

Pacemaker

Team 7

Table of Contents

- Main Problem
- Overview: Pacemaker
- Key Solution
- Existing Solutions
- Usage Scenario
- System Overview
- Specifications
- Challenges
- Planning
- Evaluation Strategy & Success Criteria
- Task Designation

Main Problem

Problem

“Running is difficult”

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

Target Users

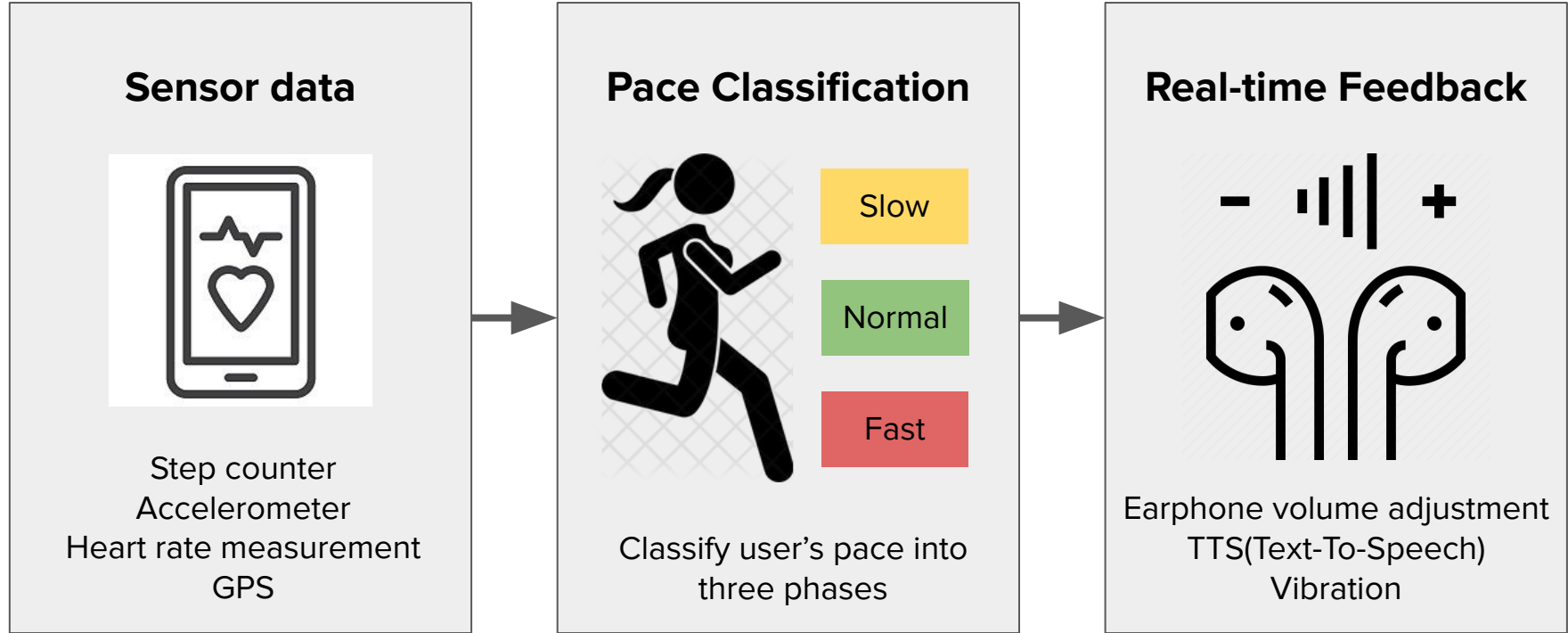
- People who want to lose weight by running
- Professional runners who want to beat their record times



Overview: Pacemaker

1. **Pace Detection** and Adjustment Service
2. **Feedback System** for Real-Time Personalized Pace
3. **Gamification Features** for Increased Motivation

