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SENSOR TECHNOLOGY AND DATA ACQUISITION

1. ***Suggest a technique to measure the tyre pressure in a 4 car indirectly with the help of torque measurement on the shaft connected the wheels.***

Measuring tire pressure indirectly through torque on the shaft connected to the wheels is an interesting approach, but it's important to note that this method may have limitations and would require careful calibration.

1. Establish a Baseline Torque: Before you can correlate torque to tire pressure, you need to establish a baseline. This involves measuring the torque when the tires are at the recommended pressure. This can be done using a torque sensor on the shaft.
2. Torque Variation with Pressure Changes: Conduct controlled experiments where you deliberately change the tire pressure and measure the corresponding torque variations. Ensure that you vary the pressure within a safe range and take note of the torque values.
3. Calibration: Develop a calibration curve or equation that relates torque to tire pressure based on your experimental data. This calibration will be crucial for accurate pressure estimation in real-world scenarios.
4. Real-time Monitoring: Implement a real-time monitoring system using the calibrated torque-to-pressure relationship. This system would continuously measure the torque on the shaft and convert it into an estimate of tire pressure using the calibration curve.
5. Validation: Validate the system's accuracy by comparing the estimated tire pressure with actual pressure measurements using conventional methods (e.g., pressure gauges). Make adjustments to the calibration if needed.

It's important to consider several factors that can affect torque readings, such as road conditions, vehicle speed, and temperature. Additionally, the relationship between torque and tire pressure may not be linear, and it might vary between different vehicle models.

This indirect method can provide a rough estimate of tire pressure but may not be as accurate as direct pressure measurement methods. Always prioritize safety and consider incorporating redundant systems or additional sensors to enhance accuracy and reliability. Keep in mind that regular direct measurements with a tire pressure gauge remain the most accurate way to ensure proper tire inflation.

2. ***<u>With the help of the experiment done in the lab for measuring the shear strain due to torque applied, find out the maximum torque which can applied to a shaft made up of a aluminium hollow cylinder having 50 cm long and 5 cm outer diameter and 3.5 cm as inner diameter can withstand maximum shear strain 5x10-4 . For aluminium ,E=0.7*106 kg/cm2 and v=0.3. For the measurement of shear strain, four strain gauges (R=250Ω, G=2.5) are bonded 45° to the shaft axis in opposite directions. Find out the change in resistance for the applied torque in full-bridge configuration.</u>***

Shear strain calculations

$$\gamma = \frac{r}{L} * \theta$$

- r is the radial distance from the centre to the location of the strain gauge,
- L is the length of the shaft,
- θ is the angular displacement (related to the applied torque).

Given that

$\gamma=5\times10^{-4}$

$L=50L=50$cm,

and the shaft is a hollow cylinder, you need to relate r to the outer and inner diameters.

Radial Distance (r) calculations

$$r = \frac{D_{outer} - D_{inner}}{4}$$

$$r = \frac{5 - 3.5}{4} = 0.375\ cm$$

$$\theta = \frac{\gamma * L}{r}$$

$$\theta = \frac{5 \times 10^{-4} * 50}{0.375} = 0.067$$

Polar moment of inertia (J):

$$J = \frac{\pi}{32} * (D_{outer}^4 - D_{inner}^4)$$

$$J = \frac{\pi}{32} * (625 - 150.0625\ ) = 46.603$$

Maximum torque (T_{max}) :

$$T_{max} = \frac{G * J}{L}$$

where G is the shear modulus. So,

$$G = \frac{E}{2\ (1 + v)}$$

$$G = \frac{0.7 * \ 10^{-6} \, kg/cm^2}{2 \, (1 + 0.3)} = 269.2307 \, pascal$$

$$T_{max} = \frac{269.2307 * 46.03}{50} = 247.85$$

Change in resistance (ΔR) in full bridge configurations

$$\Delta R = R * G * \theta$$

$$\Delta R = 250 * 2.5 * 0.067 = 41.875\Omega$$