Mechanical energy scavenging for in-wheel sensors - background to the project

In Europe tyre pressure monitoring has until recently been driven by the benefit to both the car owner and the environment. Under inflation of tyres is known to lead to additional tyre wear and reduction in fuel efficiency. The European Union has estimated that a 40kPa reduction in tyre pressure from the recommended level will result in a 2% increase in fuel consumption and a 25% decrease of tyre lifetime.

The European union has now brought in legislation that from 2014 will mean that all new cars are required to have TPMS as standard. This brings Europe in line with the US where the monitoring of tyre pressures has been a mandatory requirement since 2007, due to safety legislation introduced as part of the Transportation Recall Enhancement, Accountability and Documentation (TREAD) Act. All new passenger cars, light trucks and buses are required to have Tyre Pressure Monitoring Systems (TPMS), monitoring the tyre pressure and reporting back to the central control system that provides a warning when the tyre has deflated by 25% or more.

The specification in the regulations means that most systems are ‘direct’ sitting in the wheel measuring pressure directly. This is in contrast to many systems currently seen on European cars that are based on wheel speed differential termed ‘indirect’ and work off the antilock braking signals. The direct systems offer a challenge to sensor designers as they cannot be wired and need an in-wheel power source to drive the measurement and wireless transmission system.

The TPMS power requirements are only in the 10’s of micro-Watt range as the system powers down to a sleep state in-between the intermittent measure and transmit phase that only lasts milliseconds. Power is currently provided by lithium button cells that can in principle provide 7-10year lifetime given the low power requirements. In practice the extremes of temperature seen in automotive applications mean that the battery driven system becomes less reliable toward the end of its designed lifetime. This is a major concern to automotive manufacturers and the TPMS designers are looking at ways to supplement or replace the battery.

In addition to the battery lifetime issue the mandatory introduction of direct TPMS systems in the US has resulted in a significant environmental cost, this will be further exacerbated by the introduction of the systems in Europe. With 13million new cars being sold in the US each year and a similar number across western Europe there will be over 100million new batteries each year that will require disposal at the end of their lifetime.

Energy harvesting offers a solution to these problems. To-date most solutions have been based on inertial energy harvesters that scavenging energy from the vibration of the wheel. However most of these systems are aimed to top-up and extend the battery lifetime. Clockwork energy storage and harvesting offers a solution that can remove the battery completely.

Clockwork Energy Harvesting (/research/activity/mechanical-engineering/bio-micro/micro-nano/energy-wheel-sensors/clockwork-energy-harvesting.aspx)

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