Key Solution



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



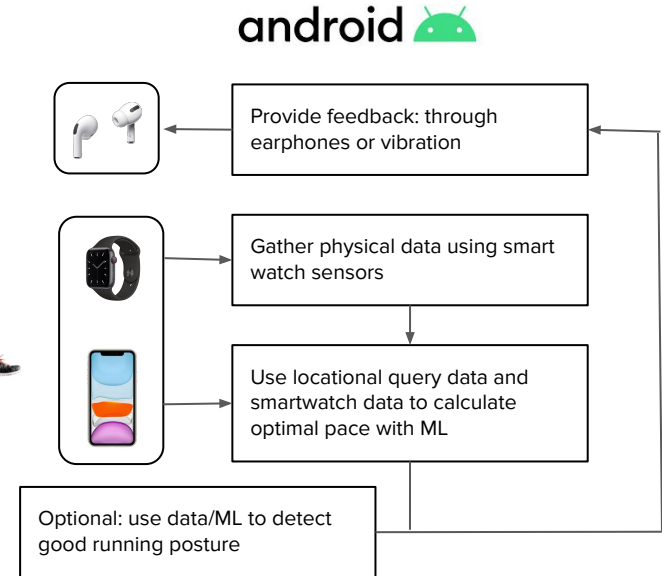
System Overview

Smartwatch Application (*Galaxy Watch 4*)

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

Smartphone Application (*Samsung Galaxy S20*)

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



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

Challenges

- Lack of knowledge in fitness

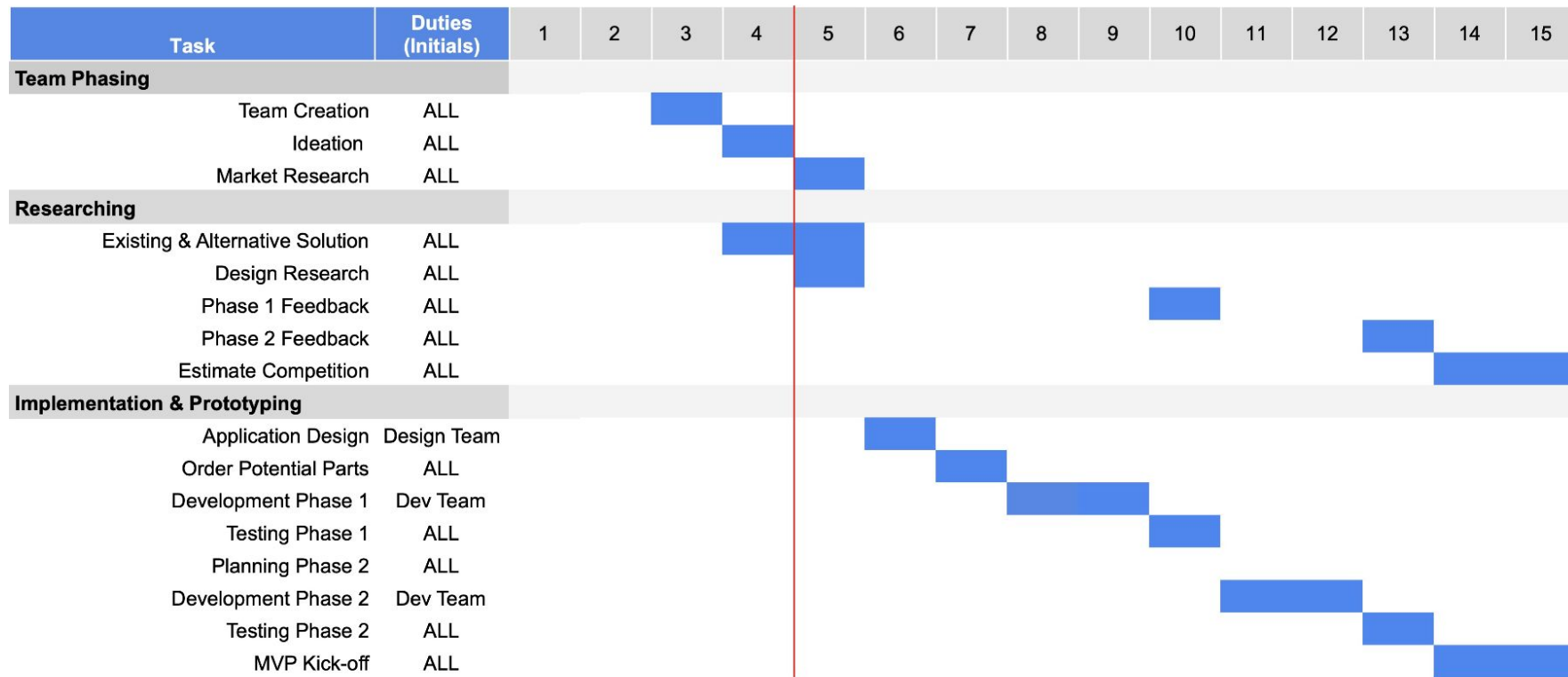
- Hard to determine “optimal” pace for individual
- Lack of data to train deep neural network model
- <https://www.healthline.com/health/running-heart-rate#ideal-rate>

