VRIJE UNIVERSITEIT BRUSSEL

The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING SCIENCES

of **Yuri Durodié**

The public defense will take place on **Thursday 28th August 2025 at 4 pm** in room **D.2.01** (Building D, VUB Main Campus)

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AD-HOC ACTIVE RELATIVE POSE ESTIMATION USING VISUAL INERTIAL ODOMETRY AND A SINGLE UWB ANTENNA PER ROBOT FOR MULTI-ROBOT COLLABORATION SYSTEMS.

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Abstract of the PhD research

When robots collaborate, they need to know each other’s pose—that is, theymust know where the other robot is and which way it is facing. In unknownGPS-denied environments, robots often use a method called simultaneouslocalisation and mapping (SLAM) to estimate their pose. SLAM builds a map ofthe environment, while simultaneously estimating the robot’s pose within thatmap. However, SLAM is prone to drift—the gradual accumulation of errors inboth the map and the estimated pose. Active relative pose estimation can help address this issue for collaboration. Inthis approach, robots are equipped with devices that directly measure thedistance between them. While this does not prevent drift in the SLAM-basedpose estimates, it provides independent distance measurements even whenthose pose estimates are inaccurate. This makes the relative pose betweenrobots at measurable under certain movements. For example, if both robotsremain stationary and only their separation distance is known, the other robotcould be anywhere along a circle (in 2D).

In this dissertation, visual–inertial odometry, a form of SLAM, is used to trackeach robot’s motion, and ultrawide band sensors are used to measure inter-robot distances. A new method is proposed for estimating relative poses whencertain robot movements make them unobservable. This is achieved using anunscented particle filter, which samples possible poses and progressivelyeliminates improbable ones as more measurements become available. Theproposed method successfully tracks relative poses and demonstrates greaterstability than current state-of-the-art techniques.

The dissertation also investigates how to detect when environmental factorsinterfere with distance measurements. Two solutions are explored. The firstchecks whether a measured distance is consistent with the estimated poses. Itdoes this by classifying the measured distance between correct andfaulty. While straightforward, this method requires knowledge of the initial poseof both robots and struggles to recover after some misclassifications, which areprone to happen. The second uses a neural network trained on simulated datato classify faulty measurements. This network achieves high classificationaccuracy and generalises well across different scenarios and environments.

By addressing these underexplored challenges, this work advances activerelative pose estimation toward practical use in multi-robot collaboration.