Pacemaker

Team 7

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Main Problem

Problem

“Running is difficult”

- ➔ Hard to maintain a consistent, “healthy” pace throughout a run
- ➔ Easy to lose motivation

Target Users

- People who want to lose weight by running
- Professional runners who want to beat their record times

Overview: Pacemaker

1. **Pace Detection** and Adjustment Service

1. **Feedback System** for Real-Time Personalized Pace

1. **Gamification Features** for Increased Motivation

Key Solution

Sensor data

Step counter
Accelerometer
Heart rate measurement
GPS

Pace Classification

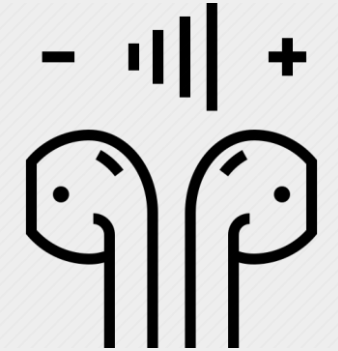
Slow

Normal

Fast

Classify user's pace into three phases

Real-time Feedback



Earphone volume adjustment
TTS(Text-To-Speech)
Vibration

Existing Solutions

Pros:

- Keeps track of running pace
- Provides voice-assisted coaching
- GPS-based tracking
- Provides running statistics

Cons:

- Feedback is given **after** the exercise
  - No real-time feedback
- Pace is not personalized during the run

Usage Scenario

- **Assumption**
  - Outdoor running scenario
  - A user (runner) w/ mobile & wearable devices (smartphone, smart watch, ear buds, etc.)
  - There exists pre-defined objective about pace
    - ex. 30 min. for 5 km
    - ex. 120~150 bps

- **Pacemaker operation**
  - Provide instantaneous information about running condition
  - Give feedback to the user so that it could help maintaining desired pace
  - Increase motivation by gamification

Specifications

- We have to use sensors to accurately measure the user's speed
- Ideally, we want instantaneous speeds, not average speeds
- Three possible ways
  - **Step counter**
    - Assume person's stride and calculate the speed
    - Speed = Step counts * stride / elapsed time
    - Not an instantaneous speed, highly dependent on strides
  - Accelerometer
    - Use acceleration to compute the speed

$$\vec{v}(t) = \vec{v}(t = t_i) + \sum_{t_i \leq t_j < t} \vec{a}(t_j)(t_{j+1} - t_j)$$

    - Need to check the accuracy
  - GPS
    - Included in Android GPS functionality
    - Speed = Distance / elapsed time, based on the coordinates from GPS
    - Not an instantaneous speed

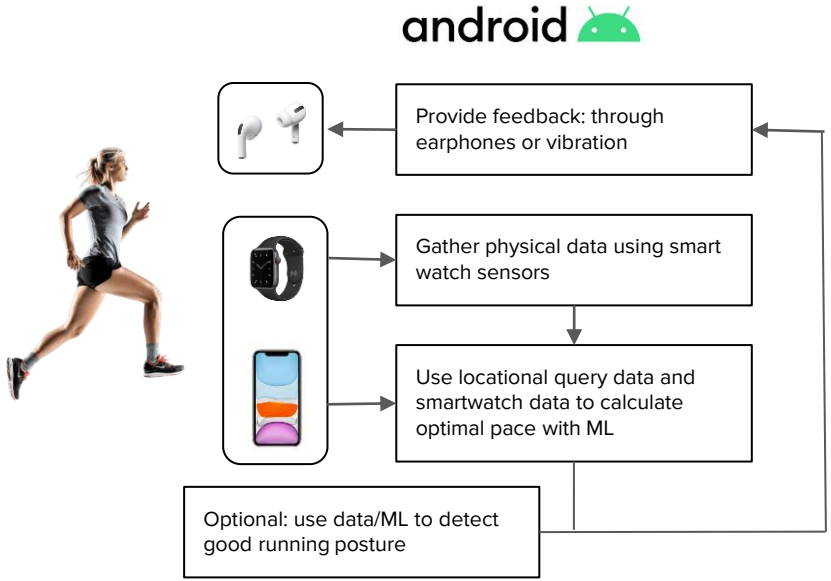
System Overview

Smartwatch Application (*Samsung Galaxy S20*)

- ➔ Records geological and physical information
  - ◆ Sends information to smartphone
- ➔ Provides real-time feedback

Smartphone Application (*Galaxy Watch 4)*

- ➔ Calculates optimal pace based on information
- ➔ Uses ML/DL for good running posture detection



