

LIDAR Technology and Its Diverse Applications

HI-TEC 2020 Transformed



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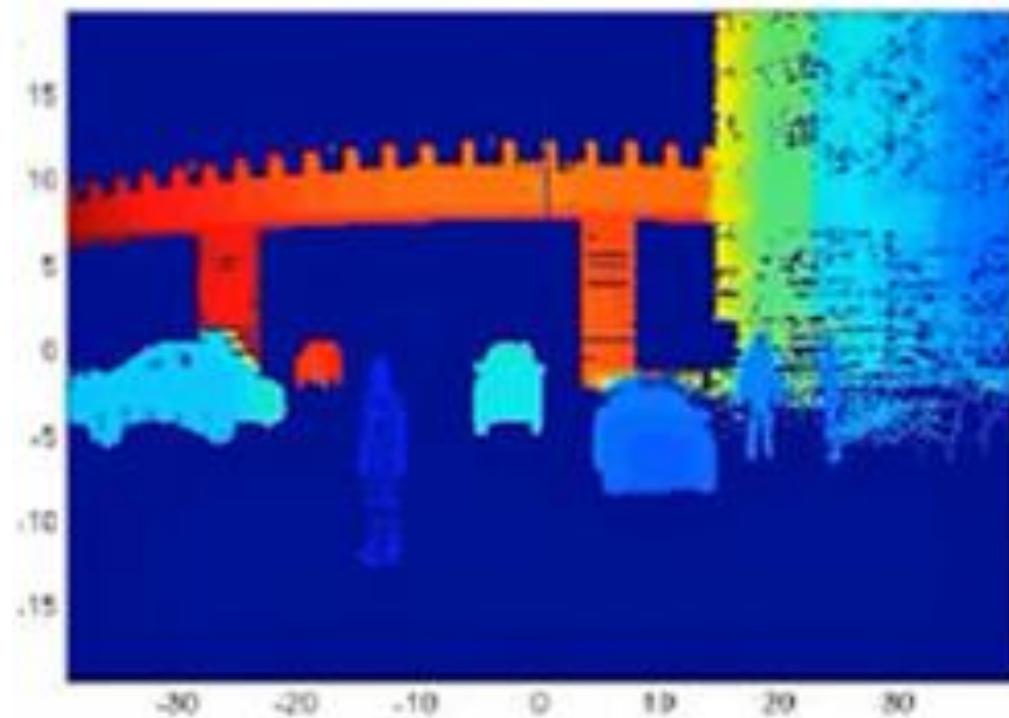


Outline

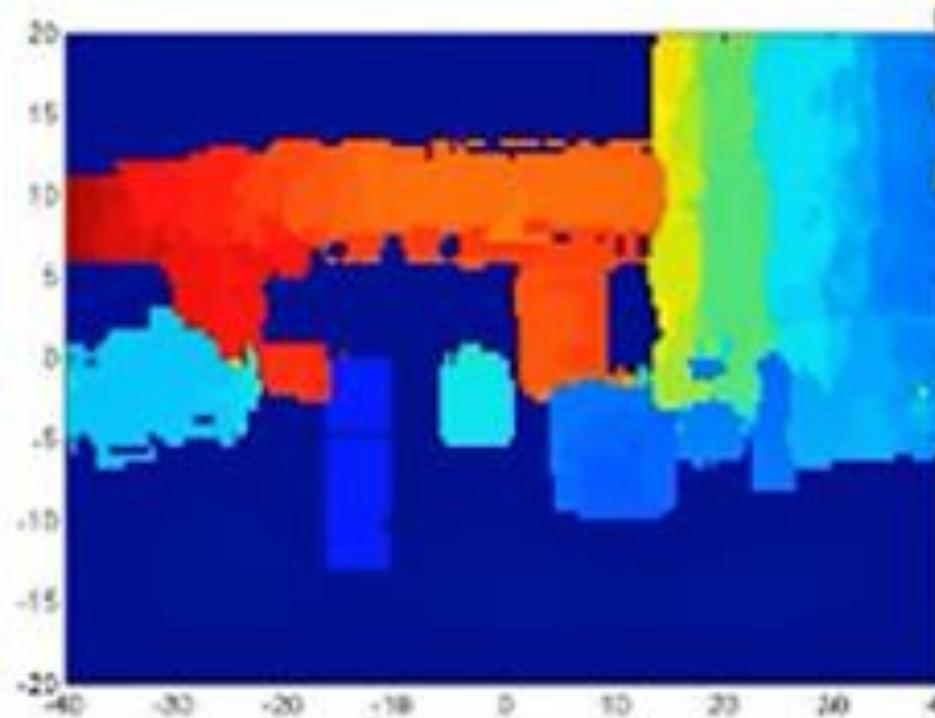
- I. What is LIDAR?
- II. LIDAR Basics
- III. Components and Types
- IV. Performance
- V. Applications
- VI. Lidar in ATE
- VII. Student Projects Using Lidar
- VIII. Resources

