

# DES535

# Ubiquitous Computing

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INDRAPRASTHA INSTITUTE of  
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Google Classroom Code : pcwnf5t

# Ambient & Context-Aware Computing

Module III (Part II)

## Case Study 3

UIST '23: The 36th Annual ACM Symposium on User Interface Software and Technology

# RadarFoot: Fine-grain Ground Surface Context Awareness for Smart Shoes

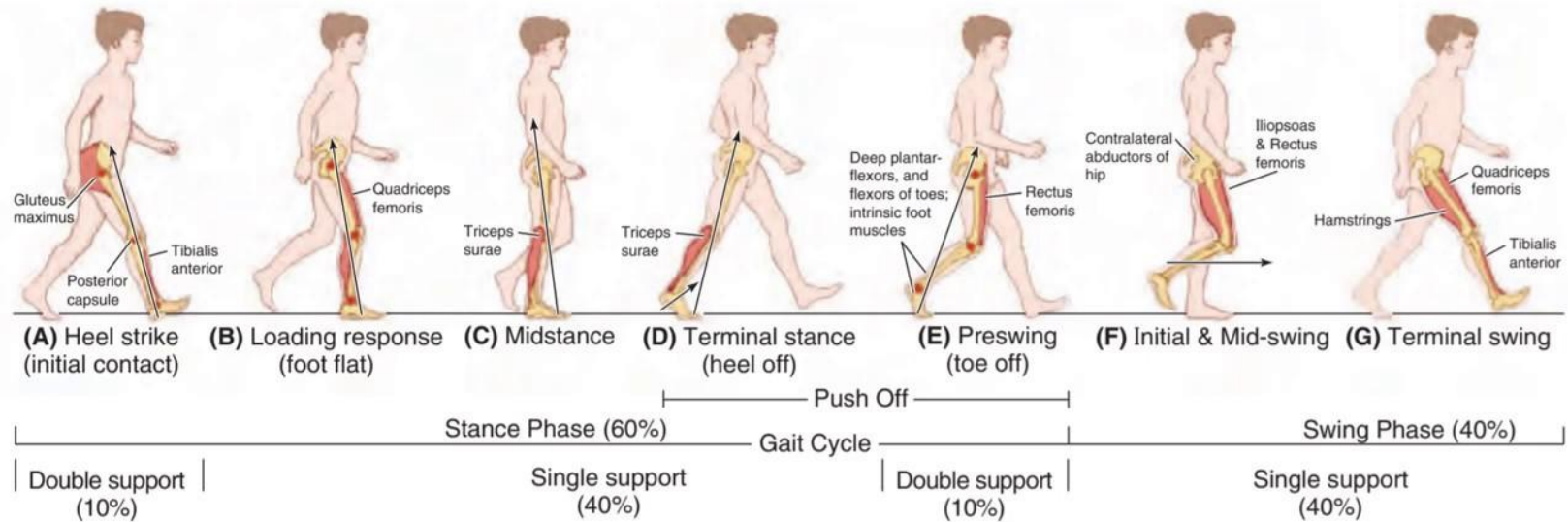
Don Samitha Elvitigala, Department of Human Centred Computing, Monash University, Australia

Yunfan Wang, School of Computer Science & Engineering, University of New South Wales, Australia

Yongquan Hu, School of Computer Science & Engineering, University of New South Wales, Australia

