Use of Laser Range Finders in Mobile Robots & AGV's

Sensing industry needs

22nd April 2009 Hannover

SENTEK solutions

Presentation Outline

- Introduction to Sentek & Hokuyo
- Laser Range Finders: What, where & how
- Some real life applications
- Summary
- Questions

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A Brief Introduction

- Sentek Solutions consists of:
  - Sentek Solutions Inc: N America
  - Sentek Solutions Ltd: Europe
- We specialise in supplying Opto electronic devices for Automation & Robotics
- To most of you here we are the supplier of everything HOKUYO
- Which means small, low power
  - Laser Range Finders
  - Obstacle Detectors
- Ideal for robots and autonomous devices

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Hokuyo Profile

- Established : 1946
  - Turnover ¥5bn (€32m)
  - 150 employees
- Specialisation
  - Range Sensors
  - Optical Data Transmission Devices
- Other sensors (Photoelectric, ultrasonic, Counters....)
- Based in Osaka, Japan (Development and Manufacture)
  - Operate in Europe & US via Sentek Solutions



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What is a laser range finder

- It’s simple really
  - A rapidly rotating IR laser beam & receiver
  - Some smart electronics
  - And some clever software
- All miniaturised
- Then packed into a compact, protective and vibration resistant, housing

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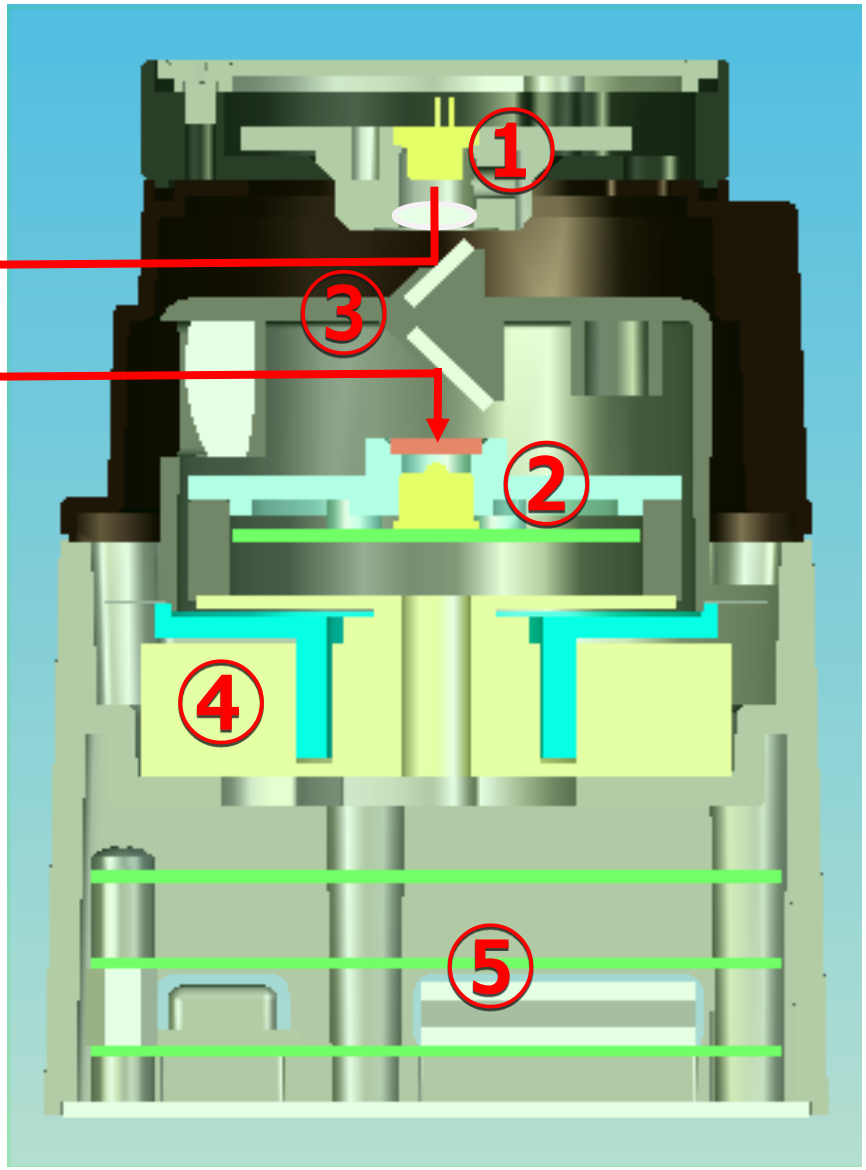
URG-Design