I. What is LIDAR?

- Light Detection and Ranging
- Analogous to Radar, but based on light waves instead of microwaves
- Technology that uses a laser beam and its reflections from surrounding objects to determine the distance between the laser source and the objects
- Using light waves allows for higher resolution than radar
- Can create high resolution, 3D maps of the environment
- Technology is becoming ubiquitous, with growing number of applications



Lidar



High Resolution Radar

Lidar vs Radar comparison

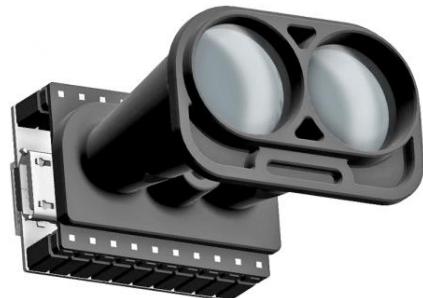
- Lidar has better resolution and produces a much clearer picture
- Lidar is worse than radar in bad weather conditions like fog, snow

II. LIDAR Basics

- Lidar has been around for 50+ years
- The technology was invented soon after the invention of the laser in 1960
- Initially developed for use by the military, in applications such as rangefinders and weapons guidance systems
- One early application was mapping the surface of the Moon by Apollo 15 astronauts in 1971
- Since then Lidar applications have multiplied
- A highly anticipated, high volume commercial application is in self-driving vehicles

III. Components and Types

- Basic components of Lidar
 - Laser source - transmitter
 - Photodetector - receiver
 - Electronics - for synchronization and data processing
 - Motion control equipment or components for precise laser steering
- Types of lidar
 - Mechanical scanning – rotating, covering 360° or smaller field of view
 - Solid state – no moving parts – based on MEMS or optical phased array
 - Flash – emits a single pulse of light, spread over large area



Laser Source

- Plays a large role in device performance
 - Beam divergence impacts the lateral resolution, in the x, y axes
 - Power impacts the range of the device – big range requires high power, on the order of Watts or more. High power is also needed if the target has low reflectivity.
 - Pulse duration impacts the longitudinal resolution, in the z axis
 - Pulse repetition impacts the data throughput, how much data is generated per second
- Different types of lasers were used historically – ruby, Nd:YAG, CO₂, fiber
- Diode lasers and VCSELs are now the most common

Laser Source

- Laser wavelength depends on the application
 - 355 nm (UV) for atmospheric applications
 - 532 nm (visible, green) used in water applications
 - 830 nm - 940 nm are common in many Lidars
 - 1.55 μ m (IR) works well for detecting solid bodies and is better for eye safety
- Safety considerations for commercial applications – the 355 nm and 1.55 μ m wavelengths are safer