Aaron J Quigley, Science Director and Deputy Director, CSIRO's Data61, Australia

# The Gait Cycle



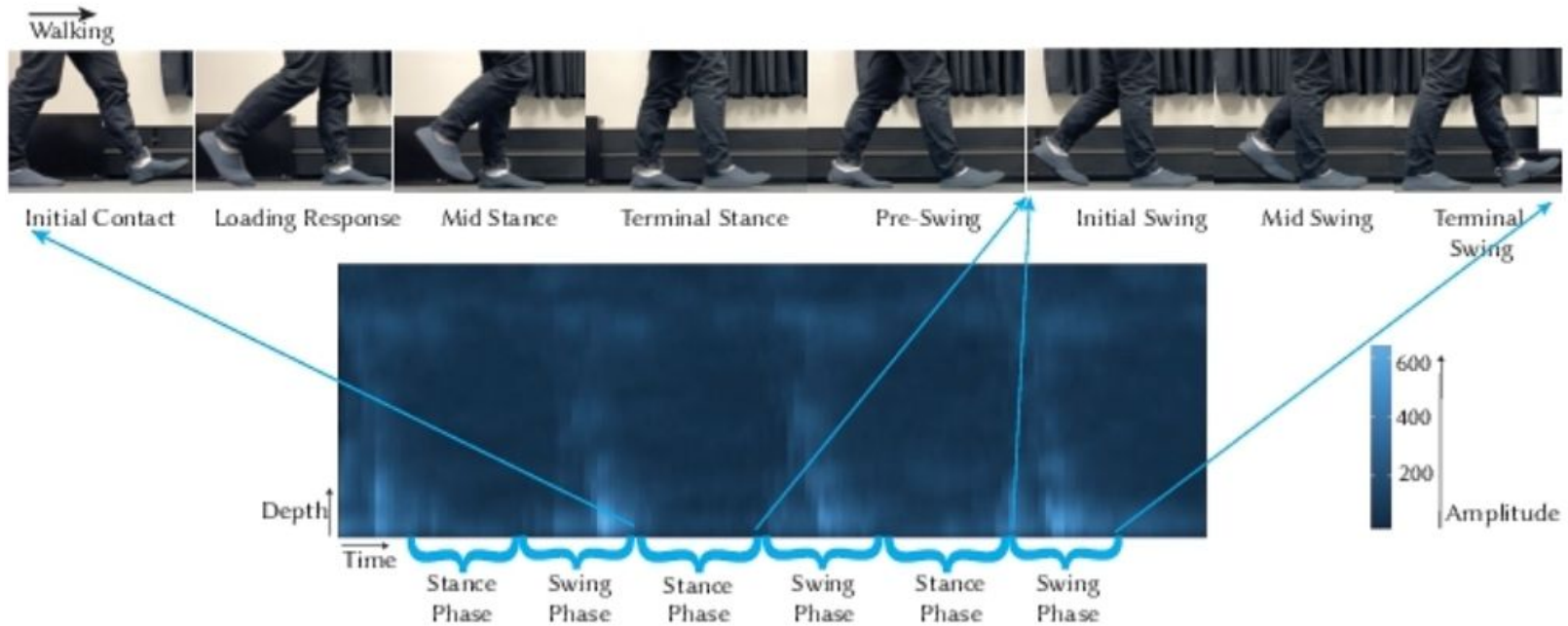
Moore KL, Daley II AF, Agur AMR. *Clinically Oriented Anatomy* [ebook]. 7th ed. Baltimore: Wolters Kluwer; 2014. Figure 5.20, 'Gait cycle'.

# Sensing Principle

Factors affecting the **intensity** (power per unit area) of the reflected radar signals:

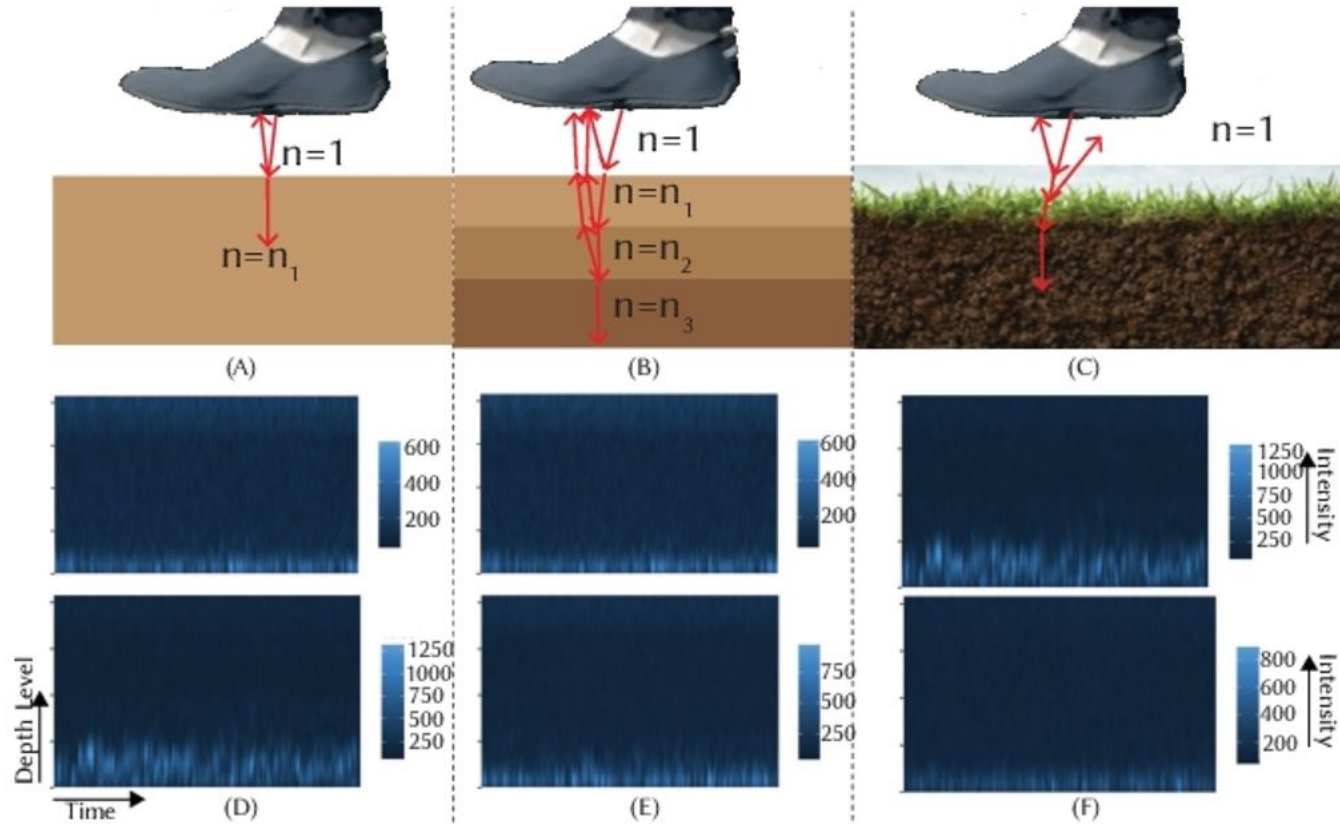
- Signal's travel distance in free space
- The reflection coefficient ( $r$ ) of the surface
  - $R$  depends of the refractive index of incident and transmitted material.
    - Refractive index depends on the **permittivity** ( how much electric field is "permitted" to pass through the material) of the surface.
- Absorption of the wave in the surface.

# Sensing Principle



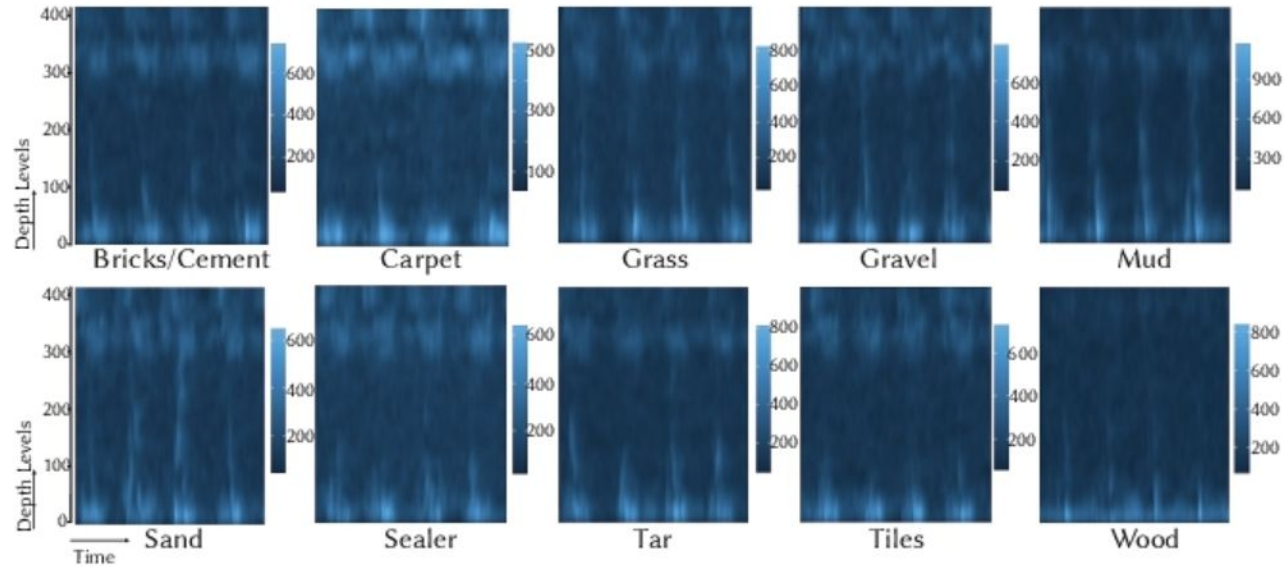
# How can various surfaces be detected using mmWave signals?

