DES535

Ubiquitous Computing

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INDRAPRASTHA INSTITUTE *of* INFORMATION TECHNOLOGY **DELHI**

Google Classroom Code : pcwnf5t

Ambient & Context-Aware Computing

Module III (Part II)

Case Study 2

CHI 2015

SwitchBack: Using Focus and Saccade Tracking to Guide Users' Attention for Mobile Task Resumption

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Motivation

- One of the most significant contextual factors that affects people’s mobile device usage is divided attention.
  - For example, if pedestrians are checking email on their smartphones while walking across the street, they must break their attention from their devices to maintain awareness of their surroundings, or else they put themselves at risk of physical injury.
- Although safety is of the utmost concern when it comes to situational impairments, damage to users’ productivity is also a concern.
  - It is likely that when pedestrians return their attention to their mobile devices, they will have lost track of their progress. C

Contribution

- Once SwitchBack detects that the user has returned from a distraction by looking back at the screen, it guides the user back to where he or she last left off by highlighting the appropriate region of text. Focus And Saccade Tracking (FAST) can also be used to enable automatic scrolling when the user reaches the end of the text visible on the screen. This capability can prove very helpful in a number of situations, for example, when a user has gloves on and the capacitive touchscreen will not work.

SwitchBack

FAST first determines whether or not the user is looking at the screen. If the user is looking

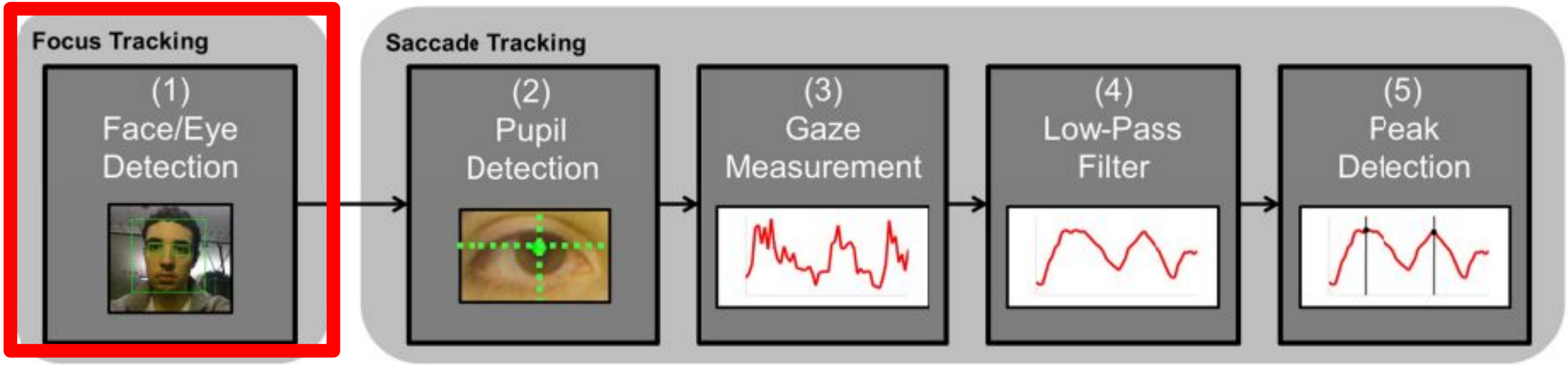
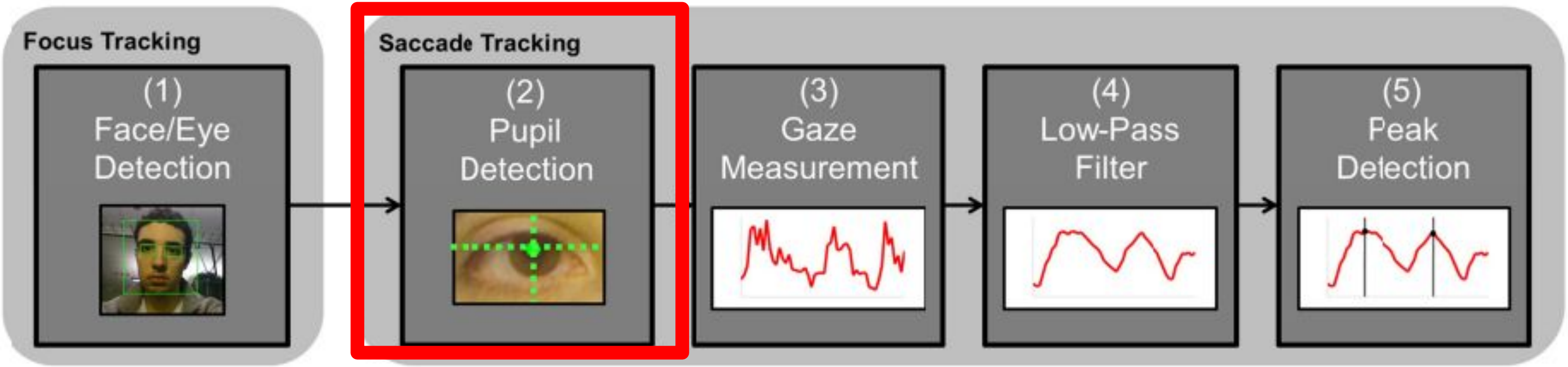