- 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

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

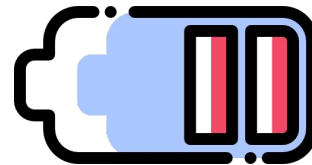
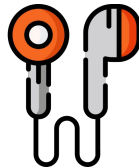
Planning









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, 송재현
 UI/UX	 이상민
 Model Training & Algorithms	 김영석, 손성욱

Thank You

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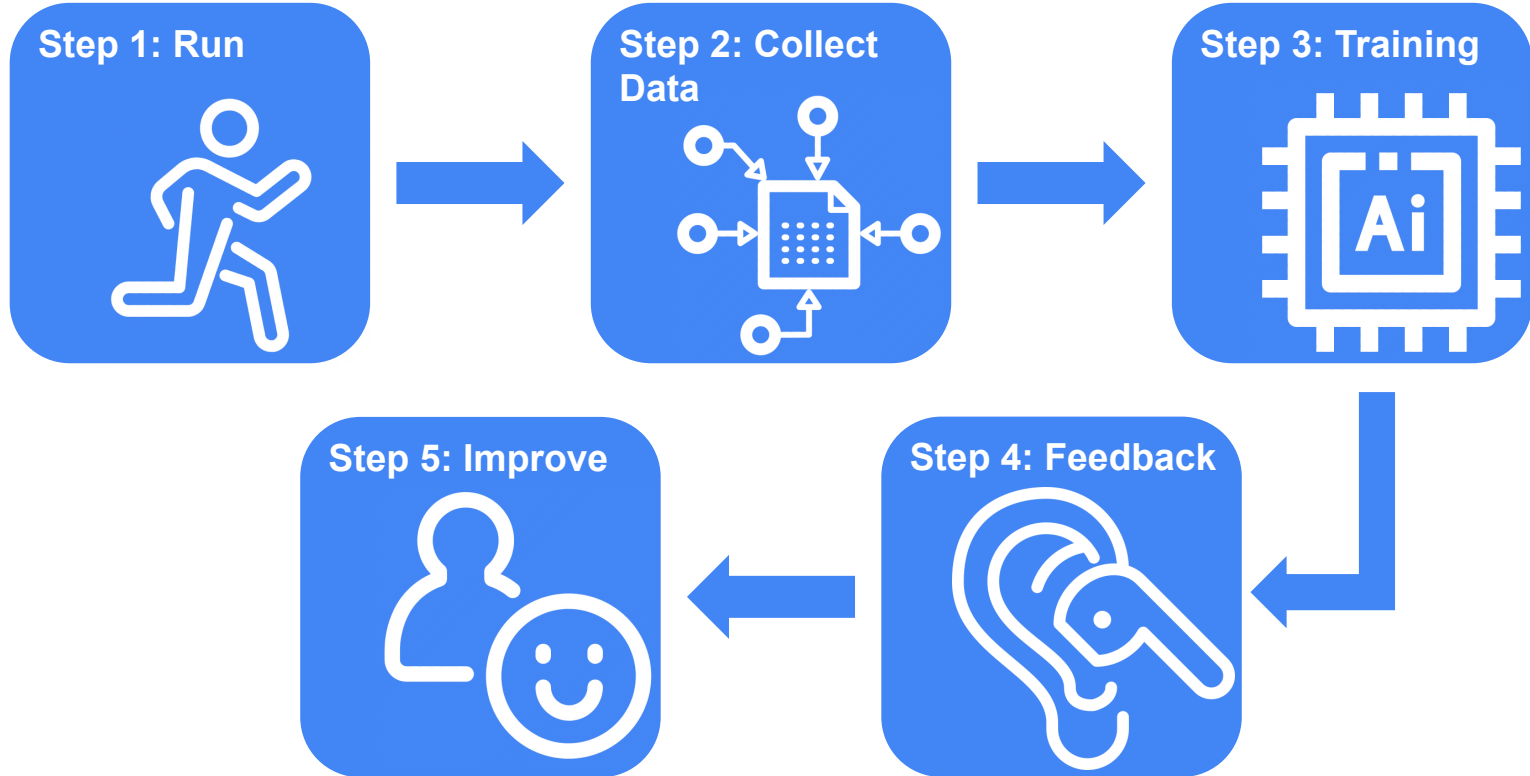
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Q & A

