



E4: Run With It

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Problem Statement



Running with a phone
a **hassle**

Running with music that is too fast or too slow
an **interference**

Manually matching music to an unknown pace
NOT feasible

Solution

Run with **JUST** a watch

Run with music that **MATCHES** your pace

Run with **ANY** music of your **CHOICE**



Process Diagram



Solution Approach



Phone/Watch App	Time-Warping Algorithm	Step Detection Algorithm
<ul style="list-style-type: none">● Android Studio● Default list of music tagged with tempos	<ul style="list-style-type: none">● Wavelet Transform● Plan B:<ul style="list-style-type: none">○ Phase Vocoder	<ul style="list-style-type: none">● Parse accelerometer data● Try built-in step detector function

Design Requirements & Specifications

- Step detection of at least **95%** accuracy
- Music will begin playing within **250 milliseconds** after button-press
- Music should be warped every **20 footsteps**
- Pitch should stay accurate within **25 cents**, or $\frac{1}{4}$ semitone
- Music tempo range: **95-153 BPM**

Trade-offs

	Power	Ease-of-use	Comfort	Storage
1 Smartphone	✓	✗	✗	✓
2 Smartwatch	✗	✓	✓	✗

Metrics, Testing, & Verification

- **Step detection error**
 - Validate smartphone accelerometer measurements with pedometer
- **Time between tempo updates**
 - Real-time feedback every 20 footsteps
- **Pitch changing annoyance**
 - Range of $\pm \frac{1}{4}$ semitone relative to the original music
- **Pace and tempo difference**
 - Maximum music tempo: 150 BPM

Challenges



- Artifacts from time-warping music
- Smartwatch and phone compatibility
 - Different GUIs
 - Different accelerometers
- Processing music quickly to allow for seamless warping & real-time feedback

Risk Mitigation



Wavelet Transform has undesirable properties	Use phase vocoder or open-source code
Android step detector is inaccurate	Compute accelerometer data with an attached sensor
Smartwatch has insufficient processing power	Complete music processing on a phone

Division of Labor



