RAdar para Detection and Avoidance em Veículos Aéreos Não Tripulados

RADAVANT
E6.6
IP AND PATENT CONTRIBUTIONS FROM THE RADAVANT PROJECT (EN)
CONTRIBUTOS PARA IP E PATENTES DO PROJETO RADAVANT (PT)

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SUMMARY (EN):

This Deliverable lists the Intelectual Property and Patent contributions related to the work developed in the RADAVANT project, either filed or to be filed, or kept as trade secrets. For its confidential nature, this report only addresses the matter in a summarised way, for the public knowledge.

SUMÁRIO (PT):

Este Entregável lista os contributos de Propriedade Intelectual e Patentes relativos ao trabalho desenvolvido no projeto RADAVANT, submetidos ou a submeter, ou guardados como *segredos do negócio*. Pela sua natureza confidencial, este relatório apenas aborda os assuntos de forma resumida, para conhecimento do público.

Keyword list: UAV, Drones, Radar, Scientific, Communication, Dissemination

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List of Acronyms

CFO	Carrier Frequency Offset
COTS	Component-Off-The-Shelf
FIFO	First In, First Out
FOV	Field of View
FPGA	Field-Programmable Gate Array
INPI	*Instituto Nacional da Propriedade Industrial*
IP	Intelectual Property
QAM	Quadrature Amplitude Modulation
RF	Radio-Frequency
SDR	Software Defined Radio
SNR	Signal-to-Noise-Ratio
STDCC	Swept Time-Delayed Cross-Correlation
SWaP	Size, Weight and Power

1. Scope

This Deliverable lists and summarily describes the Intelectual Property (IP) and patent contributions related to the RADAVANT project, resulting from its execution. For its confidential nature, this report only addresses the matter in a summarised way, for the public knowledge.

The Consortium members have contributed to this project with their own IP background. TWEVO has brought its Software Defined Radio (SDR) communication platform in, implemented and integrated in Component-Off-The-Shelf (COTS) hardware in Field-Programmable Gate Array (FPGA). This platform is part of TWEVO's IP core technology. IT has contributed with its channel sounding platform, as the support base for RADAVANT's radar function, i.e., the Radio-Frequency (RF) hardware base. Besides these, both TWEVO and IT have contributed to their intangible crucial knowledge and experience on using the required tools of the trade, either regarding hardware, software or firmware. These initial assets kick-started the project and provided the foundation for the IP contributions achieved in the course of the project.

TWEVO and IT have defined the technology transfer strategy between them, under the RADAVANT project. In addition to technology transfer actions, the Consortium has internally defined the commercial strategy to patent and register firmware, software and hardware. They have also evaluated the feasibility and the Freedom to Operate, deciding on patent filing or on the strategy of keeping technology as trade secret.

At the current date, under the project scope, there has been one filed patent in the area of antennas, and two other technologies are being considered for patenting, in the areas of radar processing and antennas. A considerable amount of IP knowledge has been generated, not planned to result in patent filing, but to be currently kept as a trade secret.

2. Patent Contributions

2.1. Patents Filed

Patent A_Antenna

COMPACT PARABOLIC REFLECTOR ANTENNA FOR RADAR AND RADIO COMMUNICATION APPLICATIONS, initially filed as a first patent application in November 2019 at the Portuguese national IP office (in Portuguese, *Instituto Nacional da Propriedade Industrial*, INPI); the corresponding final patent application has been submitted in November 2020.

The proposed invention includes, but is not limited to, the following characteristics: the use of plastic material in the manufacturing of the antenna, instead of metal; high reflective electromagnetic capability ensured by the reflector superficial conductive coating; the monoblock antenna form factor, providing a unique, compact, innovative shape easily adaptable to any radar and radio communications system; the reduced weight resulting from the use of plastics, making it suitable to be used by systems with limited payload; high cost-effectiveness compared to equivalent performance antennas.

The proposed invention aims to solve the following problem(s): it is a known difficult technical task to achieve a low Size, Weight and Power (SWaP) system antenna, as a single block, with high gain and high efficiency, keeping low cost and simple manufacturing; the market needs this type of antenna solutions.

2.2. IP being considering to be patented

Patent B_Antenna

The IP generated includes, but is not limited to, the following characteristics: a small monoblock microwave band antenna for low SWaP systems, capable of high gain and efficiency, with beamsteering covering a Field of View (FOV) of ±30° in elevation and ±180° in azimuth.

The IP aims to solve the following problem(s): it is a known difficult technical task to achieve a low SWaP system antenna, as a single block, with high gain and high efficiency, implying low cost and simple manufacturing, further capable of beamsteering with large elevation and azimuth FOV; the market needs this type of antenna solutions.

Patent C_Radar Processing

The IP generated includes, but is not limited to, the following characteristics: a radar processing method and means to implement it, based on the Swept Time-Delayed Cross-Correlation (STDCC); it reduces the time required to acquire moving targets or a changing channel, while improving processing gain and detection; it allows the independent management of STDCC-related radar parameters, in-between the multiple observation intervals, useful to optimise radar detection and make the radar or sounding system flexible.

The IP aims to solve the following problem(s): the STDCC implies a long sliding cycle duration vs target/channel coherence time, requiring that the targets are static for the whole full sliding cycle time; only with this static scenario will the correlations provide the highest peaks at target positions, with the highest processing gain; if the targets move, or the channel changes significantly within such full sliding cycle time, the sliding correlations will no longer be optimum; the STDCC is then considered to be too slow, regarding the targets or regarding the channel; for this, the STDCC is frequently eliminated as a radar implementation for many practical applications, due to such long radar pulse cycle, mainly dedicating/limiting its application to channel sounding; also, for related reasons, the STDCC is frequently rigid and implies lengthy pulse integration capability, not allowing effective pulse coherent integration; pulse integration is a known crucial radar tool to increase the Signal-to-Noise-Ratio (SNR) in the target signal detection stage; the market needs this type of radar processing solutions.

3. IP Contributions Worthy of Notice

Several IP blocks within the baseband radar and data link digital FPGA implementation, designed and implemented in the TWEVO FPGA core, are kept as trade secrets.

TWEVO has developed a modular architecture, fully pipelined, with distributed control and parallel processing. The distributed control model relaxes the synchronisation requirements by restricting the timing constraints to small synchronous islands. This simplifies the simultaneous

processing of multiple blocks, exploiting the parallelism of the architecture and enabling asynchronous computational demanding processes.

At the lowest architectural level, the architecture adopts interconnecting First In, First Outs (FIFOs) between each processing block, reducing the signalling and control paths. This also allows the implementation of complex designs operating at higher clock rates. The adoption of such architecture in the RADAVANT stages allowed the agile design, development and standalone testing of new processing blocks in the SDR baseband processing chain, either for the radar baseband blocks or for the data link stages.

Regarding the data link within RADAVANT, we point out the following key core characteristics: configurable modulator/demodulator for several Quadrature Amplitude Modulation (QAM) schemes; shaping of the transmitted signal spectrum; blocks to render frames into the time/frequency domain; Carrier Frequency Offset (CFO) estimation block for synchronisation; channel estimator blocks to acquire channel state information; filters and equalisers to compensate for channel distortion.

4. Conclusions

This Deliverable E6.6 lists and summarily describes the patent and IP contributions related to the work developed within RADAVANT. For its confidential nature, this report only addresses the matter in a summarised way, for the public knowledge.

The IP and patents developed during the RADAVANT project are not only diverse in their fields, covering antennas, radar processing and data link stages, but also cover several types of contributions - a filed patent, patentable IP and IP trade secret electronic implementations.