IV. LIDAR Performance

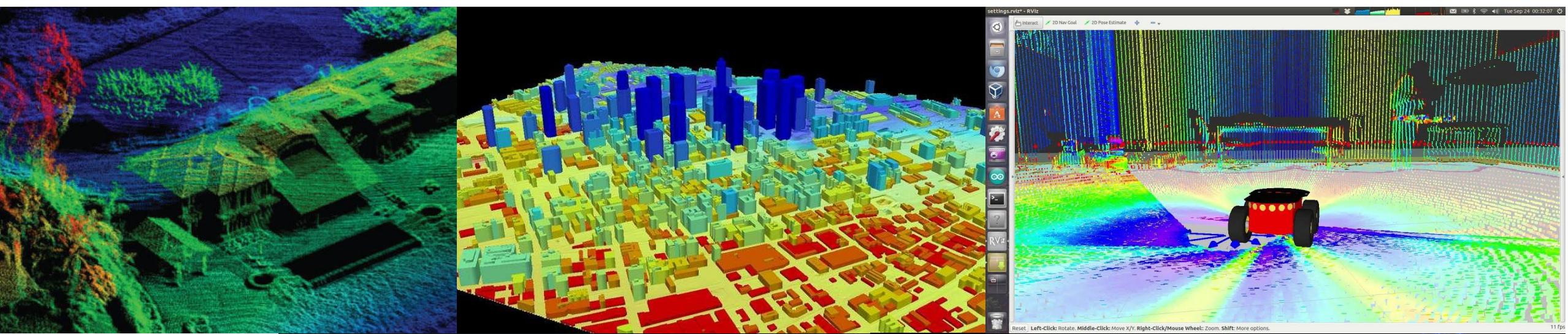
- Resolution: on the order of cm
- Range: <1m - 300 m
- Size: varies from table top size to compact electronic device
- Cost: from \$ tens of thousands to < \$100, depending on performance
- Evolution has been towards smaller size, higher reliability and smaller cost
- Last decade has seen intense competition for producing an inexpensive, high performance Lidar for self-driving vehicles
- Hundreds of companies are developing Lidar for automotive and other industries