Figure 2. The FAST algorithm. **(1)** The user's face and eyes are detected in order to establish whether the user is focused on the screen or not. If the user is facing the screen, **(2)** the pupils are identified and compared relative to the bounding box of the eye to **(3)** identify the user's gaze in the horizontal and vertical directions. **(4)** These measurements are applied through low-pass filtering and **(5)** peak detection to identify saccades.

SwitchBack

FAST measures the movement of the user's pupil relative to the rest of the eye to track where the user is looking on the screen



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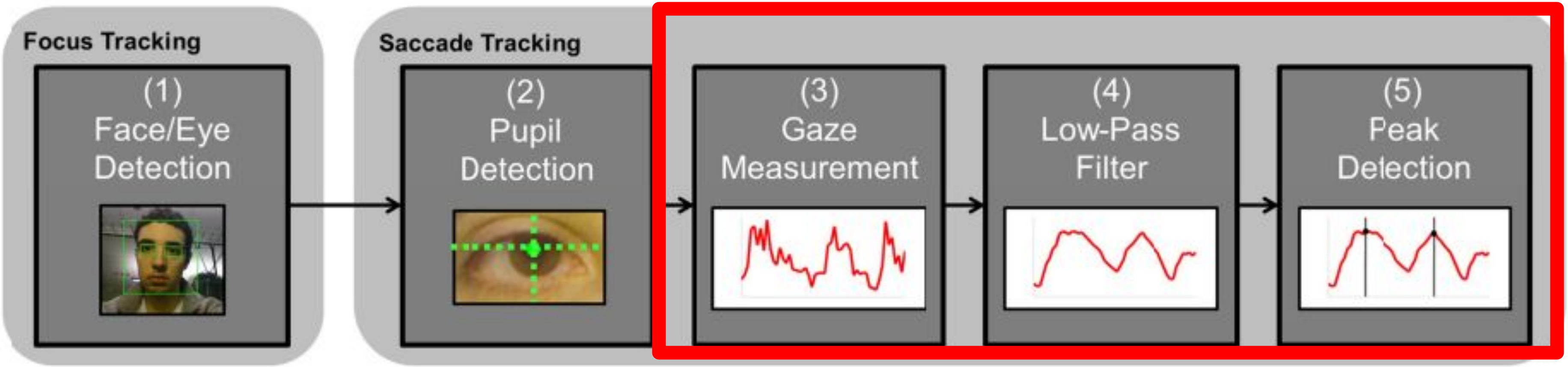
SwitchBack

In cases when the screen is displaying text (e.g., emails or web articles), FAST detects quick, horizontal jumps. These gaze jumps, or saccades, are used as a proxy to determine when the user moves to a new line and to estimate where the user is in a body of text.



