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 **Ayman Morsy**

The public defense will take place on **Friday 25th April 2025 at 4pm** in room **I.0.03** (Building I, VUB Main Campus)

To join the digital defense, please click here

A NOVEL APPROACH TO DEPTH-SENSE IMAGING USING CORRELATION-ASSISTED DIRECT TIME-OF-FLIGHT

BOARD OF EXAMINERS

Prof. dr. Valéry Ann Jacobs

Prof. Wendy Meulebroeck

Prof. John Lataire

Prof. Jan Genoe

Dr. Morin Dehan

PROMOTORS

Prof. Maarten Kuijk

VRIJE UNIVERSITEIT BRUSSEL

Abstract of the PhD research

Time-of-flight (ToF) imaging has emerged as a vital technology in machine vision and sensing, expanding into applications such as augmented and virtual reality, gaming, robotics, autonomous driving, autofocus, and facial recognition on smartphones and laptops. ToF technology determines the distance to an object within the detection range by emitting a light source and measuring the time it takes to return. This round-trip time determines the object's distance, with different sensing technologies employing distinct methods to determine this time.

For ToF applications, developing sensors with high image resolution, low power consumption, and the ability to function reliably in high ambient light conditions is desirable. This dissertation presents the development of a novel single-photon avalanche diode (SPAD)-based pixel called Correlation-Assisted Direct Time-of-Flight (CA-dToF), designed for in-pixel ambient light suppression and characterized by low power consumption and a scalable pixel structure. The CA-dToF pixel uses a laser pulse correlated with two orthogonal sinusoidal signals as input to two switched capacitor channels, which average out detected ambient light while accumulating the laser pulse round-trip time.

To gain insights into CA-dToF pixel operation, both Python simulation and analytical modeling were developed. Two generations of the CA-dToF pixel were developed and characterized, with the second-generation pixel achieving the first operational performance under high ambient light conditions. The two-generation CA-dToF pixel was tested under various lighting conditions and pixel design variations. Additionally, noise sources within the pixel implementation were analyzed, and potential solutions were proposed.