RADAR IN AUTONOMOUS VEHICLES

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RADAR

» Acronym for RAdio Detection And Ranging
  • Currently it is accepted as a word not acronym
» Used firstly for detection of targets and estimating their range
» With the advancement of technology in the middle of 20th century radars were used for measuring speed and direction of arrival, as well
» Currently, radars are used in all kinds of applications:
  • Meteorology
  • Archaeology
  • Biology
  • Automotive
  • Military
  • etc.
» Use fancy words that not always mean better! Also, love dB units.
» Three dimensional radar results generally correspond to range, radial velocity and one angle!
“There is nothing new in radar for the past 30 years. Fundamentally, it still is only triangles and FFTs.”

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HOW WAS RADAR DISCOVERED?

» Heinrich Hertz

- Proved the existence of electromagnetic waves
- Found that these waves scatter, reflect and refract similar to light

"It's of no use whatsoever[...] this is just an experiment that proves Maestro Maxwell was right—we just have these mysterious electromagnetic waves that we cannot see with the naked eye. But they are there."
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“It [now] seems to me that it should be possible to design [an] apparatus by means of which a ship could radiate or project a divergent beam of these rays in any desired direction, which rays, if coming across a metallic object, such as another steamer or ship, would be reflected back to a receiver screened from the local transmitter on the sending ship, and thereby immediately reveal the presence and bearing of the other ship in fog or thick weather.”
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» **Christian Hülsmeyer**
  - In 1904, Christian Hülsmeyer gave public demonstrations of the use of radio echoes to detect ships. He patented the device, called the *telemobiloscope*. 
HOW DOES A RADAR OPERATE?
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Through the magic of antenna technology and signal processing further information about the target can be obtained:
- Speed
- Angular position
- Material
- 3D geometry
TYPES OF RADARS

By usage some of the types are:

- Moving target indicator (MTI) and tracking
- Ground penetrating radars (GPR) – usage in archaeology
- Doppler radars – mainly speed guns
- Space observation – planet and asteroid detection, also used on satellites
- Imaging radars
- Early warning radars – over the horizon radars, ballistic missile defense systems
- Proximity radars – fuses and triggers
- Weather radars – cloud and rain movement, also butterfly swarms sometimes
- etc.

Each system has different hardware and signal processing requirements.
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Automotive radars
WHY DO WE NEED RADARS IN CARS?

The ability of a radar system to detect and measure the parameters of targets is based on three physical phenomena:

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- The ability of objects to scatter electromagnetic waves;
- The Doppler effect.
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» The important peculiarities of radar compared to visual or acoustic observation are the abilities to:
  • Operate in light or darkness over a long range;
  • Operate in all weather conditions;
  • Extract the targets true range and radial speed as well as spatial coordinate
WHAT IS AN IMAGING RADAR?

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Systems with poor resolution only output a single blob in range-Doppler (or range-angle) domain.

The size of the ship is 200m x 20 m.
High bandwidth synthetic aperture radar (SAR) demonstrator fitted on an airborne platform (plane).

Car park roughly 1.5 km away during the measurement.
AUTOMOTIVE RADARS

As far as I am aware one of the first radar systems fitted on a car (for road imaging purposes) was done by Lucas on a Triumph 2000. (Ka band)

Also measurements were done by Phillips Research Labs in the UK. (1971)

- They used a military grade mm-Wave radar with a slot antenna fitted on the roof of an old Land Rover
- First (I think and only) test was done on an airfield in the UK. The driver was relying on the radar display only.
HISTORY OF AUTOMOTIVE RADARS < 1960S
WHAT ABOUT THE FUTURE IN AUTOMOTIVE RADARS?

» Near-future:
  • High-resolution imaging radars (using the 76-81 GHz extended frequency allocation) – reference models already available on the market
  • “Satellite” radar system – centralized signal processing for few radar sensors around the vehicle
  • Dedicated SAR imaging radars for automotive applications

» Long-term development:
  • Low-THz and THz radars – 150, 300, 670, … GHz with range resolutions of order of mm.