V. Applications

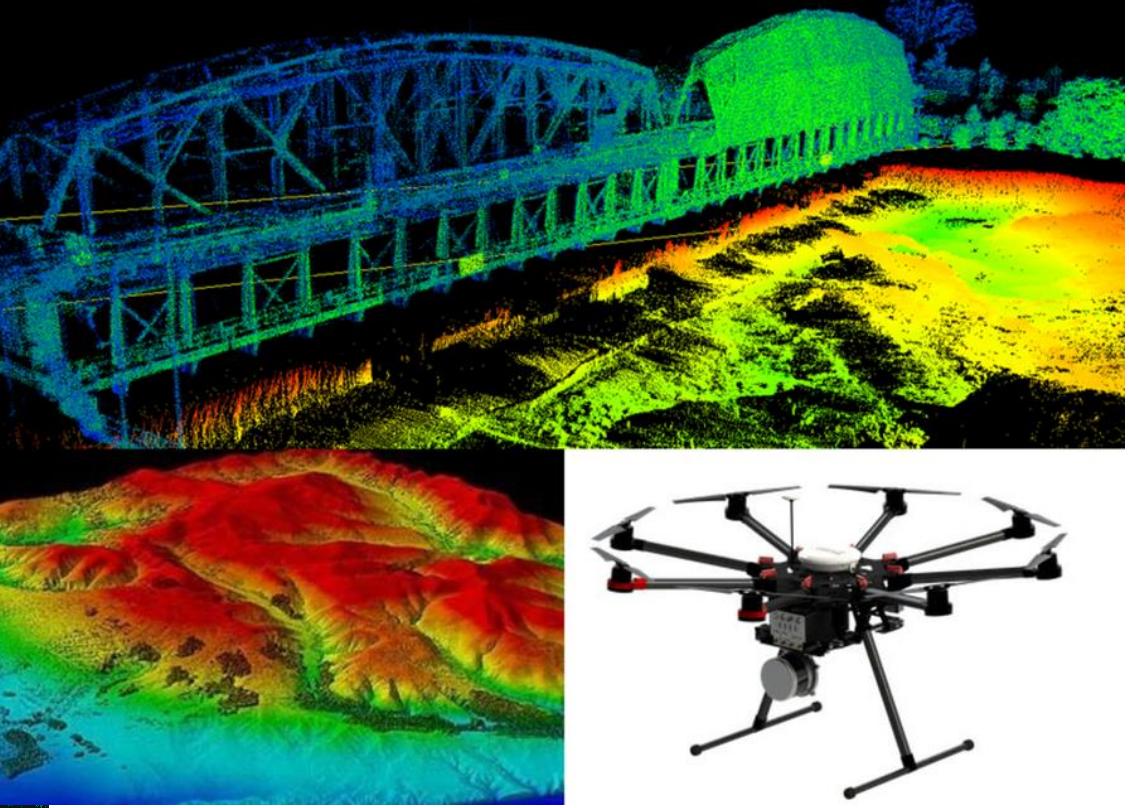
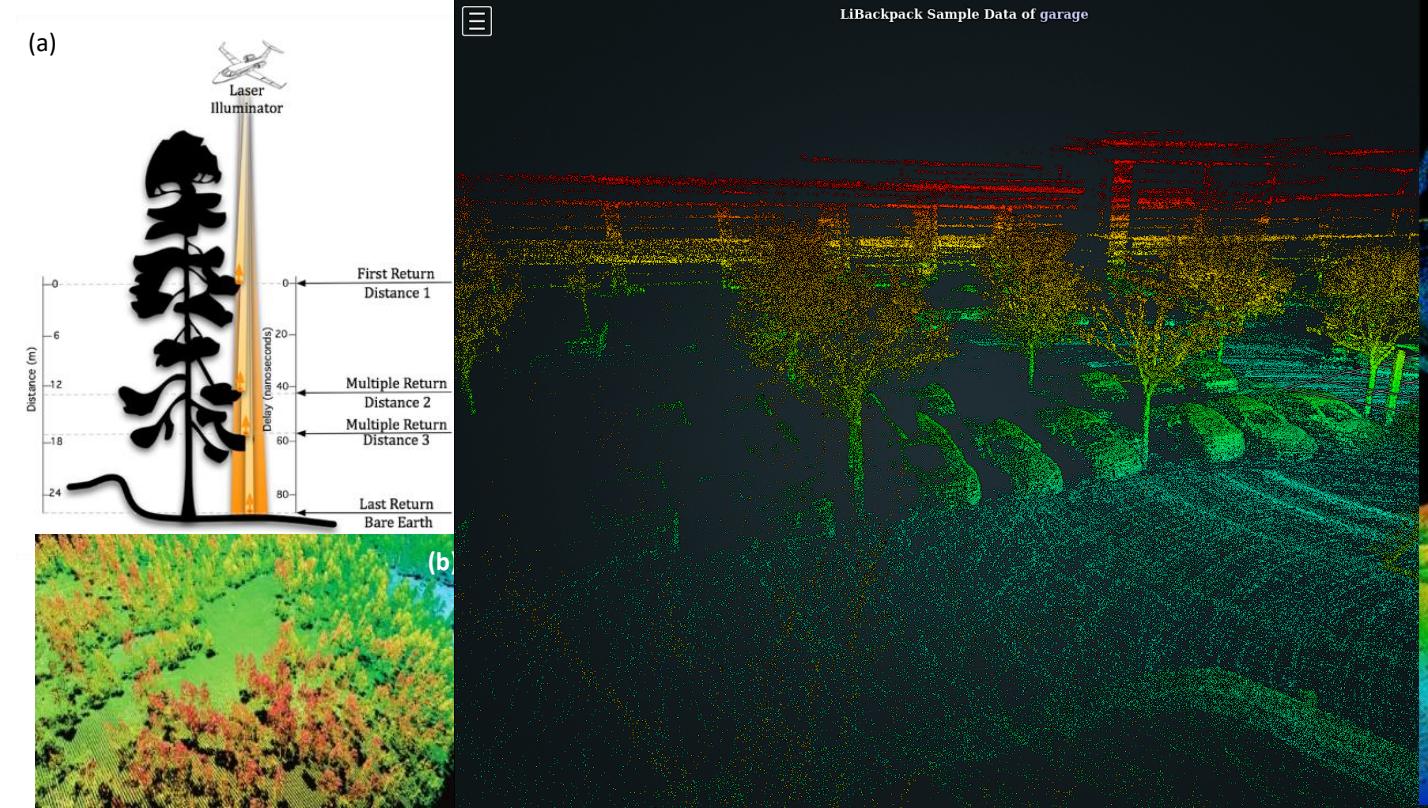
- Agriculture
 - map terrain, monitor health of crops, determine use of fertilizer and pesticides
- Airborne applications
 - obstacle detection, terrain following, wind sensing
- Archeology
 - mapping of ancient sites
- Autonomous vehicles
 - self-driving cars, trucks, boats and planes
- Environmental
 - determine composition of atmosphere and oceans, detect pollution, monitor deforestation

