

## Motivation

**Aim:** To provide real time identification of roads' image in complex environments (off-road, humps, kerbs) in severe weather conditions (rain, snow, spray)

**Existing Sensor technologies include:**

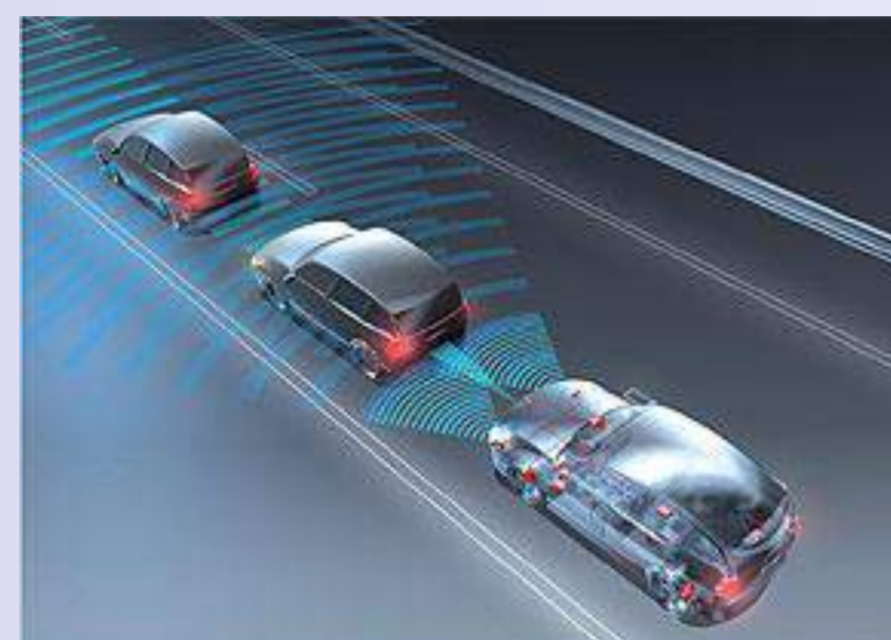
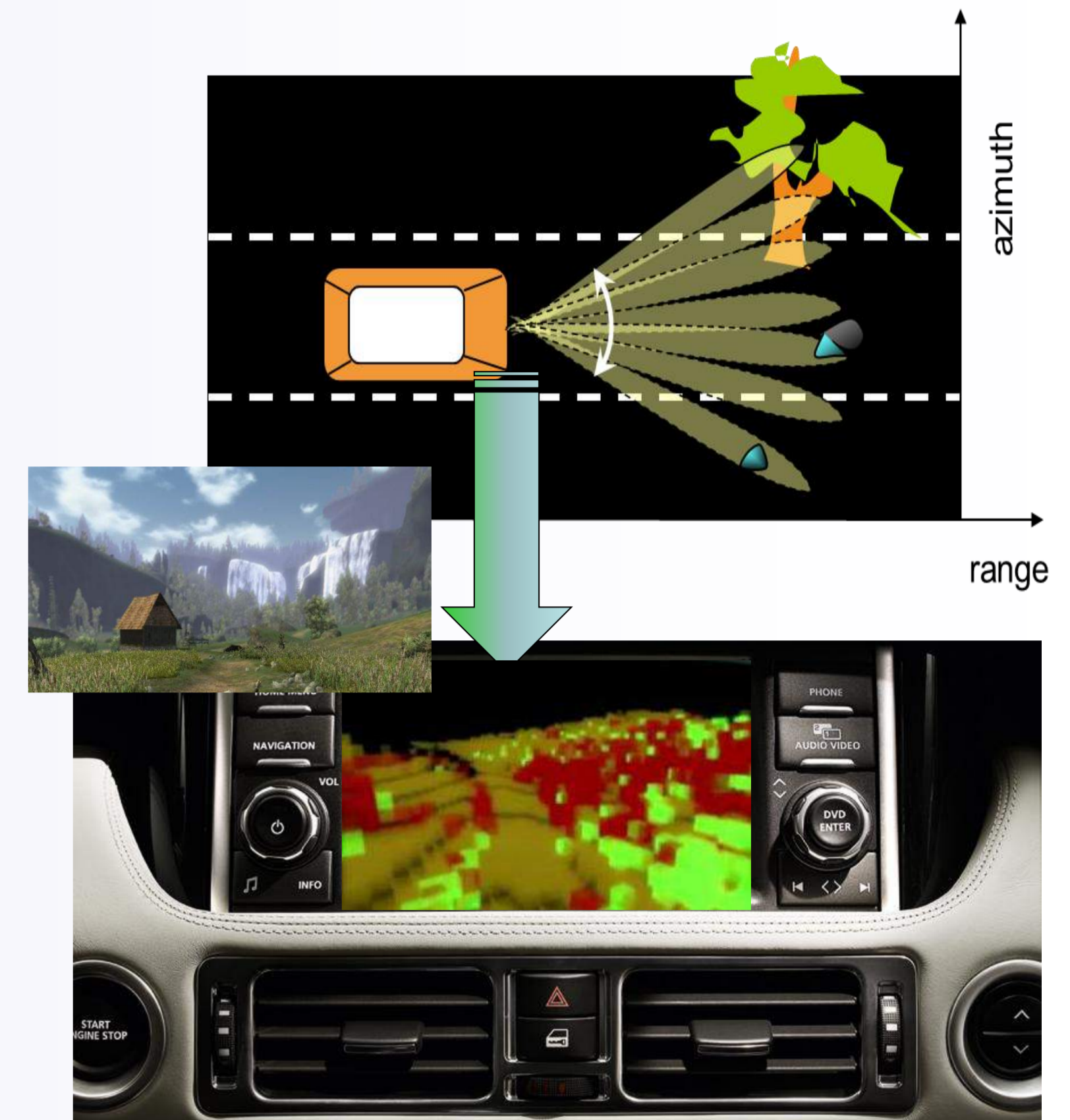
- Optical sensors
- Lidar (Lasers)
- Thermo-graphic cameras (for night vision)
- Radars at 24 GHz and 77 GHz

