

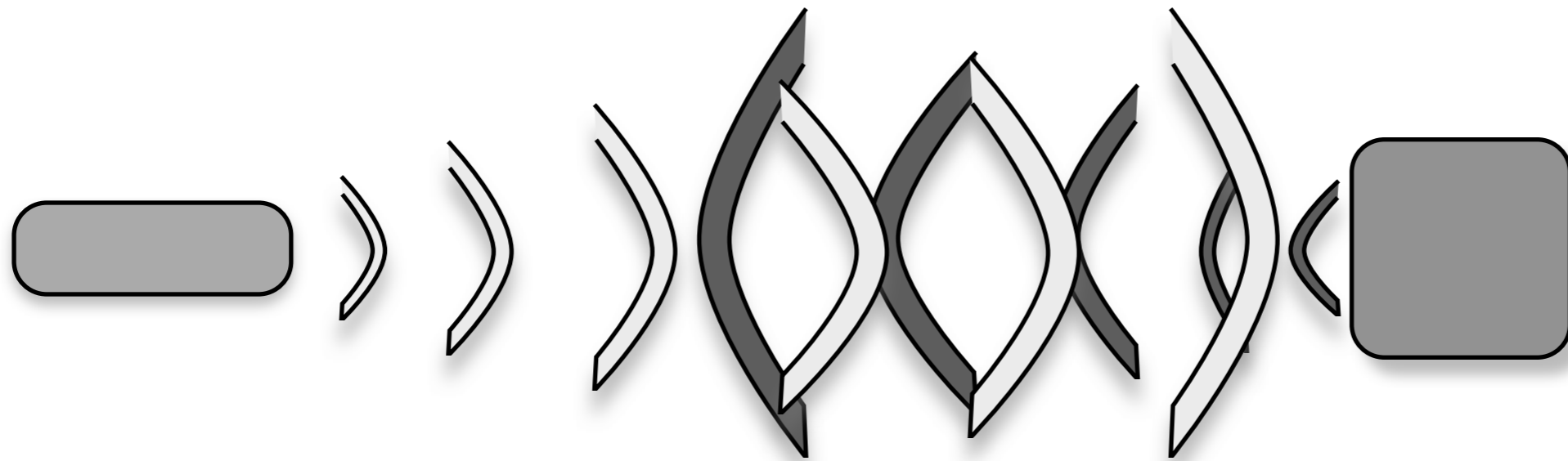
Ultrasonic Sensors

for Planetary Exploration

What they are

- Ultrasonic: Sound at a higher frequency than can be heard by humans (> 20000 Hz)
- Sensors use sound to sense objects that reflect sound
- AKA Sonar

How They Work



- Piezo-electric mechanism
- Different Types:
 - Modulated Waves
 - Echolocation
 - Frequency Sweeps

What They are Good For

- Obstacle Avoidance
- Navigation
- Map Building
- Underwater Exploration!

What are the Advantages?