1. Light Source (Laser)
2. APD
3. Mirrors (Transmitter, Receiver)
4. Motor
5. Control Circuit



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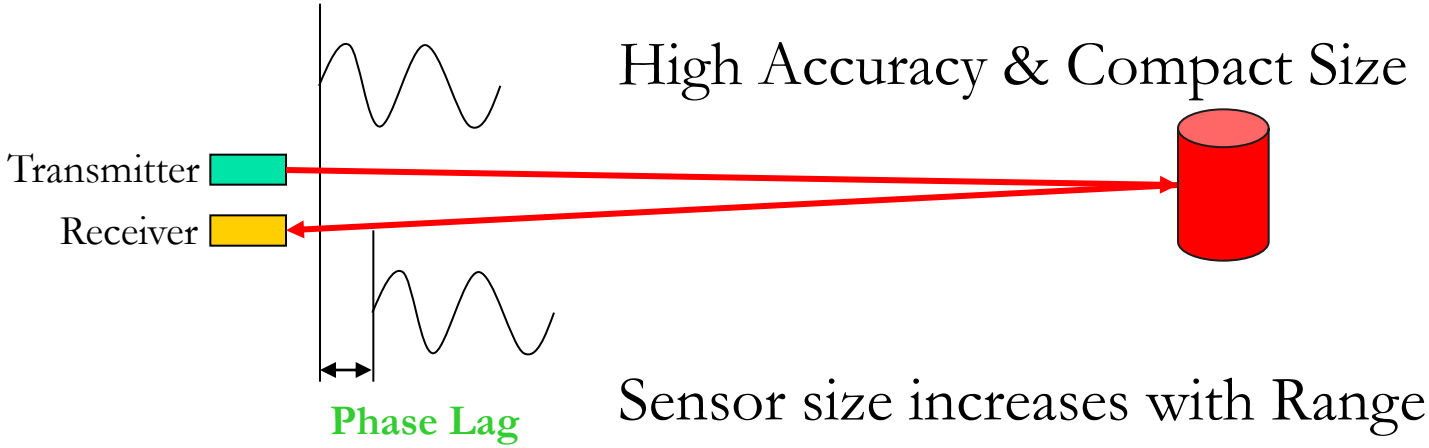
So how does it work?

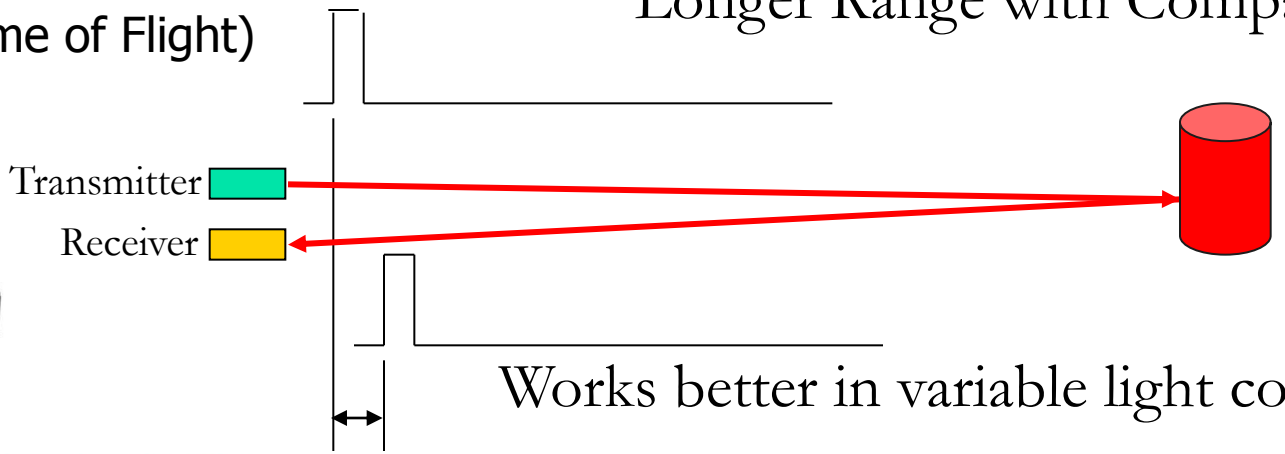
AM (Amplitude Modulated)