**A fusion of technologies are usually used.**

**Optical sensors are most used driver assistance/path detection**

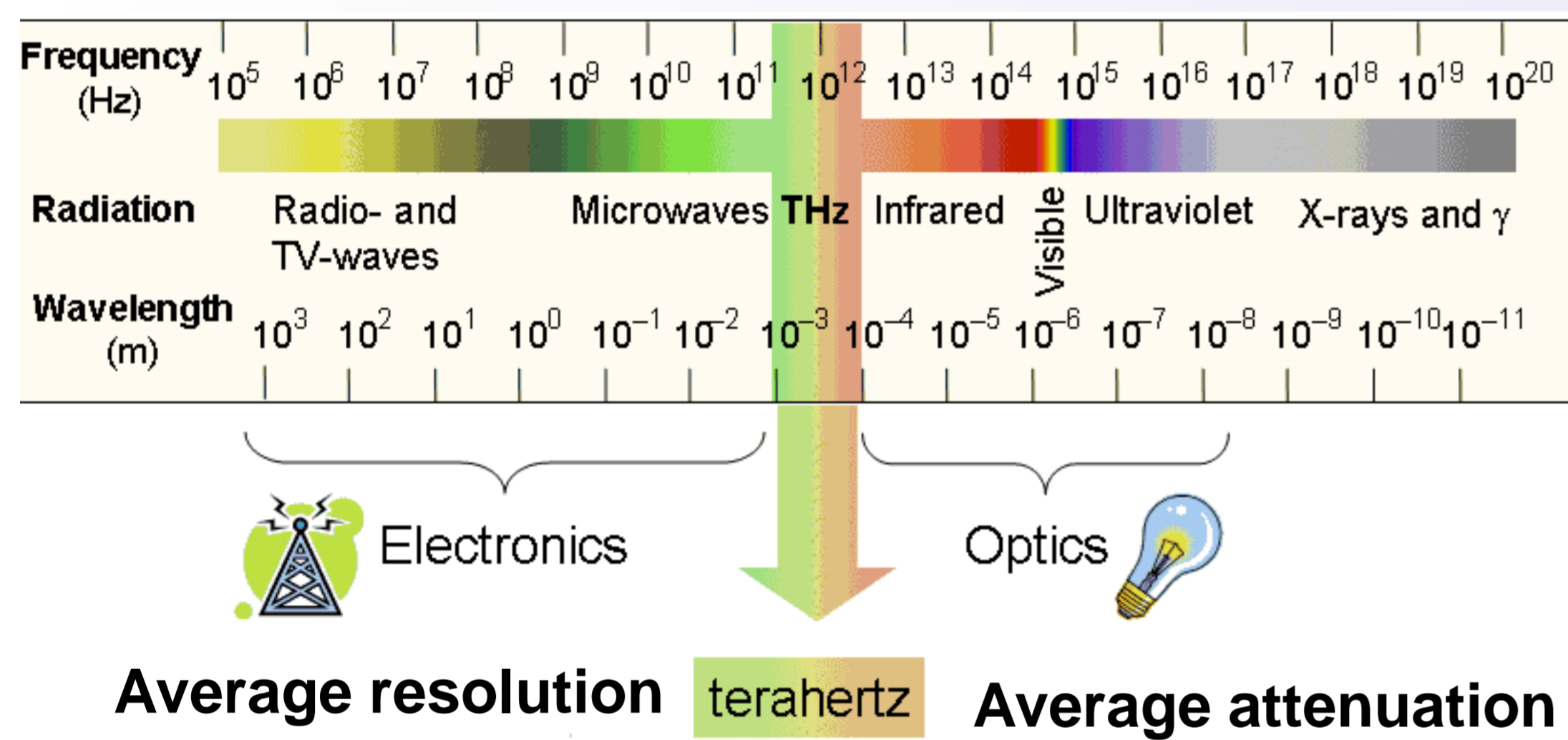
- However they fail in**
- Spray/fog/smoke
  - Sand/dust storm
  - Snow/rain

