Electromagnetic Circumferential Power Generator (CPG) for Battery-less Tire Pressure Monitoring Sensor

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The proposed research aims at developing a compact electromagnetic "circumferential power generator" ("CPG"), and adapt it for powering a tire pressure monitoring sensor (TPMS). The CPG concept includes a coil unit attached on a rim and a magnet attached on a stationary point. The magnetic flux change generated by the relative motion between the wheel and the fixed magnet results in an induced electromagnetic current in the coil. This concept will realize a battery-less TPMS and resolve multiple disadvantages on chemical batteries which most commercial TPMSs rely on: limited lifetime, environmental harmfulness, and possible explosion. Even though few companies have developed a battery-less TPMS using an electromagnetic closed-coupling technology or a SAW (surface acoustic wave) based passive sensing technology, these concepts cost much higher and require professional installation for additional wiring or a dual band antenna in the vicinity of the rim/tire.

Recently the PI (Dr. Soobum Lee) proposed an innovative concept design of CPG (provisional patent filed) and the prototype was tested using bicycle frame to demonstrate the feasibility. The test was conducted with the coil (10 cm long, 800 turns) and the magnet. Even though the test was conducted at low rotating speed (24 km/h), a sufficient power was obtained (3.0mW) which is far beyond the required power (250μW). Design optimization, miniaturization, and the follow-up collaboration with TPMS/rim manufacturer will accelerate successful commercialization and facilitate the advantageous position in the US/world market share.

For the success of the proposed research, the PI will conduct a research planned with three subtasks: (1) Analysis model construction, (2) Design optimization and prototype fabrication, and (3) Experimental design validation. For the analysis model construction, the variable rotation speed and its variation is identified from the real car operation. The simulation-based analysis model calculates the output performance (electrical power or current) for the given magnetic field and coil unit. This analysis model is used for design optimization through which the design parameters on the coil unit (e.g., coil layout, number of turns, size) as well as the required magnetic field are found. The prototype of the optimal design will be manufactured and the lab test will be conducted. The PI plans to implement a testing apparatus similar to a wheel balancer, with a DC motor and a variable frequency drive (VFD) controller for realizing variable spinning speed in lab environment. The proven performance can be commercialized with potential industrial partners.

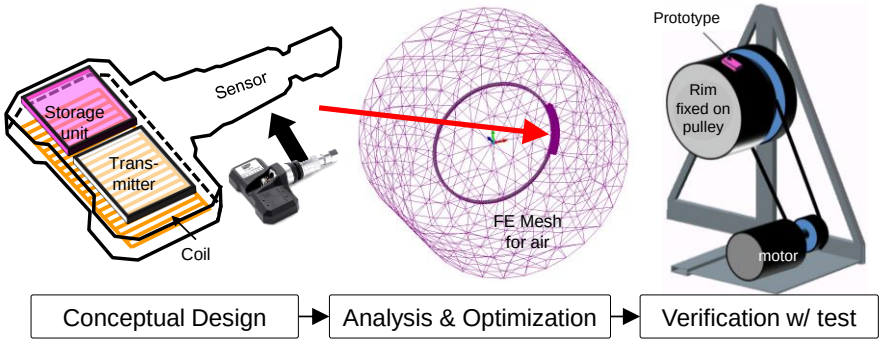

Figure: **Research plan for the development of self-powering TPMS**