- RadarFoot aims to leverage the difference of reflected signals off a surface.
- Interesting signal changes depending on the ground surface material composition and the surface morphology.



# Why is it not enough to consider the loading response and midstance phases only?

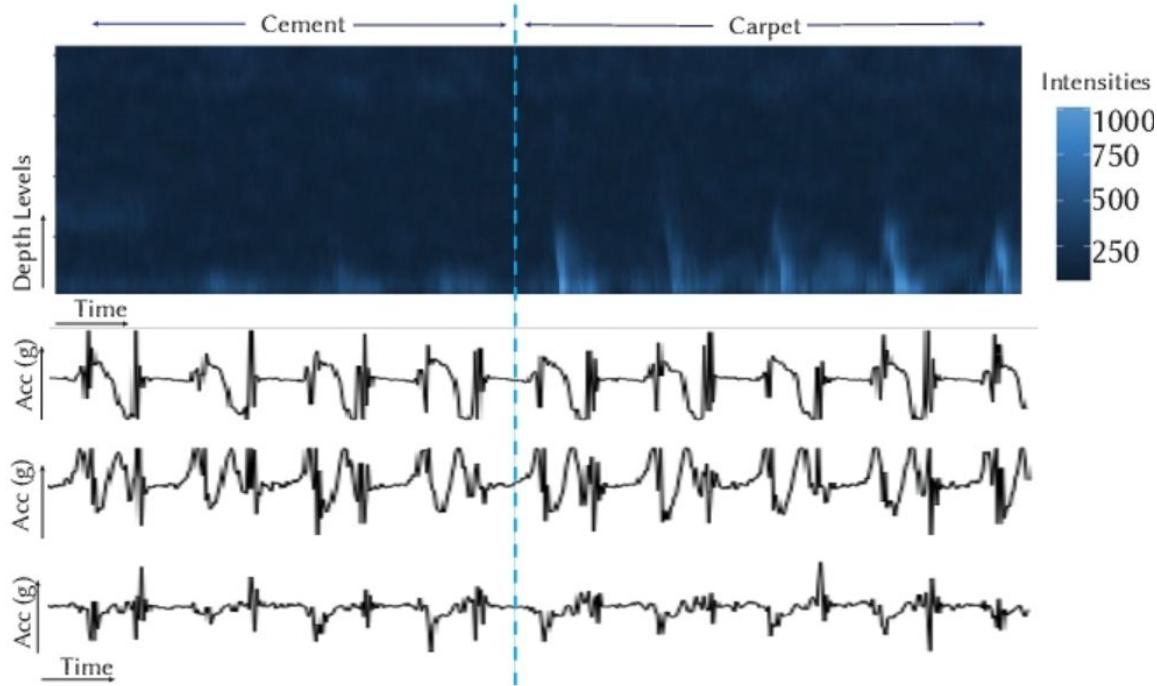
- RadarFoot emits signals from different heights allowing us to sense unique signals from various surfaces.
- Amplitude intensity signal of a complete walking cycle for detection is used.





# Why is it not enough to use IMU for surface detection?

- No change in IMU signal when surface is changed.
- 14 features were extracted from the reflected signal amplitude



# Why is it not enough to use IMU for surface detection?

- No change in IMU signal when surface is changed.
- 14 features were extracted from the reflected signal amplitude
- Random Forest performed the best.