## Imaging of the road ahead



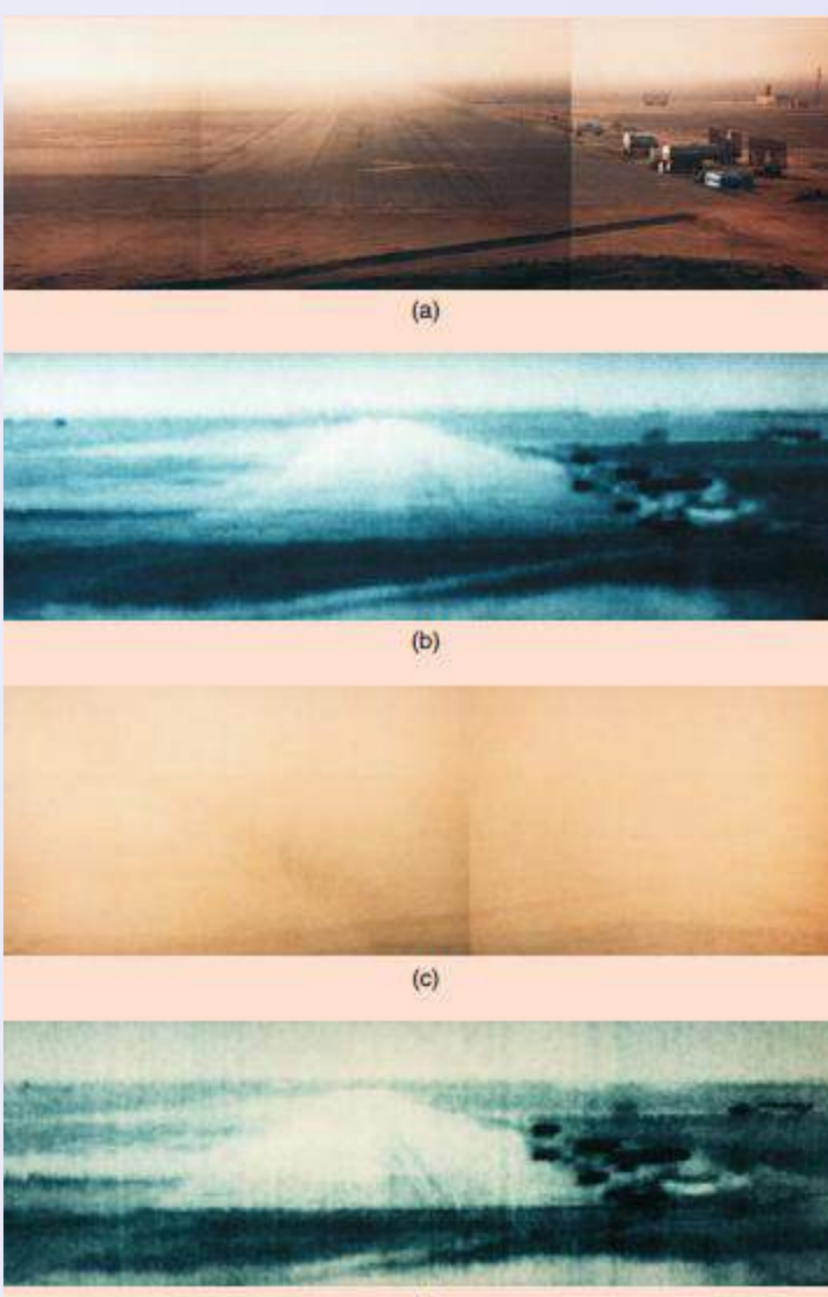
## A Trade off between microwave imaging and optical imaging