High Accuracy & Compact Size

Sensor size increases with Range

TOF (Time of Flight)



Longer Range with Compact Size

Works better in variable light conditions

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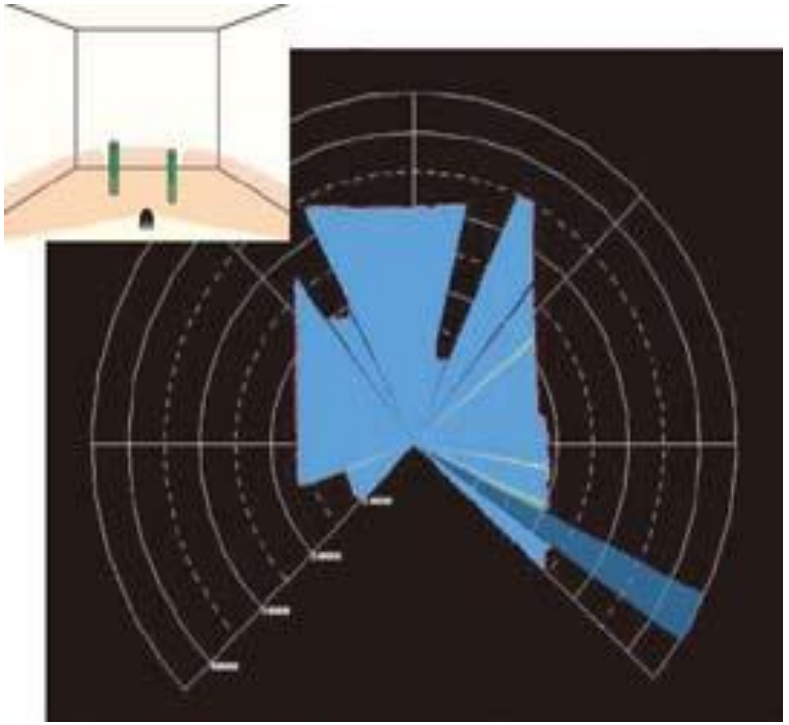
What information is produced?

- Converted raw data (binary) gives:
  - Data step number (scan window / resolution)
  - Direction in Radians
  - Distance from X axis
  - Distance from Y axis
- This can be viewed in VMON our Visualisation programme



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How is this information used?

- Laser range finders break down into two functional categories
  - Obstacle Detectors
    - These are standalone LRF devices, for AGV's etc
    - Once pre configured on a PC they will trigger NPN outputs when objects encroach into defined zones around the AGV
    - This enables control
  - Pure Laser Range Finders

