



Project 13: Wearable Sensing

Project Sponsor: Professor
Reinkensmeyer

Graduate Advisor: Shusuke Okita

Undergraduate Team: Nicholas Gurnard,
Colin Nisbet, Xianling Yan, Philip Park,
Zachary Montoya

Team Objective

- Freedom to continue rehab wherever/whenever
- Provide a motivational wearable sensing device to encourage consistent workouts
 - Current population: Stroke patients
- Analyze *quality* of exercises, not just quantity





Problem Statement: Original Stroke Rehab Device

What Went Wrong

- Did not increase patient exercise activity
- Limited or no feedback on exercise
 - Exercise done correctly or not?
 - Progress made or not?
- Only one arm movement exercise
- The device itself was very basic

How to Fix

- New sensors will be integrated as an application for a smartwatch
- Make the app more interactive (visuals & graphics)
- Ensure patient understands the exercises
- Track movement quality of multiple arm exercises
- Ensure a user-friendly interface



Features to Implement in New App

- Movement Quality Tracking (Colin Nisbet/Nick Gurnard)
- Easy-to-Use User Interface (Xianling Yan)
- Multiple Workout Exercises (Philip Park)
- Additional Features to Motivate the user (Zachary Montoya)

Timeline

	Planned		Actual		Week 1							Week 2							Week 3							Week 4							Week 5						
	Start	End	Start	End	S	M	Tu	W	Th	F	S	S	M	Tu	W	Th	F	S	S	M	Tu	W	Th	F	S	S	M	Tu	W	Th	F	S	S	M	Tu	W	Th	F	S
BrillAnt																																							
Wearable Sensing (Team 13)																																							
Fall																																							
Research																																							
Rehab Motivation	6-Oct	22-Oct																																					
Stroke Rehabilitation	6-Oct	22-Oct																																					
Movement Sensing	13-Oct	27-Oct																																					
Stroke Rehab Exercises / Workouts	20-Oct	27-Oct																																					
Preliminary App Design																																							
Select Smartwatch Platform	6-Oct	20-Oct																																					
Prepare List of Features to Implement	13-Oct	20-Oct																																					
App Logic Flowchart	27-Oct	3-Nov																																					
Screen Interface Visual Draft	27-Oct	3-Nov																																					
Initialize Github Repo	23-Oct	27-Oct																																					
Learn Data Processing	24-Nov	8-Dec																																					
App Development Research																																							
Prepare Coding Skills in Relevant Language	27-Oct	15-Dec																																					
Get Familiarized with Fitbit SDK	27-Oct	15-Dec																																					
Learn App Development Process	3-Nov	15-Dec																																					
Hardware																																							
Order smartwatch	20-Oct	3-Nov																																					
Start App Development																																							
Code Basic Interface	3-Nov	24-Nov																																					
Code First program	24-Nov	15-Dec																																					

Timeline

BrillAnt Wearable Sensing (Team 13)	Week 5							Week 6							Week 7							Week 8							Week 9							Week 10							Finals Week									
	S	M	Tu	W	Th	F	S	S	M	Tu	W	Th	F	S	S	M	Tu	W	Th	F	S	S	M	Tu	W	Th	F	S	S	M	Tu	W	Th	F	S	S	M	Tu	W	Th	F	S	S	M	Tu	W	Th	F	S			
Fall																																																				
Research																																																				
Rehab Motivation																																																				
Stroke Rehabilitation																																																				
Movement Sensing																																																				
Stroke Rehab Exercises / Workouts																																																				
Preliminary App Design																																																				
Select Smartwatch Platform																																																				
Prepare List of Features to Implement																																																				
App Logic Flowchart																																																				
Screen Interface Visual Draft																																																				
Initialize Github Repo																																																				
Learn Data Processing																																																				
App Development Research																																																				
Prepare Coding Skills in Relevant Language																																																				
Get Familiarized with Fitbit SDK																																																				
Learn App Development Process																																																				
Hardware																																																				
Order smartwatch																																																				
Start App Development																																																				
Code Basic Interface																																																				
Code First program																																																				

Smartwatch Platform

Selection	A	B
Criteria	Fitbit (Versa 3)	Apple Watch (Series 6)
Battery Life	+	-
Price	+	-
Development Kit	-	+
Open Source	+	-
Development Ease	+	-
Temperature Sensor	+	0
OS Compability	+	-
Pluses	6	1
Minuses	1	5
Sames	0	1
Net	5	-4
Rank	1	2
Continue	Yes	No



Research: What Science Says

- All rehabilitation research points to the same few points:
 - Ensure the patient understands *how* and *why* to do the workout they are assigned
 - Make the barrier for entry low, so it doesn't feel unachievable
 - Only highlight the *positives* from their statistics.
 - Do not compare with other patients
 - Visual motivators create a more motivating process
 - The visuals must be kept as simple as possible. Research shows too much is overwhelming
 - Visuals must not be simple to the point of little information displayed
 - Patients must feel independent

[1] - Qualitative analysis of stroke patients' motivation for rehabilitation (*Maclean*)