Microwave Frequencies	Optics
Lower resolution	High resolution
Lower attenuation	High attenuation in non transparent medium



L. Yujiri, M. Shoucri, P. Moffa (2003) "Passive millimeter wave imaging," IEEE Microwave Magazine, 4(3), 39-50

## THz sensing



- a) and c) Optical images in clear and foggy weather  
b) and d) Corresponding passive millimetre wave images

### Microwave sensing in THz band provides

- High resolution
- Compact sensors/antennas

### Requirements in order to facilitate image interpretation:

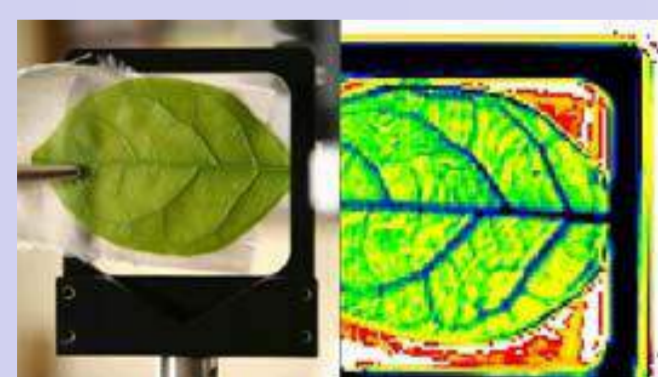
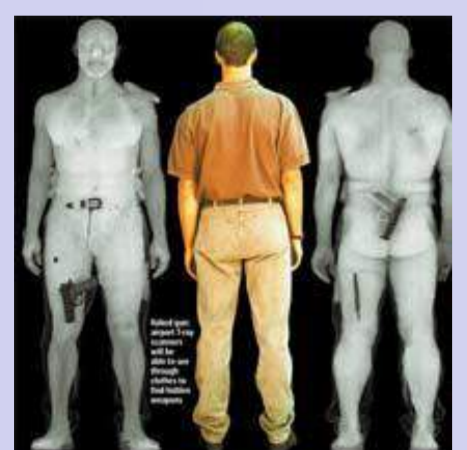
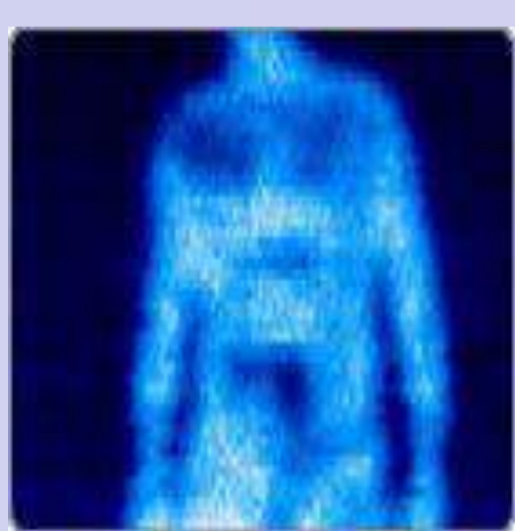
- Reasonable range resolution,
- Image resolution
- Dynamic range

The optimum vehicle progress control would be achieved by remote interrogation of the road ahead of the vehicle to allow systems to be prepared for the approaching terrain.