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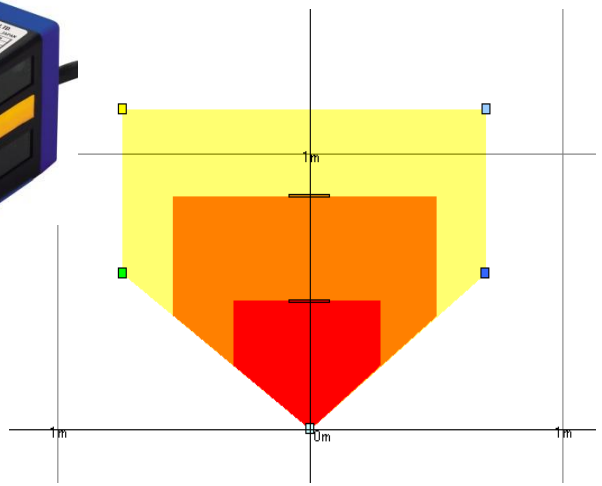
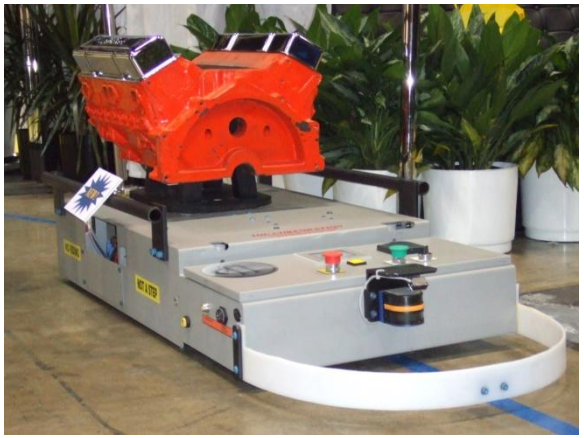
Some Obstacle Detectors in use

- For use in defined environments generally for repeatable tasks
- Carrier vehicles are not fully autonomous / robotic
- Excellent factory automation devices





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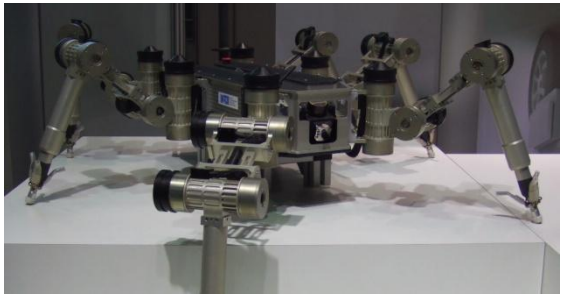
Pure: Laser Range Finders

- Laser Range finders are used for more “intelligent / autonomous” applications
- Output is raw data (effectively time stamped-visual map)
- Onboard intelligence rather than IO is needed
- Typical Applications are:
  - Robotics
    - Obstacle Avoidance
    - Path Planning
    - SLAM (Simultaneous localization and mapping)
  - Security:
    - Movement Detection with time based history
    - Configurable actions to predicted behaviour patterns



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Some real life applications

- To be honest I was hoping that some of our many customers would provide photo's, video's or stories
- But everybody is either….
  - Too shy
  - Too busy
  - Too Secretive
- So I've taken some in house applications & some that are in the public domain

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Real applications: Beego

- You might have seen our robotic dog!
  - Three wheeled rather than four legged
- If you go and say hello he will instantly take a liking and follow you around

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Beego: Explained

- Essentially Beego (and his software) recognise specific shapes and react accordingly
  - Introduction: Close covering of the sensor = reset
  - Two curved shapes moving away are legs = follow
  - Meanwhile other observed shapes are obstacles = avoid
- From this it is not difficult to imagine LRF's providing navigation from room shape recognition

