Ph.D. in Information Technology
Thesis Defense

July 25th, 2025
At 9:30 a.m.
Room Alpha – Building 24

Riccardo NASTRI – XXXVII Cycle
DEVELOPMENT OF RATE-INTEGRATING GYROSCOPES IN A COMMERCIAL MEMS FABRICATION PROCESS
Supervisor: Prof. Giacomo Langfelder

Abstract:

Over the past few decades, microelectromechanical (MEMS) inertial sensors have become widespread in the automotive and consumer electronics markets thanks to their compact size and low manufacturing cost. In recent years, the growing interest in high-end applications such as inertial navigation prompted an ever-increasing demand for high-performance inertial sensors, and especially for gyroscopes. Guided by stringent long-term stability specifications, research effort is currently being put into exploring unconventional modes of operation: the focus of this work is the development of rate-integrating gyroscopes (RIGs), whose ability to directly measure angular displacement represents a theoretical advantage over conventional rate gyroscopes, as it inherently mitigates the error accumulation associated with numerical integration. High-quality-factor devices are fabricated in a commercial MEMS manufacturing process and an FPGA-based control system is implemented. The developed gyroscopes exhibit outstanding scale-factor characteristics, achieving a stability of 45.5 ppb over a precession angle exceeding 11 million degrees, a temperature variability of 36.9 ppm in the 20 °C to 80 °C range, and a linearity error of 0.07% for applied angular rates larger than 200 dps. Concurrently, a noise floor of 100 μdeg/√Hz is demonstrated, limited by the mechanical nonlinearity of the device.

PhD Committee

Prof. Paolo Frigerio, **Politecnico di Milano**
Dr. Alessandro Nastro, **Università degli Studi di Brescia**
Prof. Takashiro Tsukamoto, **Tohoku University**