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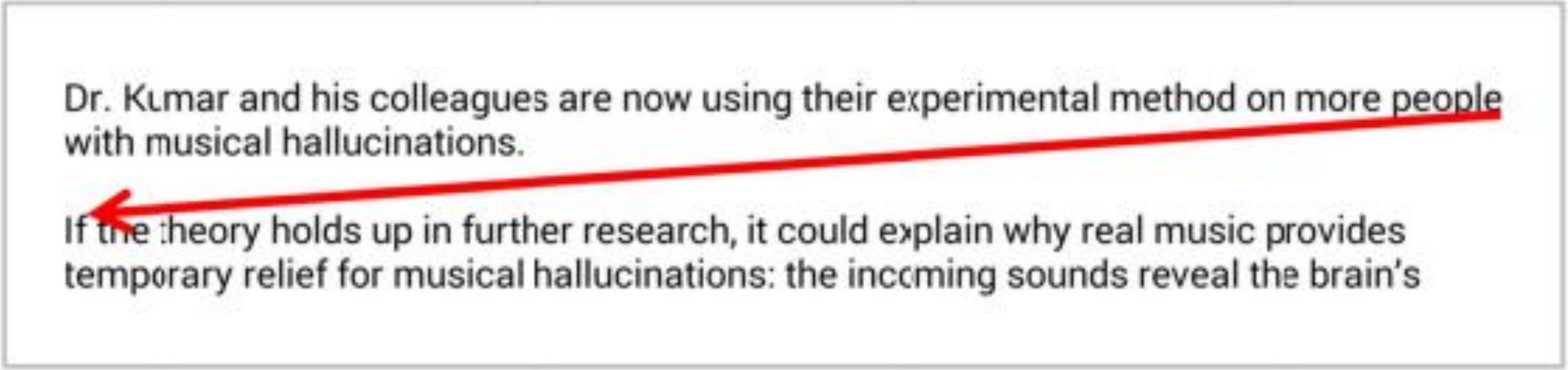
SwitchBack : Is it enough to track the saccades?

- Noise and missed detection may lead to extra or missed peaks. Counting words in each line and using the knowledge about standard reading speed (200-400 wpm)
  - tmin<tmeasured<tmax : new line
  - tmeasured<tmin : false positive, line not incremented
  - tmax<tmeasured : false negative, additional increment



SwitchBack

https://www.youtube.com/watch?v=c_gB8msTjyI

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

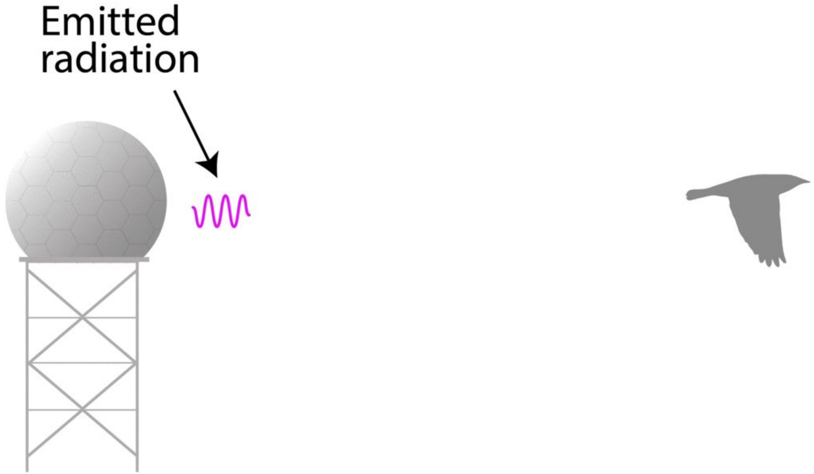
Don Samitha Elvitigala, Department of Human Centred Computing, Monash University, Australia