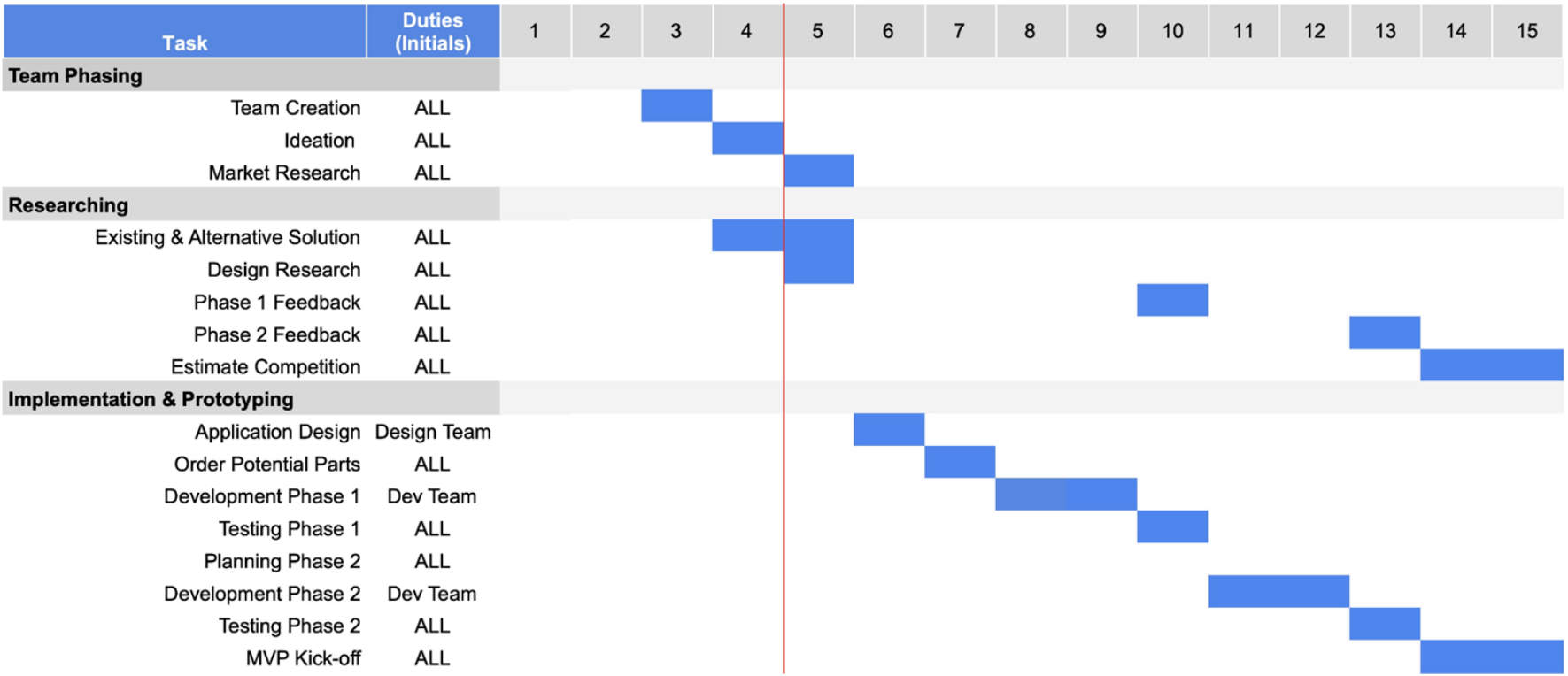
Challenges

Age in years	Target heart rate (bpm)	Maximum heart rate (bpm)
20	100–170	200
30	95–162	190
35	93–157	185
40	90–153	180
45	88–149	175
50	85–145	170
60	80–136	160

- Lack of knowledge in fitness
  - Hard to determine “optimal” pace for individual
  - Lack of data to train deep neural network model
  - https://www.healthline.com/health/running-heart-rate#ideal-rate

- Technical difficulties
  - Real-time measurement of the user’s speed using GPS is not so accurate
  - Jogging causes a lot of movements to the phone, so if we use IMU sensors, filtering such vibrations can be difficult
    - We will first implement the application with step counter, so we can come back to this problem later if step counter method fails

Planning

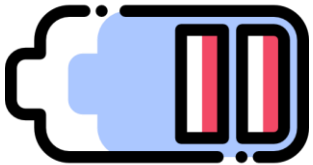


Task	Duties (Initials)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Team Phasing																
Team Creation	ALL															
Ideation	ALL															
Market Research	ALL															
Researching																
Existing & Alternative Solution	ALL															
Design Research	ALL															
Phase 1 Feedback	ALL															
Phase 2 Feedback	ALL															
Estimate Competition	ALL															
Implementation & Prototyping																
Application Design	Design Team															
Order Potential Parts	ALL															
Development Phase 1	Dev Team															
Testing Phase 1	ALL															
Planning Phase 2	ALL															
Development Phase 2	Dev Team															
Testing Phase 2	ALL															
MVP Kick-off	ALL															

Evaluation Strategy & Success Criteria

- **Success criteria**
  - Can the mobile application provide reasonable guides quickly?
    - Notify user when the pace changes
    - Provide “reasonable” guides
  - Requirements
    - It should not interfere with other applications (e.g. messenger, music player)
    - It should provide feedback promptly
    - It should consume small amount of battery (comparable to music player application..?)





Task Designation

Task Designation	
Mobile App (watch & phone)	길광연, 송재헌
UI/UX	이상민
Model Training & Algorithms	김영석, 손성욱

Thank You

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Q & A