



ASYNCRHONE LOW-COST

Sensor-less torque control of induction motors for low-cost applications

Project Summary

Sensor-less torque control of induction motors is a low-cost solution for machines that are not too demanding in accuracy and dynamics. Driving them using frequency converters is relatively cheap, but provides only for some velocity adjustability. The produced torque remains uncontrolled, which may result in damages to the machine, e.g. should abnormal resistive torques occur in the load.

Controlling the induction motor torque usually requires a position sensor for implementing e.g. a vector control algorithm. Such a sensor and its appropriate cabling multiply by 2 the motor cost.

This project achieved a similar result without any additional sensor, with $\pm 20\%$ torque accuracy, using a standard motion control drive without any additional hardware.

Several algorithms that are scientifically documented have been considered, modeled and tested. Most of them operate also at very low speed and even at stall, but only in the "motor" quadrant. This project focused on various MRAS (Model Reference Adaptive System) and DTC (Direct Torque Control) algorithms. The best results were achieved using DTC SVM (Space Vector Controlled DTC), together with a Luenberger velocity observer.

Valorisation

During this project, this algorithm has been implemented into 2 different fixtures:

- **Induction motor driven pump for running a hydraulic elevator.** As it provides for a low-cost servo pump, such a package is quite interesting for driving hydraulic actuators e.g. within electric urban utility vehicles. This technique's key feature is improved efficiency: Unlike proportional valves, a servo pump provides exactly for the required hydraulic pressure without destroying excessive power into heat. In addition, it is able to recover the mechanic energy when the load is going down.
- **Linear induction motor vehicle for storage and factories.** Three linear induction motors, which are as simple to manufacture as any 3-phase transformer, are assembled as shown in the picture above. This assembly moves freely on a steel floor covered by a thin sheet of aluminum. It provides for force-controllable motion in 2 directions as well as in rotation. Position and trajectory control has been achieved using a low-cost camera and image processing.

Both fixtures can be seen in operation on <http://www.iai.heig-vd.ch/en-gb/RaD/Pages/RaD.aspx>. They are attractive for industries that require medium-accuracy motion without the cost of additional sensors and cables, such as for building and factory automation, as well as for high-efficient hydraulic machines.

The result of this project is also very demonstrative of our UAS' expertise in the field of motor control, mechatronics, and cost efficiency.

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