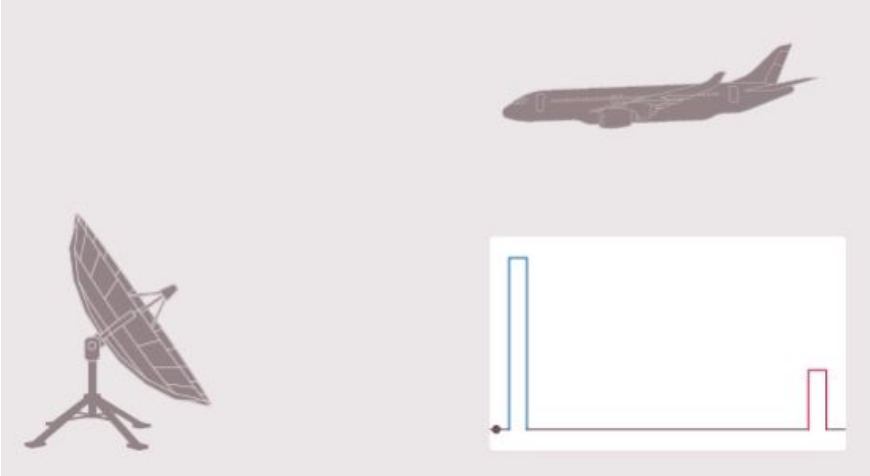
Yunfan Wang, School of Computer Science & Engineering, University of New South Wales, Austria

