In-Wheel Motors for Electrical Vehicles

**Key words**: In-wheel motor, Integrated Design, Synchronous Motors, Permanent Magnets, Axial Flux, Sensorless Control of Electrical Drives,

Electric Vehicles (EV) are ever increasingly being used as a necessary alternative to classical vehicles for environment problems caused by classical vehicles as well as for the pollution problems and the reduction of fossil energy sources.

The UTBM, with its research team CCE (Command and Conversion of the Energy) of the IRTES-SET Laboratory and its facilities, has worked for years on electrical vehicles and hybrid electrical vehicles resulting in research activity on powertrain architectures, hybridisation of energy sources and their management and power electronics and electrical drives and machines.

The thesis proposed has as target the development of competences and research activities about the integrated design of EV for urban mobility. Currently, most EVs are driven by two front wheels or two rear wheels. Considering some efficiency and space restrictions on the vehicle, people have paid more and more attention in recent years to four-wheel drive vehicles employing the BLDC in-wheel motor [2-7]. The in-wheel motor would totally change the traditional driving method: the motor sits in the hub of the wheel; the motor has an outer rotor, and the output torque is directly transmitted to the wheel, which would reduce the traditional clutch, retarder, and other mechanical differentials. Thus, his kind of vehicle is lighter, more efficient and more flexible [3-8] and would make it possible the realization of an electrical differential.

Particular attention will be paid to the realization of in-wheel motors by means of permanent magnets (PM) axial flux motors, unlike current PM in-wheel motors which are generally based on radial-flux motors. This axial flux motor has reduced axial size in comparison to radial axis ones. An electromagnetic and thermal analysis will be carried out to obtain a 2D and 3D model to be used to design the motor and the determination of a lumped parameter model suitable for control applications. The type of control of the electrical drive will be based on sensorless open-loop and closed-loop strategies, but also novel nonlinear control strategies will be adopted: this sensorless strategy will result in reduction of the inertia, increase of its reliability, and decrease of its cost. The reliability will be a key issue since the in-wheel electrical drive is subject to hostile environment (collisions, vibrations, temperature variations, etc) and will lead up to suitable diagnostic algorithms to detect the health state of the motor on the basis of its current signature and of the power converter [9-18].

The thesis will end up with the realization of in-wheel motor and an experimental rig to make experimental test for the assessment of the prototype.

### I. References


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