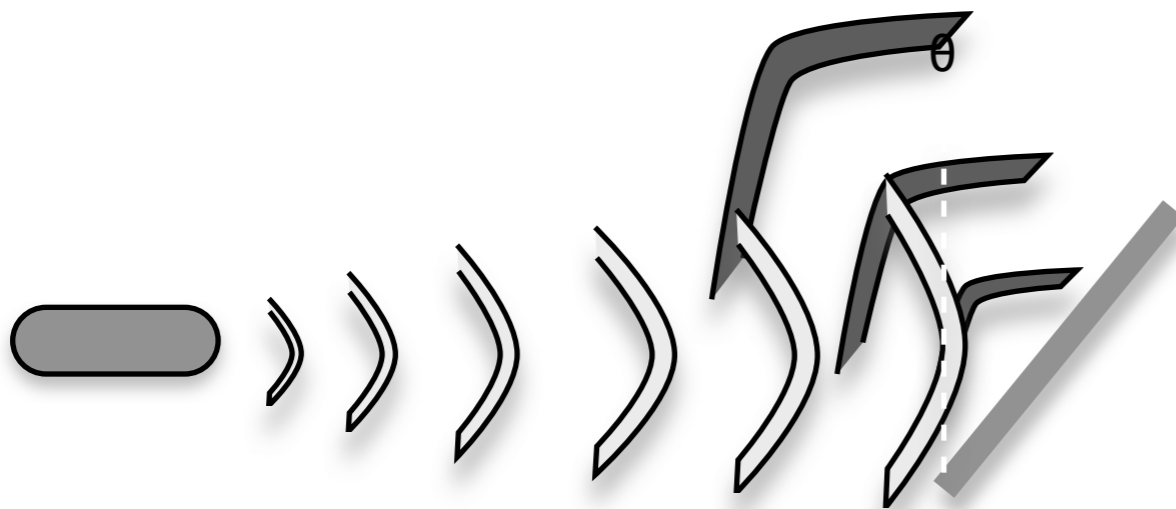
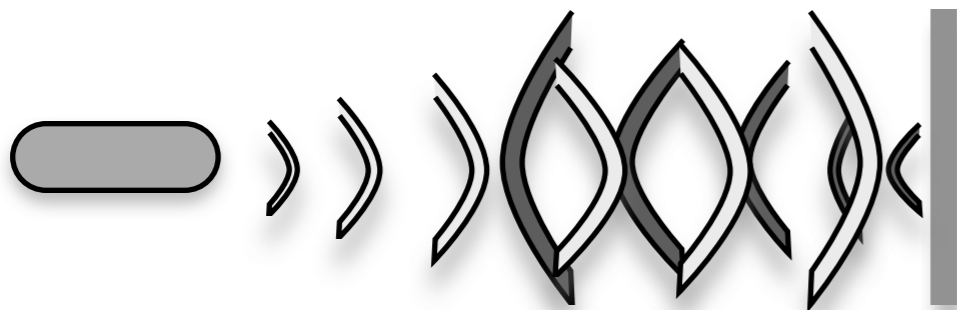
- Can detect things that are hard to see
- Not affected by colour
- Less affected by target surfaces
- Measures discrete distances to objects

What are the Advantages?

- Resistance to many disturbances we talked about:
 - vibration
 - infrared radiation
 - ambient noise
 - EMI radiation

What are the Issues?