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

mmWave Sensing : How Radar Works



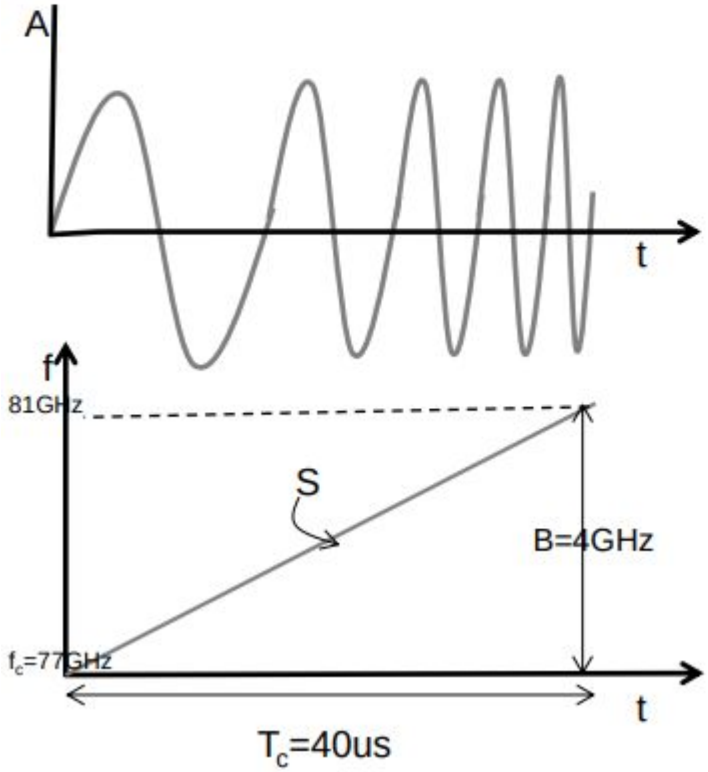


mmWaves belong to the frequency band of 30-300 GHz

mmWave Sensing : Signal and Properties

The Frequency Modulated Continuous Wave (FMCW) - chirp

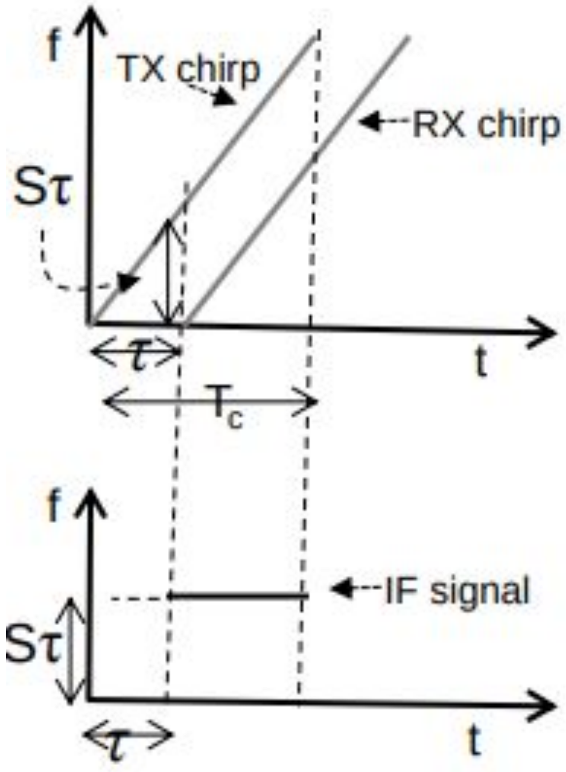
- An FMCW radar transmits a signal called a "chirp". A chirp is a sinusoid whose frequency increases linearly with time
- A chirp is characterized by a start frequency (fc), Bandwidth(B) and duration (Tc).
- The Slope (S) of the chirp defines the rate at which the chirp ramps up.



Reference material:
https://e2e.ti.com/cfs-file/__key/communityserver-discussions-components-files/1023/Introduction-to-mmwave-Sensing-FMCW--Radars.pdf

mmWave Sensing : Signal and Properties

- The RX-signal is just a delayed version of the TX signal.
- τ denotes the round-trip time between the radar and the object. τ = 2d/c where d is distance of the object and c is the speed of light.
- **A single object in front of the radar produces an Intermediate Frequency (IF) signal that is a constant frequency tone.**



Reference material:
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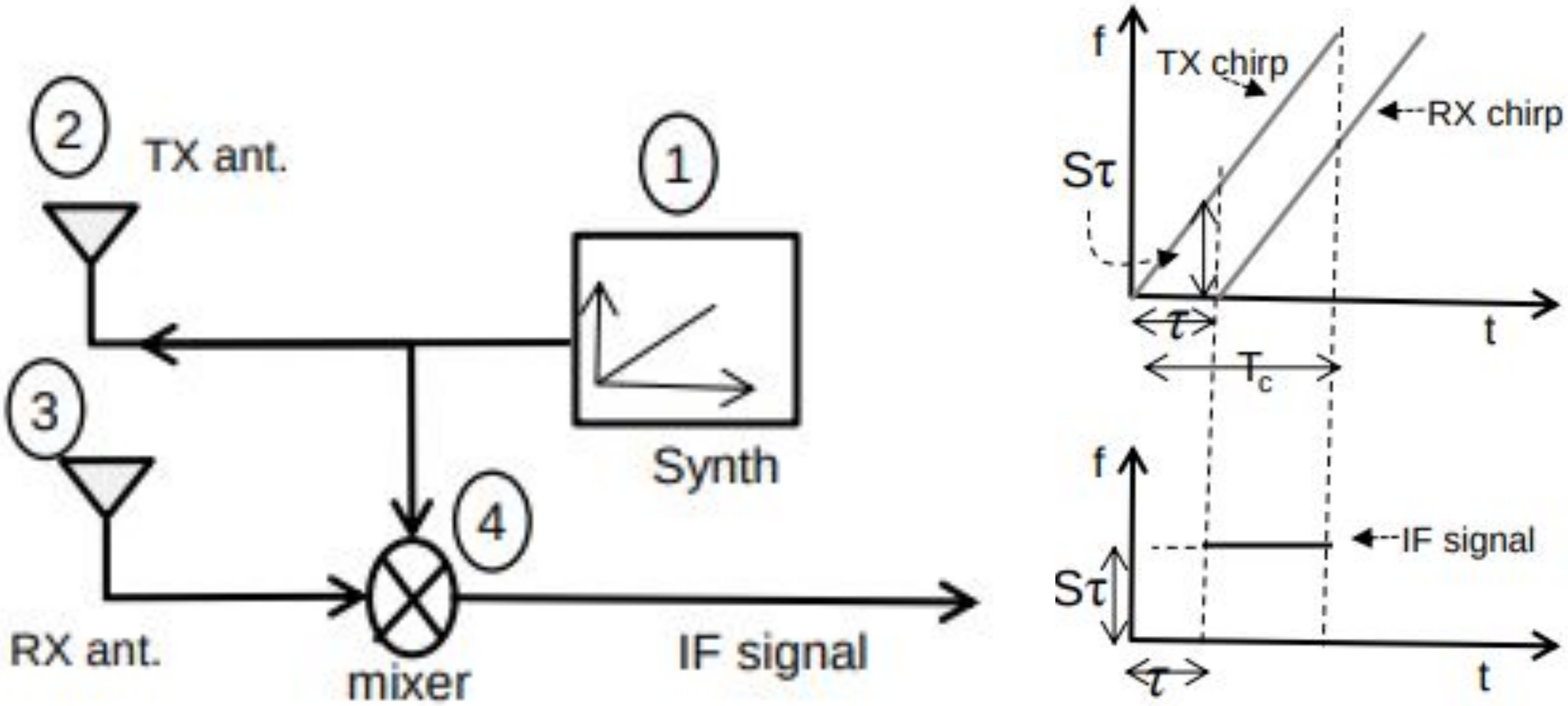