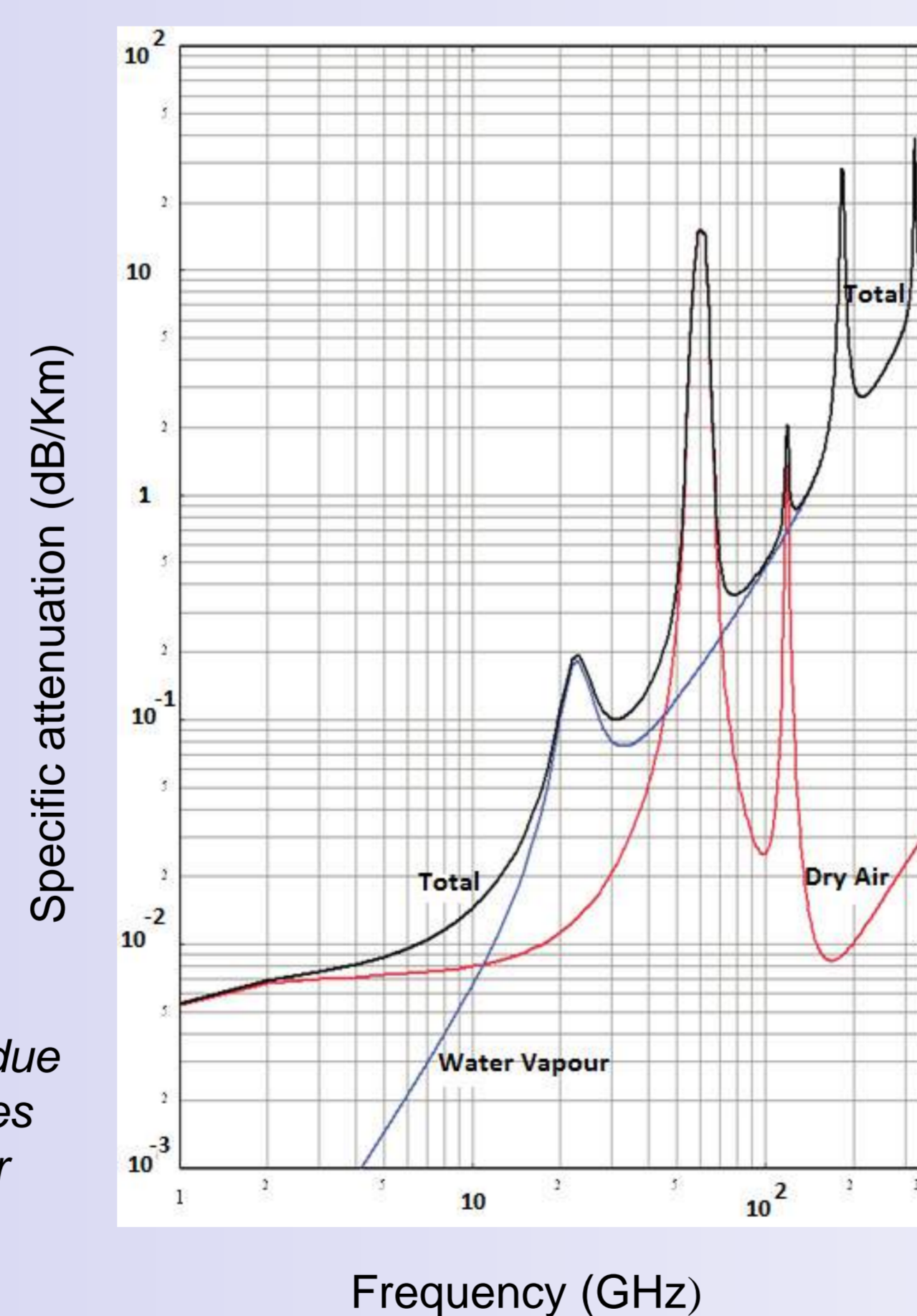
THz sensing enables optimisation of control systems including transmission, suspension, throttle mapping and torque to control vehicle progress on any terrain.