[2] - A Robust and Sensitive Metric for Quantifying Movement Smoothness (*Sivakumar*)

[3] - Design strategies to improve patient motivation during robot-aided rehabilitation (*Colombo*)

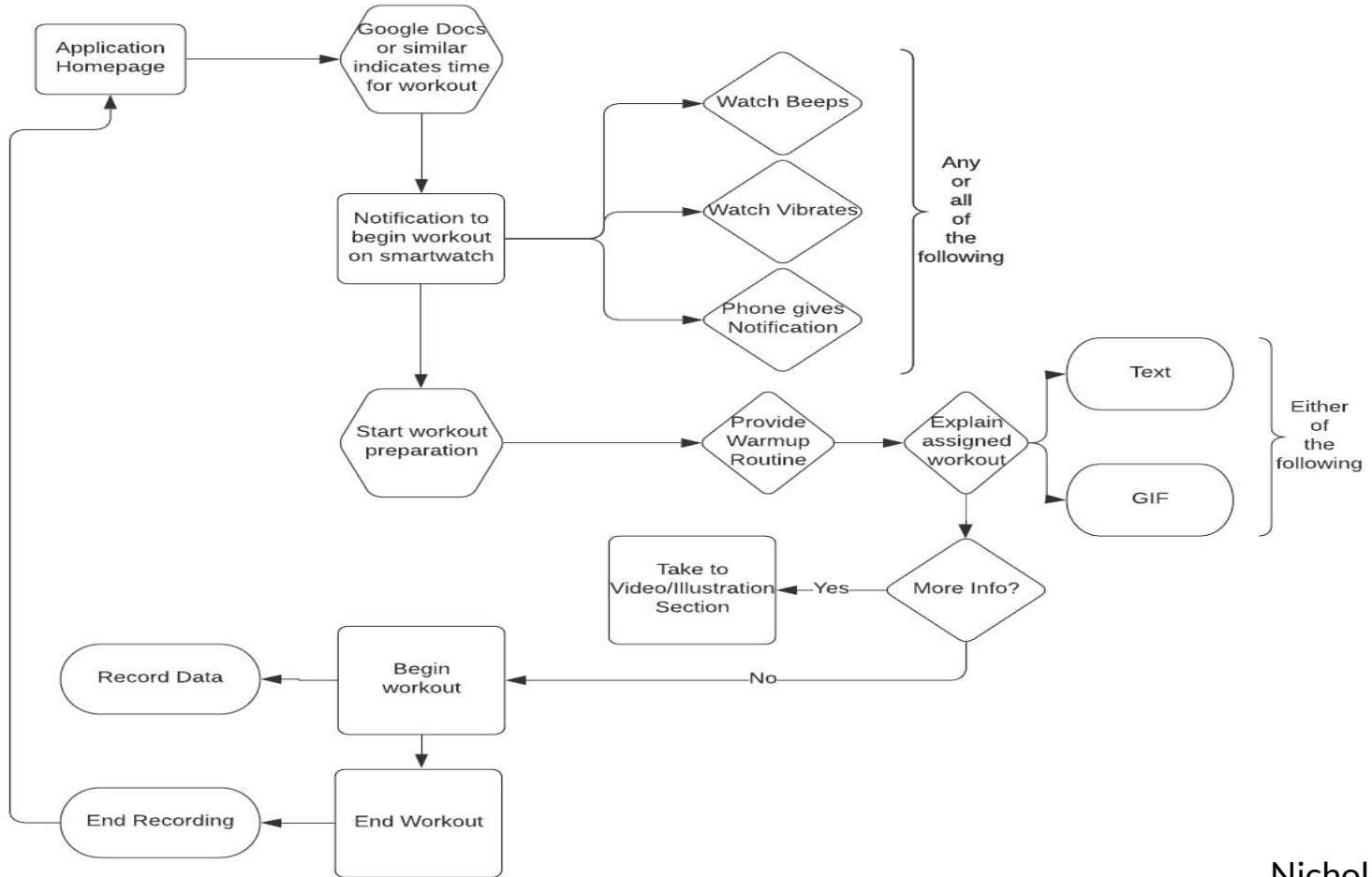
[4] - Design Strategies to Improve Patient Motivation during Robot-Aided Rehabilitation (*Krebs*)



How to Implement the Science

- Visual motivators can be kept in the companion app
 - The companion app should be where most of the heavy lifting lies so the patient doesn't feel dependent on their watch
- The barrier for entry must be low, so a level progression system would keep patients motivated
- A section in the companion app can be dedicated to videos of professionals (or us)
- No leaderboard

Smartwatch App Logic



Workout Screen Interface

Notification to
Begin Workout



Warmup
Routine



Display
Assigned
Workout



Begin Workout



Workout Screen Interface

Record Data &
Provide
Motivation



Repetition
Counter



Ending the
Workout



Update
Clockface





Verification

- Made contact with stroke patient
 - Interviewed and received feedback on concepts
 - Designing the project for stroke patient as end user



Resources Needed

- Contact with Fitbit developers/expert
 - Fitbit Discord
- Guidance on programming languages
- Contact more stroke patients and rehab therapists

Thank You!

