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EDF proposal collaboration

My name is Daniel Dumitru Banciu, CEO of a small Romanian research company, Research Beyond Limits SRL. I am looking for project partners and support from the Ministries of Defense in the European Union for my proposals.

Due to our zero turnover until now, and to the lack of co-financing, I can only target the call for projects "EDF-2022-LS-RA-DIS-NT: ***Non-thematic research actions targeting disruptive technologies for defense"***, for which I have the following proposals:

**1. PROCEDURE AND DEVICE FOR ENCODED IN-VITRO DIGITAL COMPLEMENTARY ANALYSIS**

Identified problem:

The control of epidemics in the conditions of a military and economic aggression puts maximum pressure on the response force, through the lens of material, human, access, logistical efforts, to carry out the testing of various analyzes (antigen - for the identification of various pathogens or the usual laboratory analytes; antibodies - for identifying the effectiveness of vaccination, passing through the disease or the margin of protection against new strains; known DNA sequences - for identifying different pathologies, known mutations, genetic risk factors, known antibiotic resistance sequences). The associated costs are on different levels, starting from the logistical ones (transportation and preservation under specific conditions) to those derived from the diversity of pathologies that the emergency health system must identify.

The detection devices (ELISA, PCR) are relatively expensive and are not available for use in the operational battlefield, or portable everywhere where it is necessary in the control of pandemics.

Proposed solution:

The use of a screening device for many antigens, antibodies, RNA or DNA sequences (TRL2 - the patent application is presented at

https://worldwide.espacenet.com/patent/search/family/074067248/publication/RO134652A0?q=pn%3DRO134652A0

can reduce the logistical pressure, the medical decision (which analysis to do - you do it all in one step) and allows a centralized response to a large variety of elements that cannot otherwise be implemented for the entire population of the European Union (due to costs, the necessary infrastructure or human resources). Moreover, winning some local battles against the various epidemics can only have a temporary character in the presence of massive migration at high speeds (airplane - vacations in exotic countries, trade) in areas with suboptimal health support (therapeutic, prevention through vaccination or isolation).

The proposed technology has the advantage of spatial coding of fluorescence, which implies the possibility of using optical cameras with a relatively low quantum efficiency and relatively independent of their electrical noise level (very cheap - including at the mobile phone level).

Proposed target:

A device (TRL4) capable of identifying hundreds of antigens, antibodies, RNA or/and DNA sequences, as well as a device for making consumables (microfluidic systems) to be able to test the sensitivity, specificity and limits of the method in different experimental conditions (temperature, mechanical shocks, etc.)

**2. PROCEDURE AND DEVICE FOR HIGH-RESOLUTION OPTO-ACOUSTO-OPTICAL ULTRASOUND ANALYSIS**

Identified problem:

Military polytraumas and multiple organ damage (including post-infectious ones) require fine imaging evaluations (CT, MRI, ultrasounds) that require infrastructure, access to it (which can be limited in case of military conflict) and corresponding material and human resources.

Proposed solution:

The use of ultrasound as a substitute for X-ray imaging is in full swing, especially for the prevention of breast cancer, but it still has significant limitations in resolution. This is a consequence of the number of digital-analog and analog-digital converters that can be crammed into an ultrasound probe, as well as their electrical noise. The last aspect began to be countered by ultrasound with a digital coding of the signal.

To increase the number of analog-digital converters, a mechano(acousto)-optical conversion can be used by using fluorescence anisotropy as a method of measuring mechanical forces in artificial lipid membranes. Thus, the number of analog-digital converters can be increased to the number of pixels of a fluorescence camera. You can easily find very sensitive cameras (such as those from Andor) with resolutions of the order of megapixels (millions of analog-to-digital converters) and with quantum sensitivity over 50%.

The proposed technology has the advantage of portability in the fields of military operations, the possibility of being handled by qualified average personnel, the possibility of scaling to increase the number of converters, the possibility of digital coding of the signal to withstand the acoustic noise in the theaters of military operations.

**3. PROCEDURE AND DEVICE FOR HIGH-RESOLUTION OPTO-ACOUSTO-OPTICAL ULTRASOUND ANALYSIS - APPLICATIONS IN THE DETECTION OF ADVERSE STEALTH ELEMENTS**

Identified problem:

Military imaging detection devices (sonar and/or radar) need a very high sensitivity to identify enemy elements with a small footprint, and this sensitivity correlates with a major risk of failure in case of major shocks (acoustic - bomb explosion; radar – electromagnetic pulse - EMP). The opto-electrical isolation inside or before the analog-digital converter is deficient at this moment, and the compensatory use of high-amplitude incident radiation allows the adversary to identify and unravel his own position exactly at the most sensitive moment (of the attack following the jamming on wide scale).

Proposed solution:

The use of opto-acousto-optical conversion (described in the previous point) allows the identification of mechanical forces. These can be secondary to acoustic waves, or mechanical coupling with a resonating micro-antenna in an artificial magnetic field.