## THz sensing-Applications

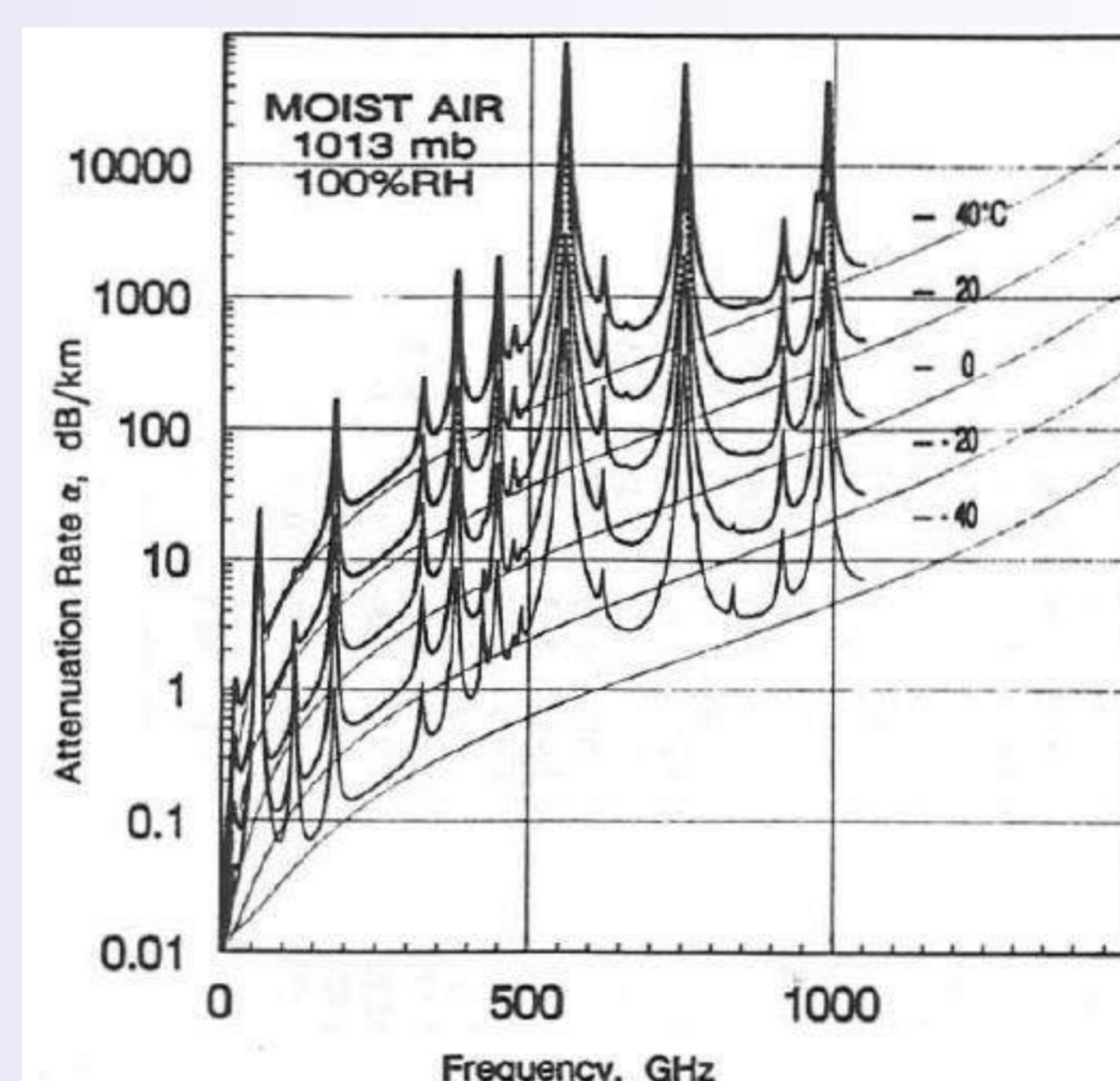


- Earth remote sensing
- Non-destructive testing of structural integrity
- Moisture content determination
- Coating thickness control
- Structural integrity
- Medical applications
- Concealed weapons detection

Specific attenuation due to atmospheric gases (Oxygen and water vapour)



## Challenges



Attenuation  $\alpha$  of moist air for frequencies below 1000 GHz at sea-level and temperatures  $\pm 40^\circ C$

- Atmospheric gases attenuation
- Water vapour absorption
- Oxygen absorption
- Precipitation Attenuation
- Rain
- Snow
- Foliage Blockage
- Scattering effects
- Diffused and specular reflections
- Diffraction

## Obstacle detection and avoidance in Robotics



## Future applications



Autonomous vehicles

