides guidelines for the safety and certification of lithium-ion batteries.

IEC 60601

Focuses on the safety and performance of medical electrical equipment. Compliance ensures that the hardware aspects of your device meet international safety standards.

Ethical Concerns



Privacy

Privacy is a requirement in the healthcare field. We kept this in mind while storing and transmitting data.



Cost-Effective

Our devices are low cost which ensure lower costs to patients and providers.



Accessibility

All patients should be able to use the device to assist them in their recovery

Thank you for your time and for everyone who has helped us!



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