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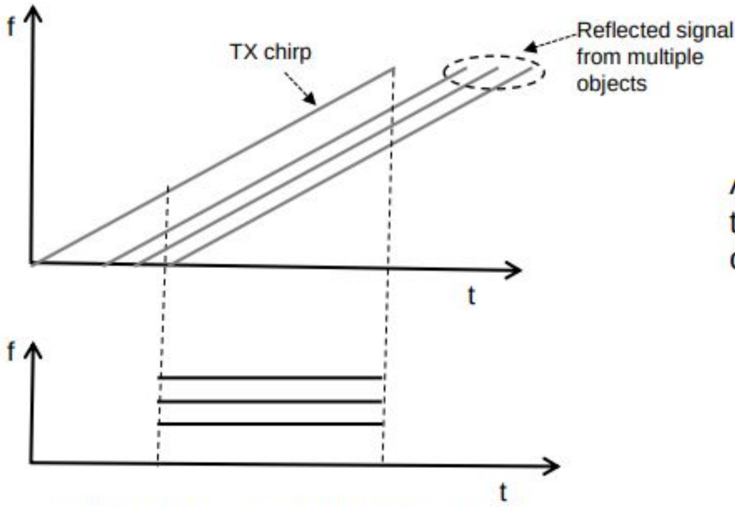
mmWave Sensing : Signal and Properties

- **Multiple objects in front of the radar creates multiple reflected chirps at the RX antenna**
- What is the correlation between the distance of the object and the IF?



Multiple tones in the IF signal

Reference material:
https://e2e.ti.com/cfs-file/__key/communityserver-discussions-components-files/1023/Introduction-to-mmwave-Sensing-FMCW--Radars.pdf