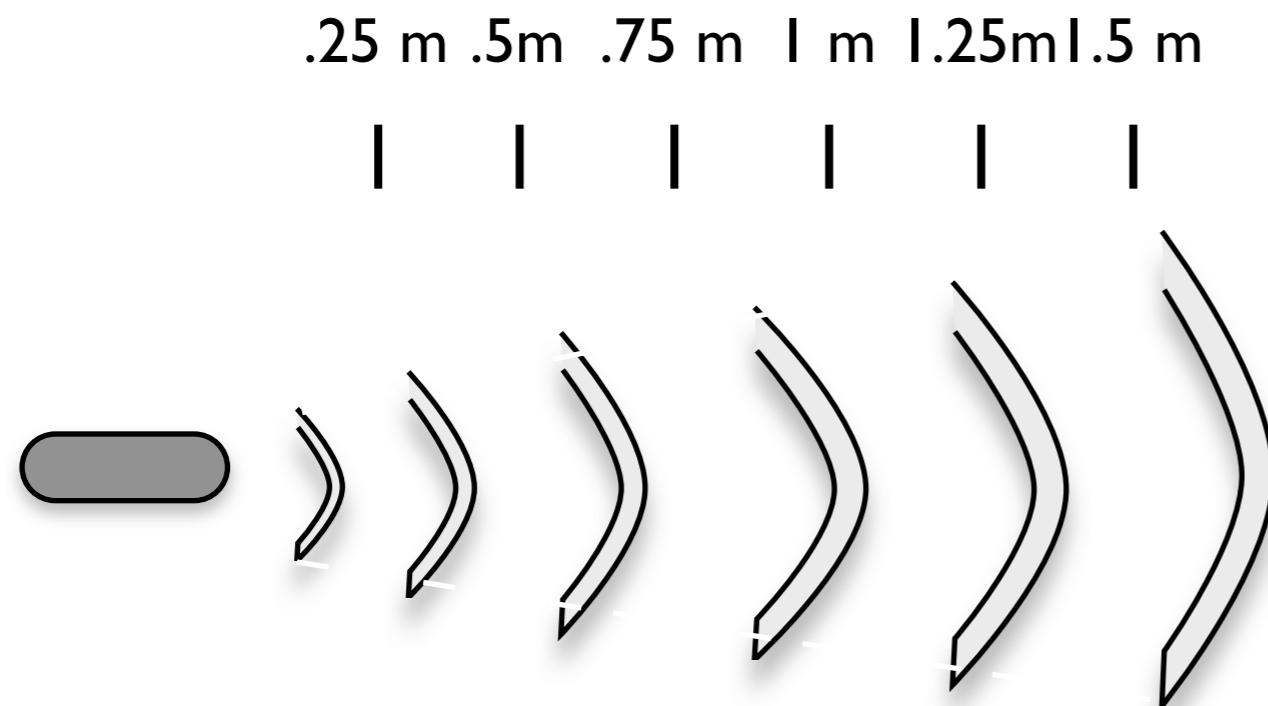
Target Angle



- Examples of Angles from Migatron Sensors:
- RPS-150: $\pm 35^\circ$
- RPS-400-6: $\pm 6^\circ$
- RPS-426: $\pm 10^\circ$

What are the Issues?

Beam Spread



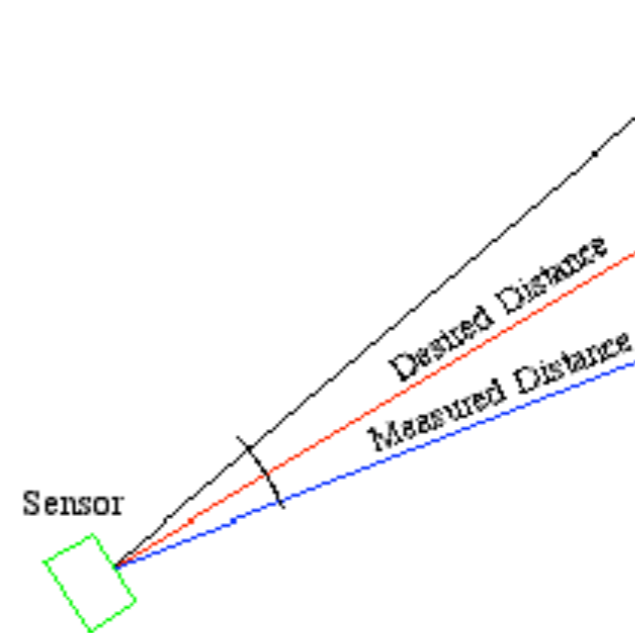
- Examples of Max Spread from Migatron Sensors:

- RPS-150: 58" at 72" away
- RPS-400-6: 1.06" at 6" away
- RPS-426: 14.5" at 72" away

What are the Issues?

- Don't work in vacuum.
- Poor sound travel on Mars, the moon
- Time of Flight error

