

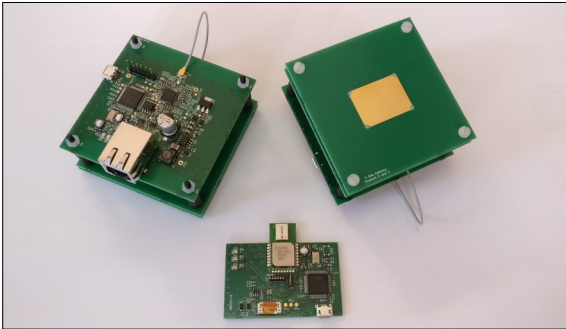


Silvio Marti

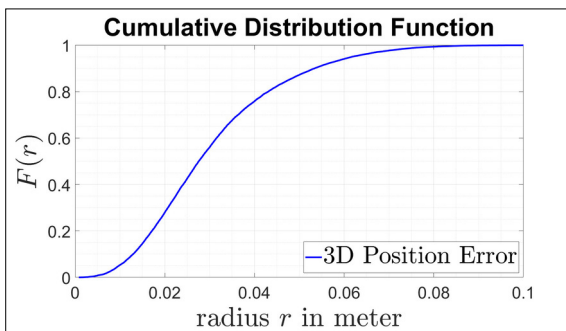
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Subject Area	Sensor, Actuator and Communication Systems
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High-Speed TDoA Indoor Localization System

Based on Ultra-Wideband Pulse Technology for Light Shows with Drones



Front and rear view of the developed anchor with patch antenna and front view of the tag to be localized.
Own presentation



Cumulative distribution function of the 3D position error.
Own presentation

Introduction: Many show events use fireworks for light effects. Recently, however, more and more event organizers have moved to producing large light shows with drones based on GNSS localization services instead. Technological advancements in indoor localization systems has made it possible to perform an air show with drones even indoors. For DJ Bobo's 2019 tour, a set of four drones was developed in combination with an ultra-wideband based localization system. Its localization service was limited to six positions per drone per second and to a mean accuracy of 30 cm.

Objective: The goal of this thesis is to develop a new, ultra-wideband pulse based localization system to increase accuracy and position update ratio. The new system, as well as the existing, is based on Decawave's DW1000 chip. The wired low-jitter clock distribution network ensures precise timestamping. Two broadband patch antennas with constant phase centers have been developed to reduce dependence on the angle of incidence. The bandwidth of the antennas is designed to exactly meet the ultra-wideband channel bandwidth to maximize immunity to out-of-band interferers. Furthermore, the proposed auto-calibration algorithm can automatically determine the coordinates of the reference points. Finally, a new message exchange scheme for TDoA-based localization has been developed.

Result: The newly developed indoor localization system can determine up to 143 positions per second. The accuracy achieved is outstanding: 68% and 95% of the positions lie within a sphere with a radius of 3.5 cm and 6.3 cm, respectively. Every drone, independent of the number of drones in the system, receives its position 12.3 ms after the pulse transmission. This low and constant latency is highly advantageous for the subsequent flight controller. The operating range of the system exceeds 100 m. In summary, the proposed localization system makes indoor light shows with more than 30 drones possible, with an accuracy equivalent to the size of an apple.



Snapshot of the main rehearsal of DJ Bobo's Kaleidoluna show with the drones.
Hannes Diethelm