Module 4: Sensors and Controllers in robots
Lecture 9: Sensors and controllers (sensor types)

Objectives
In this course you will learn about

- Actuators: Stepper Motors, Electric DC motors, Hydraulic & Pneumatic Actuators
- Temperature, Bearing Forces, Frequency response
- Brawn Vs. Brain
- Sensors
  - Internal State / External State
- Basic Movements – Position, Velocity, Acceleration
- Interaction with environment – Torques, Forces, Touch, Slip, Range, Vision

CLOSED LOOP SYSTEM

VELOCITY SENSOR
Position Sensors

- Potentiometers

  Wire wound type (Linearity 3-5% F.S)
  Conductive Polymer Type (Linearity <1% FS)

Potentiometer: Analog Output
Gray to Binary Conversion

\[
V_O = \frac{\theta}{\theta_{\text{max}}} V_s = k \theta = x V_s
\]

\[
\frac{V_L}{V_s} = \frac{x R_p R_L}{(1-x) R_p + R_z} + \frac{x R_p R_z}{x R_p + R_z}
\]

\[
\text{Error} = x V_s - V_L
= x V_s \left\{ \frac{R_p}{R_z} (x - x^2) \right\}
\]

Binary Count

<table>
<thead>
<tr>
<th>Binary Count</th>
<th>Gray</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
<td>0000</td>
</tr>
<tr>
<td>0001</td>
<td>0001</td>
</tr>
<tr>
<td>0010</td>
<td>0011</td>
</tr>
<tr>
<td>0011</td>
<td>0010</td>
</tr>
<tr>
<td>0100</td>
<td>0110</td>
</tr>
<tr>
<td>0101</td>
<td>0111</td>
</tr>
<tr>
<td>0110</td>
<td>0101</td>
</tr>
<tr>
<td>0111</td>
<td>0100</td>
</tr>
<tr>
<td>1000</td>
<td>1100</td>
</tr>
<tr>
<td>1001</td>
<td>1101</td>
</tr>
<tr>
<td>1010</td>
<td>1111</td>
</tr>
<tr>
<td>1011</td>
<td>1110</td>
</tr>
<tr>
<td>1100</td>
<td>1010</td>
</tr>
<tr>
<td>1101</td>
<td>1011</td>
</tr>
<tr>
<td>1110</td>
<td>1001</td>
</tr>
<tr>
<td>1111</td>
<td>1000</td>
</tr>
</tbody>
</table>

Gray to Binary Conversion

G3 ——— B3
G2 ——— B2
G1 ——— B1
Gc ——— B4
Recap

In this course you have learnt the following

- Actuators: Stepper Motors, Electric DC motors, Hydraulic & Pneumatic Actuators

- Temperature, Bearing Forces, Frequency response

- Brawn Vs. Brain

- Sensors
  - Internal State / External State

- Basic Movements – Position, Velocity, Acceleration

- Interaction with environment – Torques, Forces, Touch, Slip, Range, Vision

Congratulations, you have finished Lecture 9. To view the next lecture select it from the left hand side menu of the page.