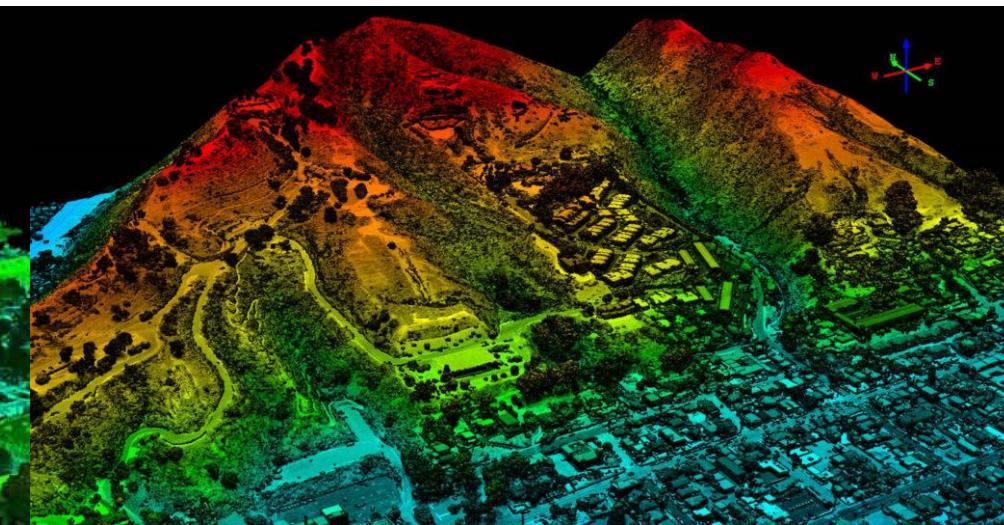
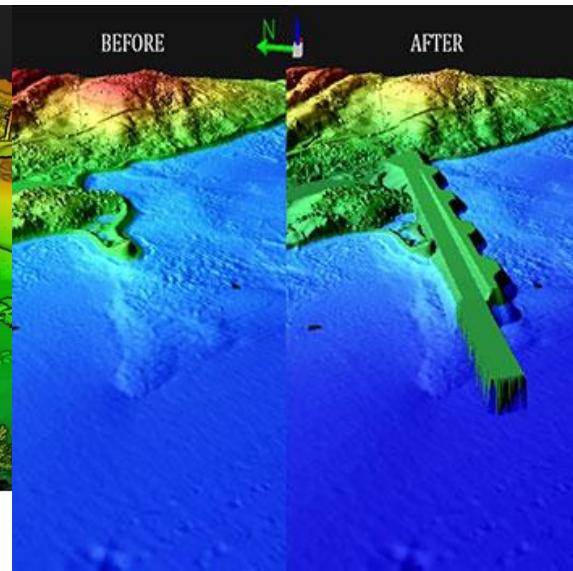
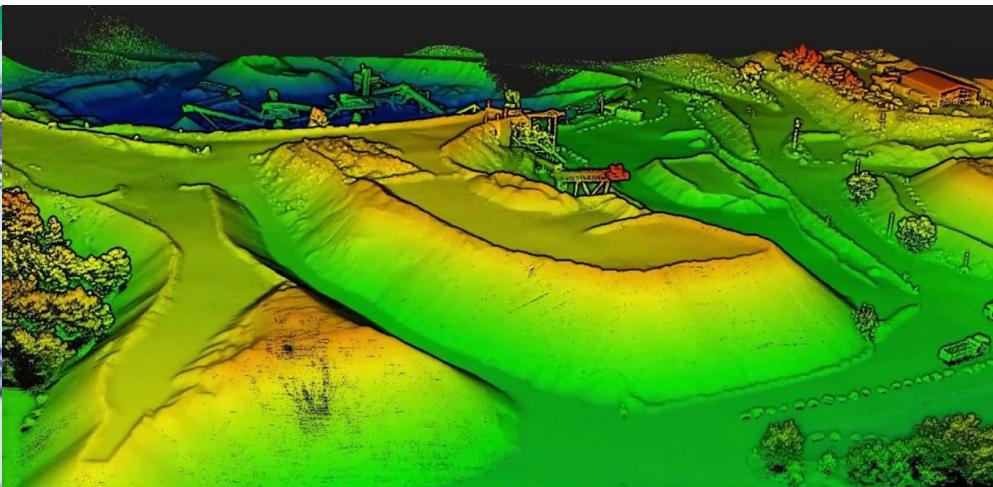
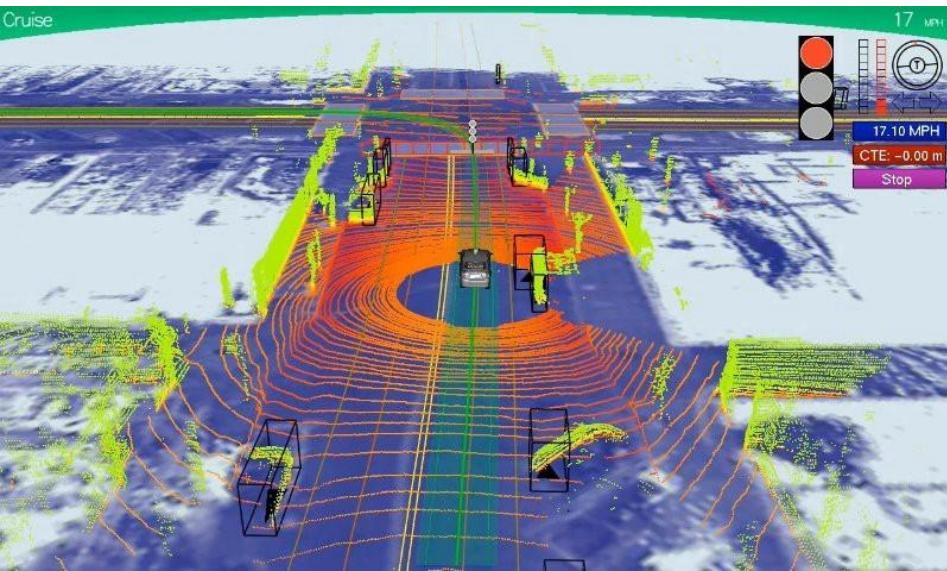
Applications

