DES535
Ubiquitous Computing

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INFORMATION TECHNOLOGY **DELHI**

Google Classroom Code : pcwnf5t

Motion & Activity Sensing

Module V (Part I)

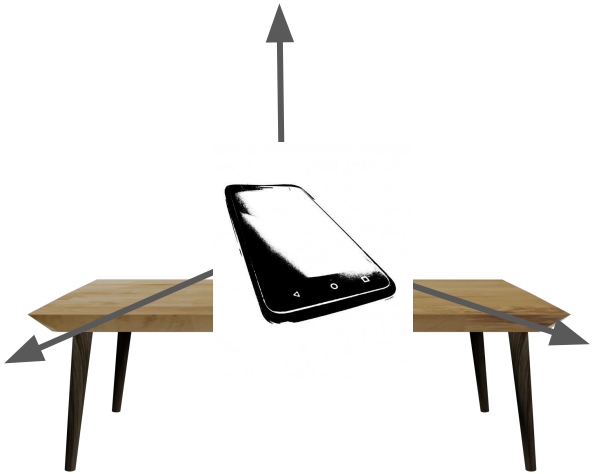
Accelerometer and Earth’s gravity

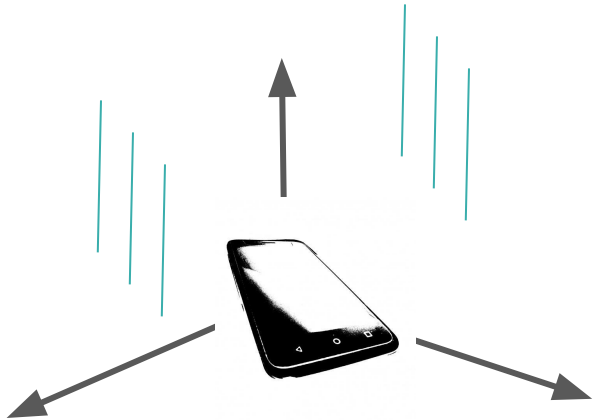
- Measures the linear acceleration i.e. the rate of change of velocity in 1, 2 or 3 axis.
- Acceleration due to Earth’s gravity (g) at sea level is 9.81 m/s2.
- Some reference points of g:
  - Earth’s gravity 1g
  - Passenger car in corner 2g
  - Bumps in road 2g
  - Race car driver in corner 3g
  - Bobsled rider in corner 5g
  - Human unconsciousness 7g
  - Space shuttle 10g

https://webpages.charlotte.edu/~jmconrad/ECGR6185-2006-01/notes/Accelerometers_Savla.pdf

Accelerometer & Motion

- What will be the reading of an accelerometer placed flat on your table and an accelerometer attached to a free falling object?