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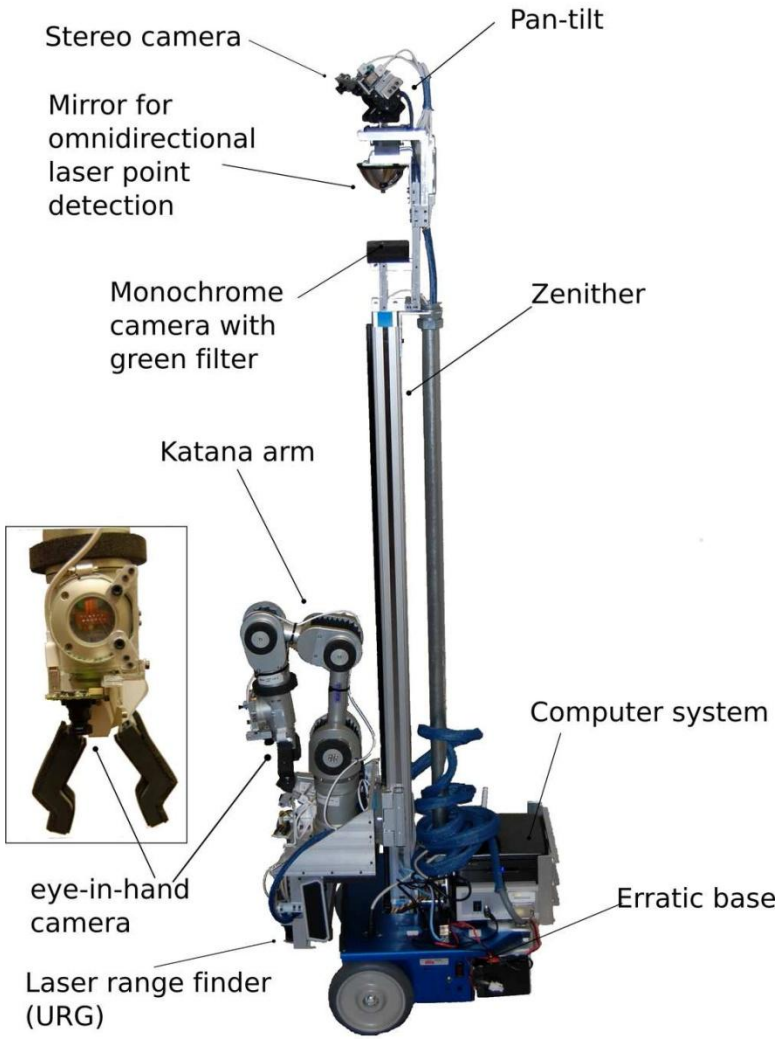
Real applications: El E

- El E is an Assistive Robot developed by Georgia Tech
- She will
  - Retrieve objects from the floor or a flat surface
  - Carry out manipulation tasks
- She uses multiple optical and tactile sensors



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El E explained

- A URG-04LX LRF & camera arrangement are used to localise and move towards a laser illuminated object
- If the object is above floor level the LRF together with a linear actuator will
  - Create a 3D map
  - Identify a flat surface
  - Position the gripping device at a defined height
- The gripping device with eye in hand camera and tactile sensing will then retrieve the object

