Distance Sensors

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ENGR 325
Distance Measurement

- Transmitter-Receiver types
  - IR, LIDAR, Ultrasonic, RADAR, GPS

- Other types
  - LVDTs, Draw Wire, Capacitive displacement
GPS Overview

• Driving directions
• Airplane navigation
• Hiking navigation
• Device tracking
• Construction layout
• Construction automation
Topcon GPS System

- Rover
- Base
- Data Collector
- Cat D6 Automation
The Base

- Receives the same GPS signal that your cell phone uses. This gets the accuracy down to ± 30 ft.
- Must be localized with surveyed control points to get accuracy down to ± .01 ft
- Sends out real time kinematic (RTK) corrections over a radio signal to other rovers
The Rover

- Receives GPS Signal and RTK corrections via radio signal
- Only capable of xyz sensing
- Excellent for layout
- Excellent for making as-builts
The Data Collector

- A computer that is designed to operate in harsh environments
- Runs Topcon’s proprietary software
- Capable of making distance measurements, volume measurements, and many other useful subprograms allow for more extensive data collection
Cat D6 Automation

- This GPS technology can be implemented to automate various machines
## GPS System pros and cons

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
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<tr>
<td>• Excellent precision and accuracy for most construction applications</td>
<td>• Steep learning curve for the older guys in the industry</td>
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<td>• Orders of magnitudes faster than the old-fashioned pulling multiple tapes method</td>
<td>• Very expensive</td>
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<td>• Only need to call surveyors once</td>
<td>• Doesn’t work in areas of radio or GPS interreference.</td>
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<td>• Speeds up overall site production</td>
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LVDT-Overview

• Linear Variable Differential Transformer
• Inductive Distance Sensor
• High Resolution, Fast Response, Widely Used, Cheap, Robust.

<table>
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<tr>
<th>Model</th>
<th>A (zero position)</th>
<th>B</th>
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<tr>
<td>DTA-1G8-3-CA</td>
<td>83 mm</td>
<td>64.3 mm</td>
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<tr>
<td>DTA-3G8-3-CA</td>
<td>89 mm</td>
<td>68.3 mm</td>
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LVDT-Theory

Open Wiring:

Ratiometric Wiring:

\[ D = M \frac{V_A - V_B}{V_A + V_B} \]
LVDT-Construction

- Nickel-Iron Core with a threaded hole
- Primary and Secondary Windings are usually copper
- Stainless Steel outer casing
LVDT Applications

- Fluid Level
- Workpiece thickness
- Diaphragm deflection/pressure
- Velocity and Acceleration
Honorable Mentions

• Draw Wire Displacement Sensors

• Capacitive Displacement Sensors

\[ C = \frac{\varepsilon A}{d} = \frac{k\varepsilon_0 A}{d} \]
References

• http://www.efunda.com/DesignStandards/sensors/lvdt/lvdt_app.cfm
• https://www.micro-epsilon.com/displacement-position-sensors/
• https://www.machinedesign.com/archive/article/21815003/the-hot-and-cold-of-lvdt