- Industrial robots
- Mapping
 - shorelines, rivers, lakes
- Medicine
 - analyze content of drugs, eye investigation
- Military
 - identify targets, weapons guidance
- Mining industry
 - map excavated areas, determine volume of material removed
- Unmanned aerial vehicles (UAV), drones
 - geospatial measurements, ...



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VI. Lidar in ATE

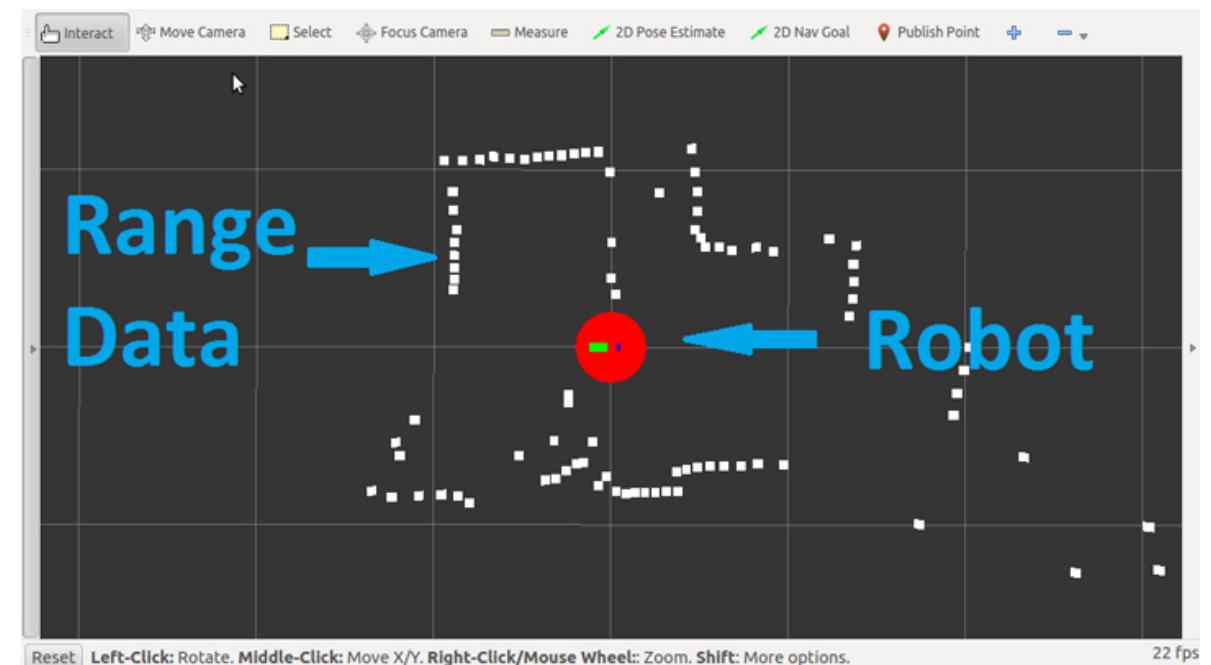
- Lidar is an Advanced Technology that combines optics and lasers, electronics, motion control, computing, data analysis and interpretation
- Its applications cover a wide range of industries
- Lidar projects can be embedded in numerous ATE programs
 - Automotive technology
 - Agricultural and environmental technologies
 - Engineering technologies including optics, electronics, mechatronics, robotics
 - Information and communications technologies
 - Geospatial technology
 - And others

VII. Student Projects Using LIDAR

- Obstacle Avoidance
- Map Generation
- Self Driving Car
- Path Planning Robot
- Websites
 - [Best Lidar projects for students](#)
 - [Best Ros projects for students](#)
 - [37 Lidar projects](#)
 - [More Lidar projects](#)
 - [Lidar-based self-driving car](#)

Student Projects Using LIDAR

- [Home made Lidar sensor](#)
- [Arduino based Lidar scanner](#)
 - www.qcontinuum.org/lidar
- [Autonomous robot using Lidar](#)
- [DIY Roomba](#)



VIII. Resources

- RPLidar A1M8 - 360 Degree Laser Scanner Development Kit, \$99, available from robotshop.com
- TFMini - Micro LiDAR Module, \$49.94, available from mouser.com
- Garmin LIDAR-Lite, \$ 59.95, available from adafruit.com
- [Getting started with Lidar](#)
- [Best Lidar sensors for makers](#)
- [What are the top 5 uses of Lidar](#)
- [Drone + Lidar](#)
- [Basics of Airborne Lidar](#)

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Thank You!