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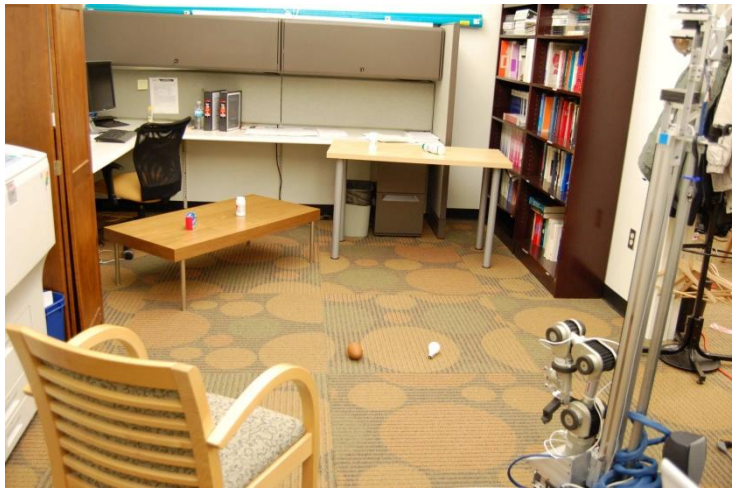
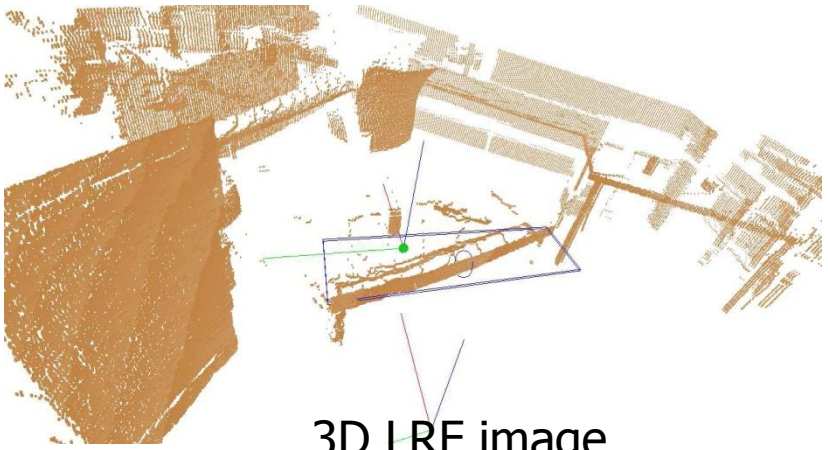
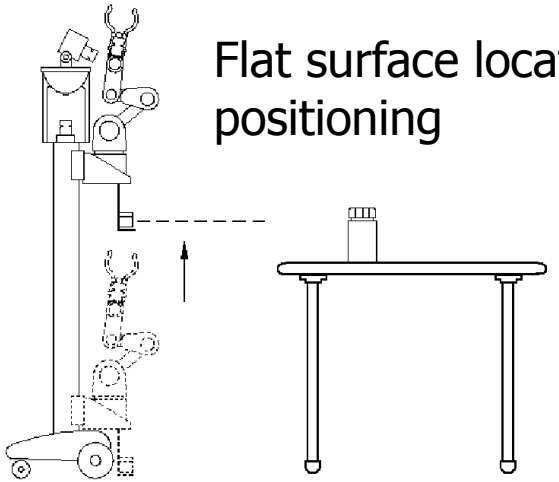
El E explained

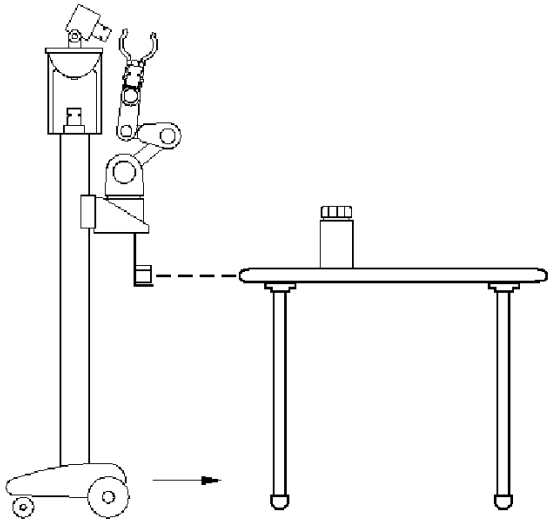




3D LRF image

Flat surface location & positioning





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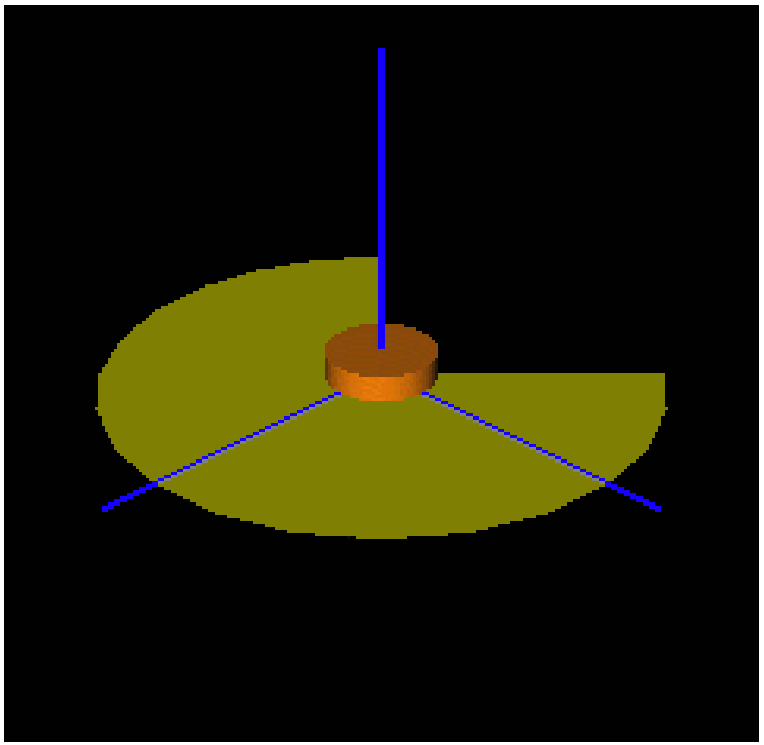
Real Applications: Tokyo Subway mapping