Accelerometer & Motion

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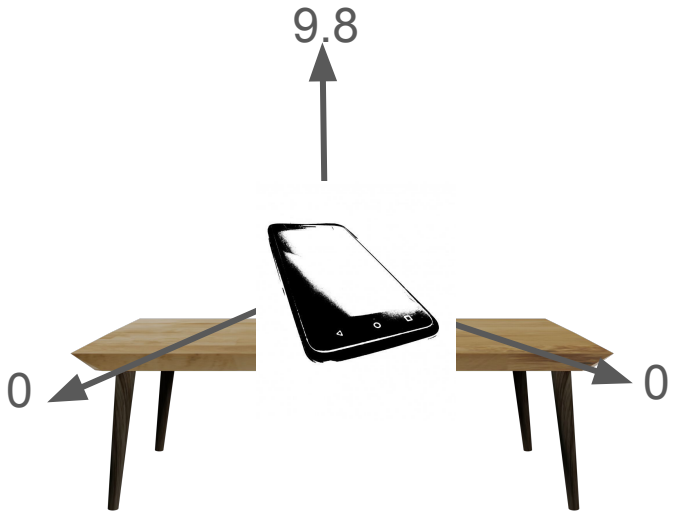
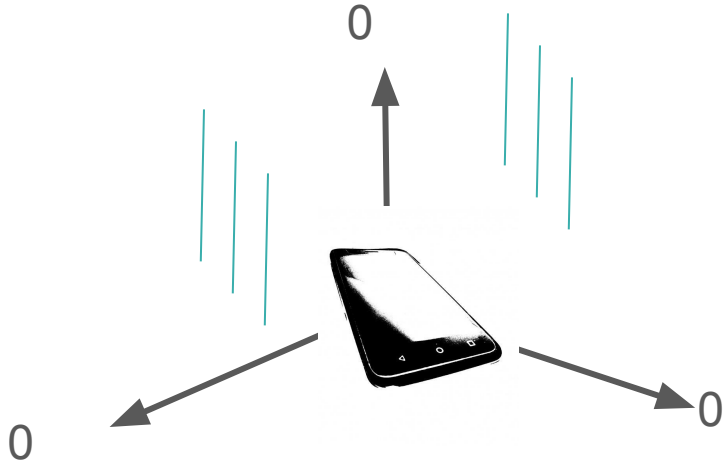
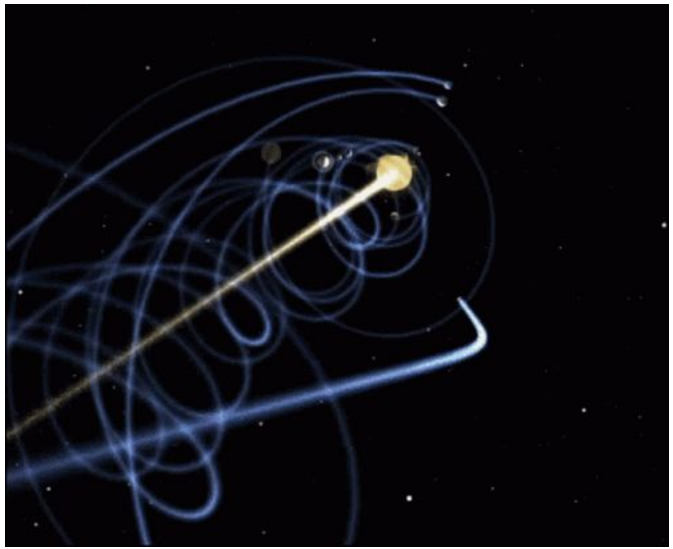




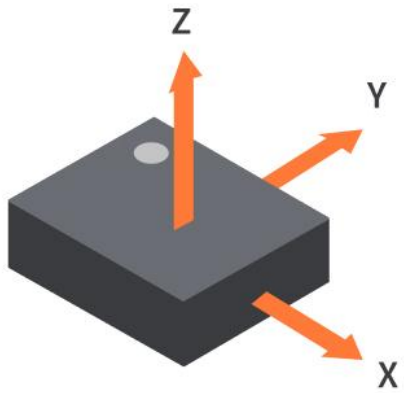
Accelerometer & Motion

- This is because an accelerometer measures proper acceleration rather than coordinate acceleration.
  - **Proper acceleration** is the actual acceleration experienced by an object as measured in the object's own **rest frame**.
  - **Coordinate acceleration** is the rate of change of velocity of an object relative to a particular **frame of reference** or **coordinate system**.



Types of Accelerometers

- Capacitive -Metal beam or micromachined feature produces capacitance; change in capacitance related to acceleration
- Piezoelectric -Piezoelectric crystal mounted to mass – voltage output converted to acceleration
- Piezoresistive -Beam or micromachined feature whose resistance changes with acceleration
- Hall Effect -Motion converted to electrical signal by sensing of changing magnetic fields
- Magnetoresistive -Material resistivity changes in presence of magnetic field