Time of Flight error

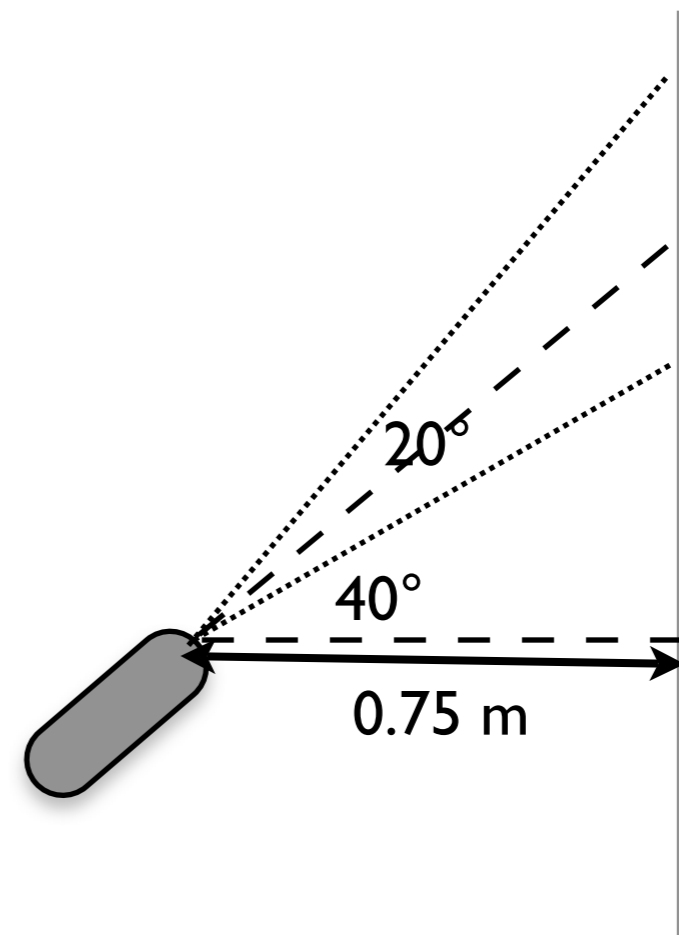


<http://www.cs.brown.edu/people/tld/courses/cs148/02/sonar.html>

Assignment

Your robot is mapping its environment with an ultrasonic sensor, and comes across a wall. Assume the beam spread is a cone with an angle of 20° , and the range is sufficient to sense the wall from its current position. The robot is 40° from pointing straight at the wall, and the shortest distance from the sensor to the wall is 0.75 meters.

What is the error between the desired distance measurement and the actual distance measured? Show your work.



What's New?

Acoustic Doppler Current Profiler / Doppler Velocity Log

- Underwater vehicles
- Sound waves point downwards
- Tracks water current
- Doppler Velocity Log: Tracks position

What's New?

Acoustic Doppler Current Profiler / Doppler Velocity Log

- Bluefin
- MIT Autonomous Underwater Vehicle Lab spinoff
- Scientific, Military, Industrial Applications
- Uses Teledyne RDI Doppler Velocity Log



<http://www.bluefinrobotics.com/>

Who Develops Them?

- Sensor Development:
 - Migatron Corp, Hitechnic, Teledyne, Maxbotics
- Low cost sensors for autonomous wheelchairs
 - Stott, Sanders, Tewkesbury, University of Portsmouth
- Finding submerged mines
 - Toin University of Yokohama

Who Uses Them?

Woods Hole Oceanographic Institution

- Puma and Jaguar
- Explore under Arctic ice
- Search for hydrothermal vents
- Multiple ultrasonic sensors onboard



<http://www.whoi.edu/>

Who Uses Them?

Woods Hole Oceanographic Institution

- Kongsberg-Simrad EM300 Multibeam Echo Sounder
- Creates 3D maps of the ocean floor
- Mounted on bottom of ships



<http://www.whoi.edu/>

Who Uses Them?

CMU's Red Team

- HILander and Sandstorm
- In conjunction with lidar
- Less accurate, longer range
- Two different ranges



<http://www.redteamracing.org>

Who Uses Them?

Aurora Flight Sciences

- PANOPTIS system
 - Micro Unmanned Air Vehicle
 - Combine optics flow and echolocation
 - Optics for large obstacles, ultrasonics for small

Conclusion

- Measures the reflection of sound
- Detects things unseen by optical sensors
- Used in all kinds of environments
 - Air, land, water

References

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- Red Team, <http://www.redteamracing.org/>