- Here a UTM-30LX is used
- Note the gyroscopic mount to allow 3D mapping



Schematic shows how a 2D scan can provide 3D information

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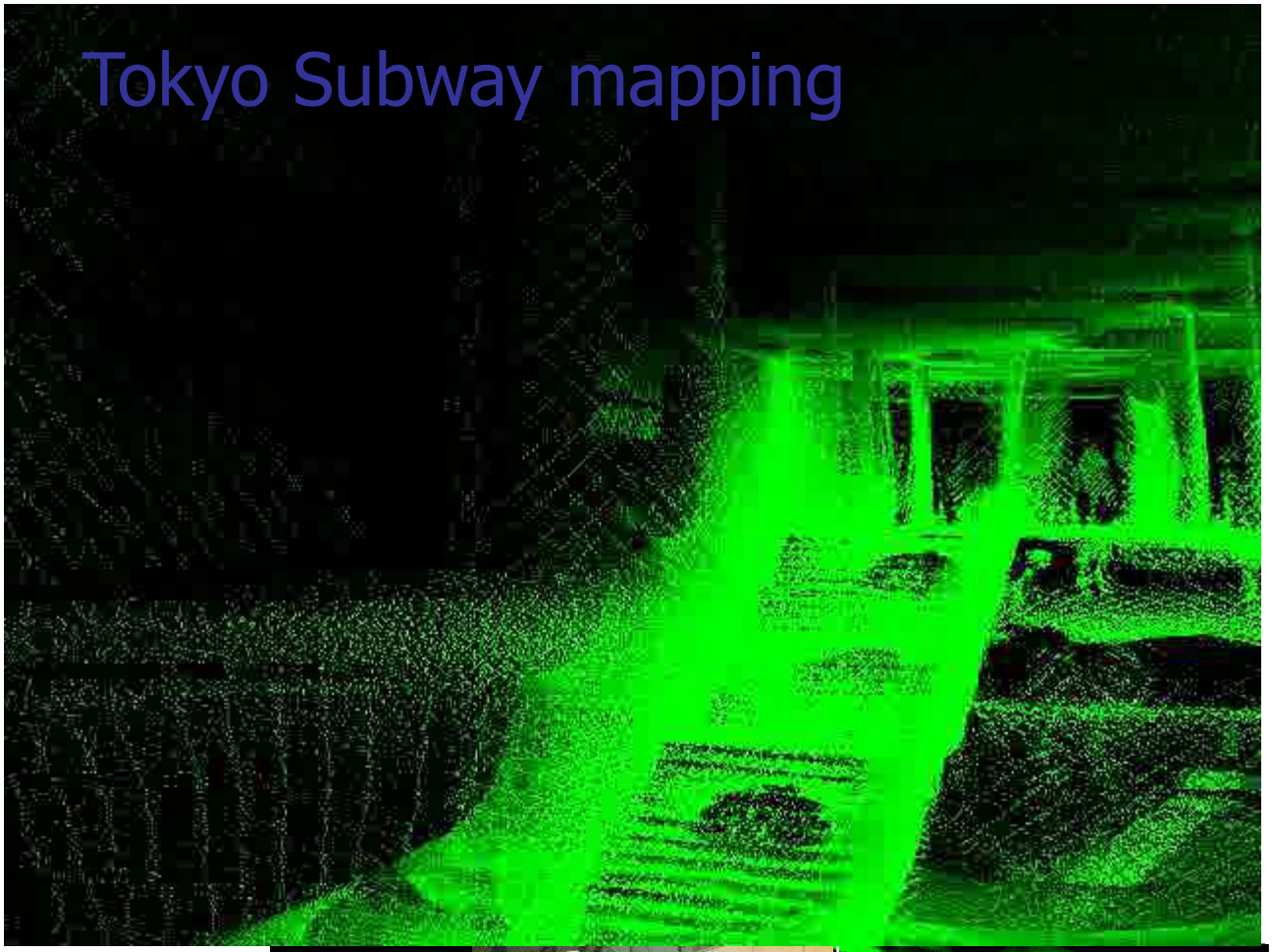
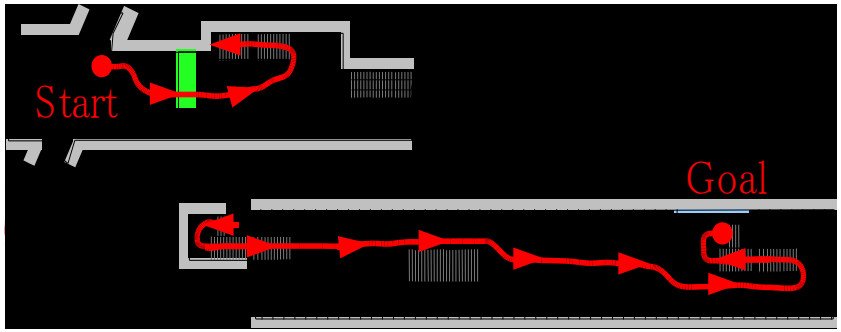
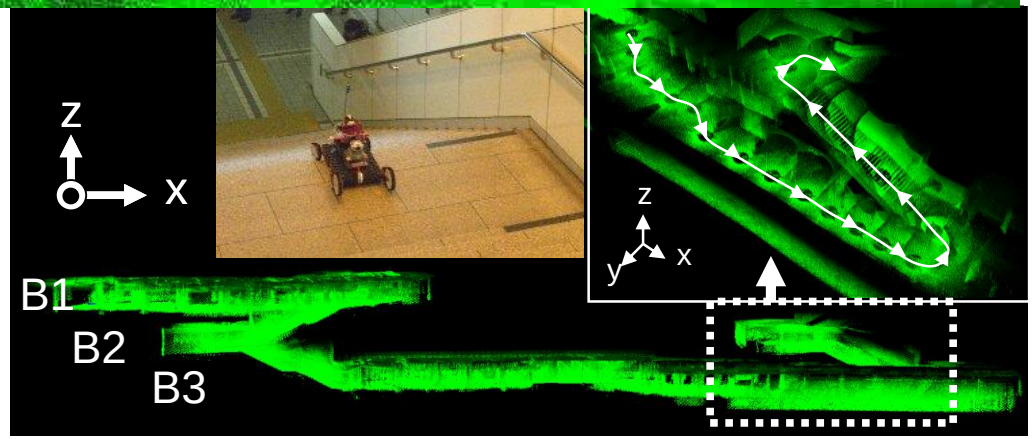
Tokyo Subway mapping

- 3D performance can be achieved with high LRF scan speeds
- This demonstrates use of LRF's for rescue / mapping







In Summary:

- Small, low power LRF's are vital robotic / factory automation tools
- As speeds & miniaturisation increase and costs decrease they will be used more extensively
- Modular functionality and size allow designers to integrate in the way they want
  - Standalone pre-programmable obstacle detectors or pure LRF
  - 2D, 3D or somewhere in between
- Performance is constantly improving: The new Hokuyo UTM-30LX
  - Tolerant of changing light conditions
  - 30m range
  - 40 Hz scan speed
  - Footprint: smaller than a credit card & only 370g
  - 12V DC & 8.4W

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