Accelerometer sensing axis orientation

https://www.circuitbread.com/ee-faq/how-do-accelerometers-and-gyroscopes-work
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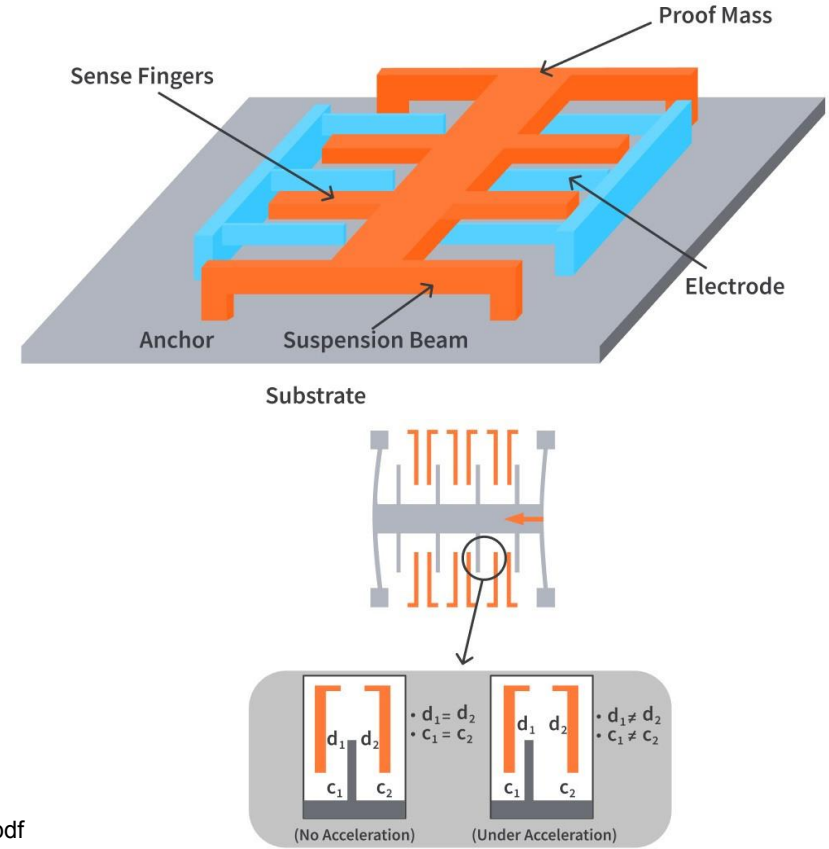
Microelectromechanical systems (MEMS) Accelerometers

- It has a **proof mass** or **seismic mass**, which is an H-shaped structure with “sense fingers” extending from it.
- The proof mass is tethered to the substrate at both ends and is allowed to perform a to-and-fro motion between the tethered ends.
- **Electrodes** are structures fixed in the substrate and remain stationary, unlike the proof mass which moves with the motion of the body.
- Proof mass and electrodes together form a comb-like structure that is used to detect the motion.
- Works by measuring the change in capacitance due to motion.



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Applications of Accelerometers

- Tilt / Roll and Vibration / “Rough-road” detection
  - Can be used to isolate vibration of mechanical system from outside sources
- Vehicle skid detection
  - Often used with systems that deploy “smart” braking to regain control of vehicle
- Impact detection
  - To determine the severity of impact, or to log when an impact has occurred
- Input / feedback for active suspension control systems
  - Keeps vehicle level