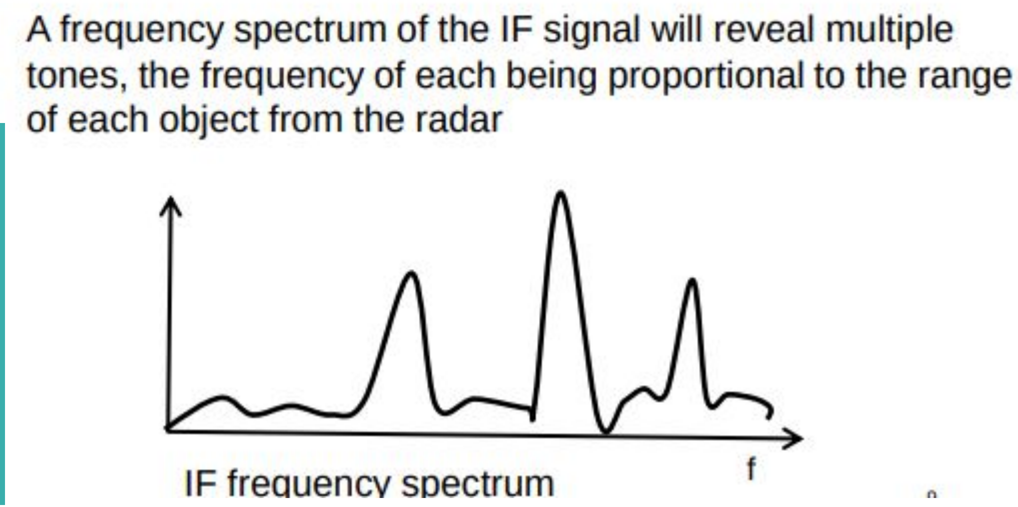
mmWave Sensing : Signal and Properties

- **How can we identify the presence of objects using the radar? - Fourier Transform**

How can we use the IF signals to distinguish 2 objects located closely?

Range Resolution refers to the ability to resolve two closely spaced objects.

How can we distinguish 2 objects located at different positions having the same distance from the transmitter?



Reference material:
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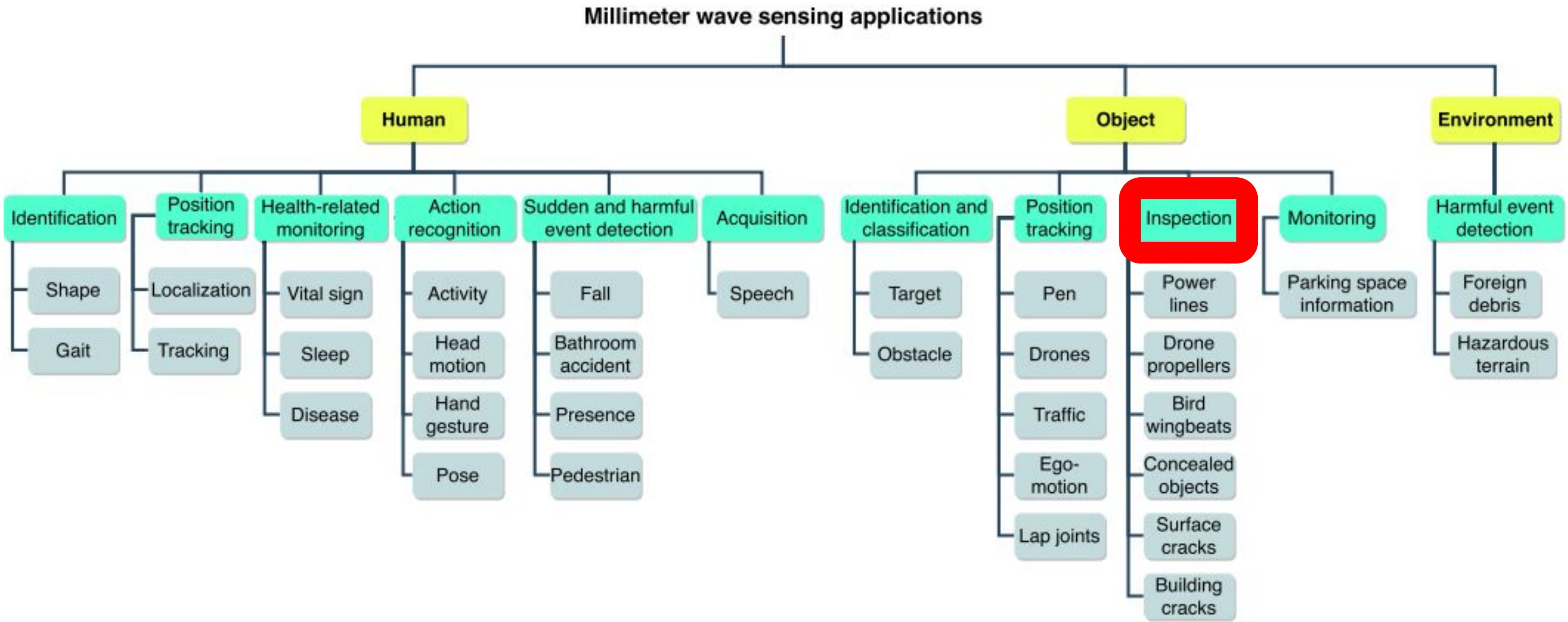
mmWave Sensing : Applications