The proposed technology allows efficient opto-electronic decoupling (by distancing shock-sensitive elements through optical elements (long optical paths/optical fibers/etc.), and the destruction by EMP of the area of microantennas attached to artificial lipid membranes can be restored through a dispenser (similar to those with which the disinfectant is spread on surfaces), with or without removing the affected elements, and even during imaging evaluations (without interrupting the detection). The digital coding of the signal makes it difficult for the adversary to detect the installation (sonar/radar) of active detection (with the emission of incident radiation) but also allows the in-depth selection of the area of interest with the complete ignoring of other areas (allowing the selection of the area of interest, as well as the scaling of multiple areas of interest).

As a by-product, the use of radar below the current noise level may lead to the development of community channels between different radar systems with a high resistance to jamming. This aspect is particularly important in communication in a conflict zone, by obscuring the existence of the communication and consequently a major resistance to cryptanalysis.

My project is under evaluation at the Ministry of Internal Affairs. If passes the scientific evaluation, the Ministry will have an important coordination component of the project, as a potential end user of the technology. In the case of EDF projects, it is important to have a user capable of acquiring the technology at a relevant maturity level.

The problem with military sensors is the balance between sensitivity and resistance to major shocks (induced by adversaries). In this sense, we have developed a theoretical model for amplifying the mechanical signal at the molecular level (which can also be correlated with the electrical signal) using bio-inspired elements. Thus, we can use the fluorescence camera (ADC) in an environment protected from shocks and the amplifier in the environment sensitive to the signal to be measured (resistant to shocks and easy to replace automatically if it breaks, including during operation).

We need an evaluation of fluorescence polarization (that correlates with the signal amplitude) for a designated area. High number of pixels means a high number of ADC (at safe distance of potential destructive shocks). For a high resistance of jamming, we need time coding of the signal (using femtosecond laser, scanning system and MEMS). Eventually, we can find a partner with this kind of expertise. Using phase shift, it can be calculated the direction and distance of the target.

I can provide only the theoretical model of bio inspired amplification of signal using fluorescence and transformation of mechanical forces into fluorescence information. Additional disposable nano-antennas into known low magnetic field can transform electromagnetic fields into mechanical forces.

Due to the specificity of the projects (which I want to be united in a single project due to the similarities between them), I need expertise and partners in the following fields: material physics, microfluidics, complex optical systems, cold plasma physics, MEMS, femtosecond lasers, IT, simulation of physical processes, optical camera.

We can use high tech camera such one from Andor. But we can develop (if we find a dedicated partner) a fluorescence camera with a very high dynamic range (for example full 24 bits or preferably higher - not 16 bits), global shutter, high number of pixels (preferably far over 1MP - like 100MP) and continuous high reading speed (preferably well over 100fps). To make the answer easier, I need a very small electrical noise, but a QE a bit higher than 1% (preferably higher - like 10%) could also work. The degree of freedom is maximum on the interface side, if it ensures the bandwidth (but it could be more interesting for the project if it is based on optical fibers). Last but not least, it must be possible to external synchronize several cameras and have a time stamp on images. Two options can be proposed (QE versus speed for example) if we fit into the budget (which I do not know at this stage, but which you can propose for the described system). This option is a solution for a verry small footprint (like for use on satellites or drones).

**SEARCHING FOR PARTNERS:**

In this moment, I have a partner preferred by Ministry of Internal Affairs from Romania, which is ***National Institute of Materials Physics – Romania.***

I have an intention to collaborate from Continium Technologies (richard.izak@continiumtech.com) on ADC/camera part of the project.

Let's imagine a radar/sonar that can remain undetected, extremely sensitive but resistant to EMP/mechanical shocks, resistant to opponents' efforts to maintain hidden equipment (passive or active), which can be mounted on vehicles, planes, submarines. It could remotely detect small drones, stealth planes, mines (requires AI for automated interpretation of ground images), submarines or underwater drones.

Depending on the configuration, a profit of 1-50 M€ per unit can easily be obtained.

I am willing to negotiate under the following conditions:

(1) IPR belongs to me 100%;

(2) The partners obtain a combined percentage of 20% of the profit (without calculating depreciation) capped in the first 10 years from the first financing, capped at €100 M per partner;

(3) The distribution of the 20% between the partners is negotiated after establishing the assumed activities and partially based on the result obtained.

**SEARCHING FOR SUPPORT FROM MoDs:**

Support from the Ministries of Defense from the European Union (or equivalents) can be rewarded with preferential contracts (on the profit side) upon reaching targets set by government bodies if these contracts are obtained before obtaining the first funding. It is preferable to sign these contracts before submitting the project in order to be able to include the targets proposed by the MoDs in the project.

Looking forward for your feedback,

MD, PhD, **Daniel Dumitru Banciu**

CEO Research Beyond Limits SRL