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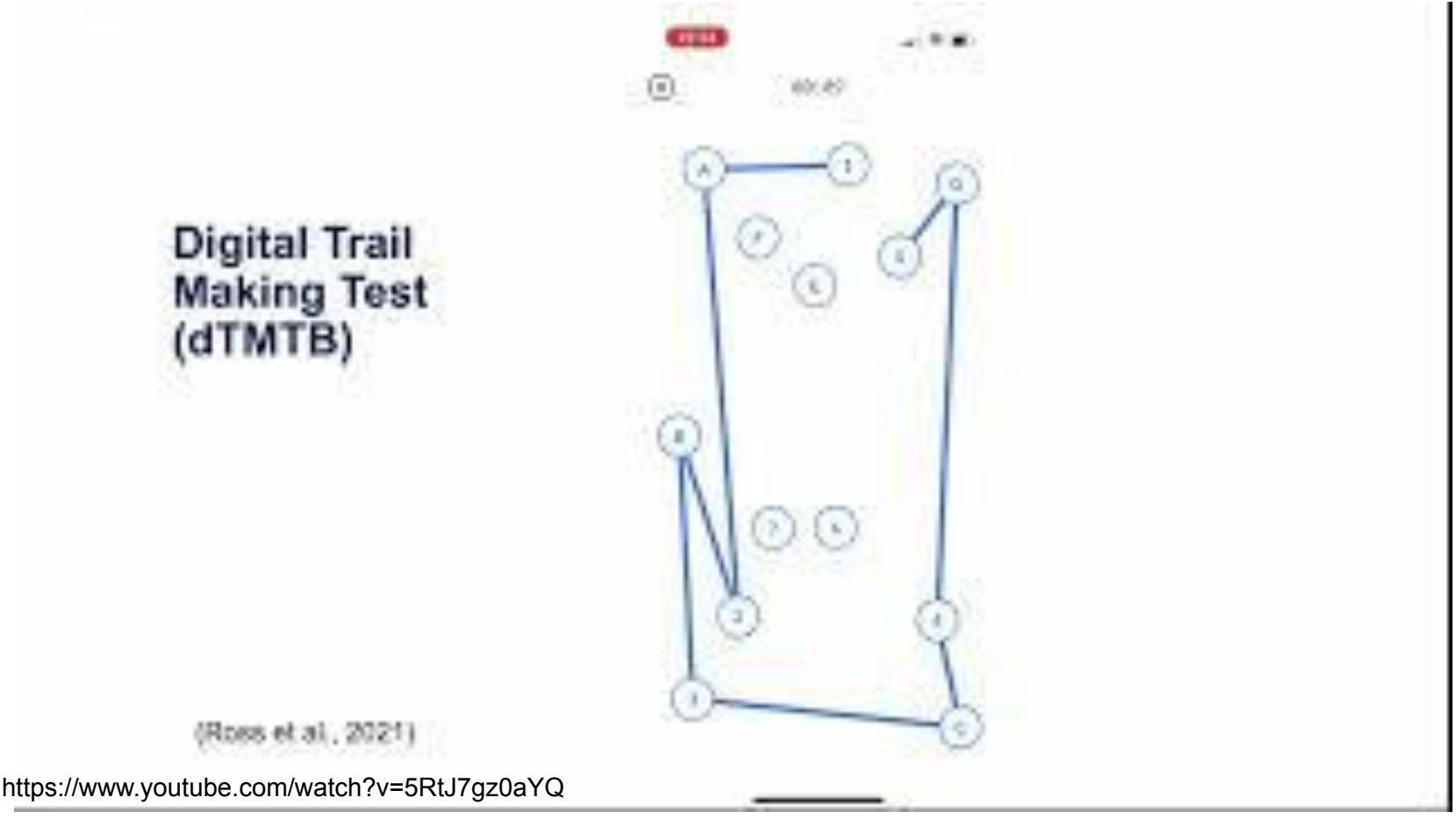
Applications

https://www.youtube.com/watch?v=-JcezIL3UKQ

Applications



https://www.youtube.com/watch?v=5RtJ7gz0aYQ

Applications

https://www.youtube.com/watch?v=4AquzDgIHnQ

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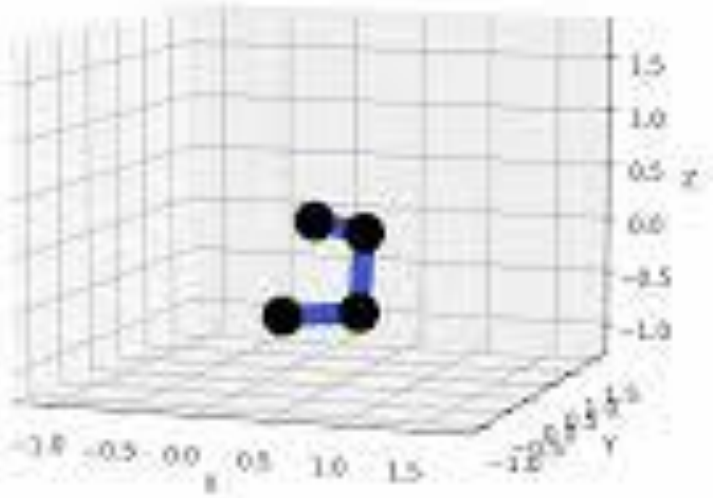

https://www.youtube.com/watch?v=AHh2vYQVb_8

Gyroscope and Motion: A Historical Inventions

https://www.youtube.com/watch?v=kUYzuAJeg3M