Project Proposal Checkbox (DUE 9/27 23:59)

TODO	담당자	완료
Target users and the problem they are facing	재현	O
Existing solutions and their limitations	재현	O
The key solution idea to tackle the problem	상민	O
Usage scenarios	영석	O
The proposed system overview and specific functions	재현/광연	O
Expected (technical) challenges and solution ideas !! NOVELTY !!	광연	O
Evaluation strategy & Final deliverable and success criteria	상민	O
Overall project plan (Gantt Chart ?)	성욱	O

Mean Viable Product



(notes)

- Main problem:
 - Many users find it difficult to maintain an optimal pace for the duration of a run
 - Many factors including weather, current health conditions, terrain, etc. contribute to this difficulty
 - Existing running apps (Nike, Samsung Health, etc.) measure speed **after a workout has ended**
 - This leads to poor feedback during the actual exercise.
 - Many people do not know how long they should exercise for, with many losing motivation after a few weeks
- Solution:
 - Create a pace-keeping application that monitors a user's running speed and proposes an optimal pace based on micro/macro factors
 - Macro factors: target weight, target distance, previous time records, etc.
 - Micro factors: current terrain conditions (asphalt, incline, etc.), heart rate, etc.
 - Implement a game system to motivate users to reach their goals
- Target audience:
 - Health-aware users who wish to augment their daily exercises with AI assisted jogging/walking routines
 - Professional runners who wish to closely monitor their running speed and improve their record times
 - Anyone who wants to lose weight through consistent exercise

System notes

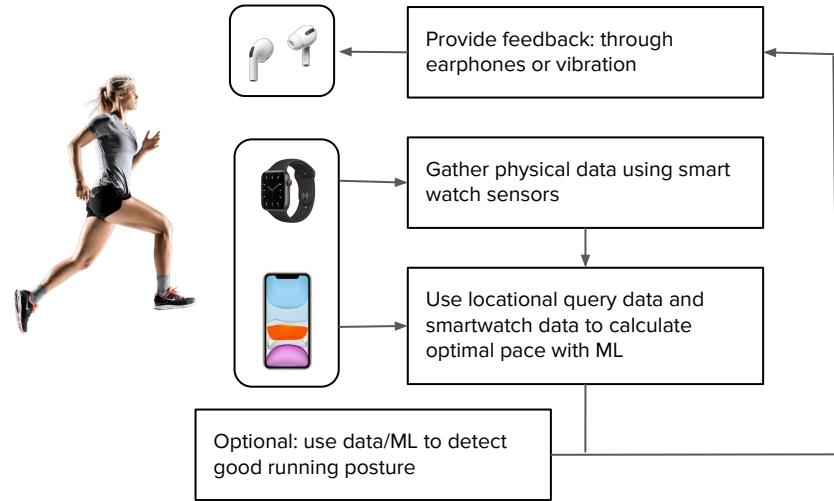
Sensor Data

Smartphone

- Galaxy 10
 - GPS, accelerometer, barometer, compass, gyroscope, proximity sensor, step counter, geomagnetic field sensor, ambient and device temperature sensor

Smartwatch

- Galaxy watch 4
 - Physical: heart rate, ECG, thermometer, pulse oximeter
 - External: accelerometer, barometer, compass, gyroscope, ambient light, GPS



REDUNDANT => written in Key Solutions