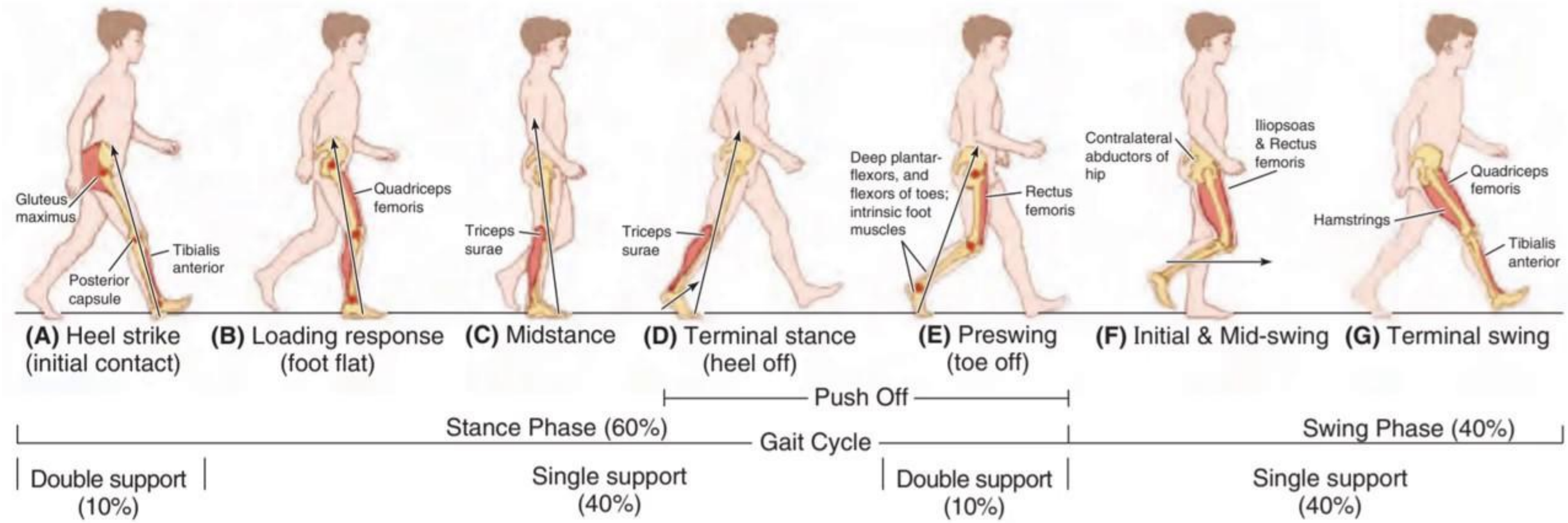


van Berlo, Bram, et al. "Millimeter wave sensing: A review of application pipelines and building blocks." *IEEE Sensors Journal* 21.9 (2021): 10332-10368.

mmWave Sensing : RadarFoot

Paper: https://dl.acm.org/doi/fullHtml/10.1145/3586183.3606738?casa_token=Zc3GoYDNq4IAAAAA:cOBJvcYGOzsA8LP5nDQIzanuqtfZitDoxN8WYlNymYKr-9A0HWPdoW3CWAWoNIkoYqXgTpUQO_TRMHs
Youtube : https://www.youtube.com/watch?v=gkYERa3H7WI

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'.

Reference: https://www.youtube.com/watch?v=-G3EFtkq3qI

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