State of the art flying wing tailsitter drone system that delivers critical help to people with sudden cardiac arrest

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Introduction / Background

SkyRescue LLC develops a high-speed VTOL unmanned aerial vehicle designed to rapidly deliver automated external defibrillators (AEDs) to out-of-hospital cardiac arrest victims. The concept originates from a patented hybrid tailsitter aircraft developed within a National Centre for Research and Development project, addressing critical delays in traditional emergency response. By combining vertical take-off with efficient fixed-wing cruise in a flying wing airframe, the system significantly reduces response time, improving access to life-saving defibrillation.

Objectives / Goals

The primary objective of the project is to improve out-of-hospital cardiac arrest survival by enabling rapid delivery of an AED using a high-speed VTOL unmanned aircraft. Key goals include developing and validating a hybrid tailsitter UAV capable of vertical take-off and efficient cruise flight, achieving response times of approximately four minutes within an 8 km radius. The project also aims to integrate the system into real emergency operations and prepare it for commercialization as a scalable rapid-response service.

An additional strategic objective is to enable future development toward battlefield medical support, where rapid autonomous delivery of critical equipment such as defibrillators, blood products or life-saving medical supplies can significantly enhance survivability in combat conditions. The high-speed VTOL capability and dual-use potential of the system create a pathway for adaptation to military medical evacuation networks and frontline emergency care.

Methodology / Approach

The project is implemented through an integrated design, testing and validation process combining numerical analysis, prototyping and laboratory verification. Aerodynamic performance and stability were refined using iterative computational methods, followed by aerodynamic verification in a wind tunnel. To ensure compliance with RTCA DO-160G and relevant EASA and FAA guidelines, the system underwent vibration testing, battery evaluation in a climatic chamber and propulsion bench tests. The composite airframe was subjected to fatigue and strength testing with digital image correlation verification to assess structural integrity, while transition and operational performance were validated through controlled flight trials.

Expected Outcomes

The project is expected to deliver a fully functional high-speed VTOL unmanned aircraft capable of delivering an AED within four minutes over an 8 km radius, validated through laboratory and operational testing. It will also prepare the system for certification and integration into emergency response networks, while establishing a scalable service model and groundwork for future dual-use applications, including battlefield medical support.

Impact / Significance

The project can significantly improve out-of-hospital cardiac arrest survival by enabling much faster access to defibrillation than traditional ambulance response, particularly in both urban and remote areas. The validated high-speed VTOL system can be integrated into municipal rescue networks and emergency dispatch centers, while also supporting industrial sites, large events and regions with limited medical infrastructure.

Conclusion

The project delivers a rapid-response UAV system that directly addresses the critical time gap in emergency care, significantly improving access to life-saving defibrillation. By combining high-speed VTOL capability with validated safety and performance, it lays the foundation for widespread implementation in civilian and military medical support networks.

The undertaking is funded by
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HYBRISONIC

Ultrasonic Assisted Joining of Hybrid Materials (MPC)

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INTRODUCTION

Joining **Metal Polymer Composites (MPCs)** presents a significant challenge due to the inherent differences in material properties. Traditional methods often result in weak bonds, thermal damage, or require complex surface treatments. These limitations hinder the widespread adoption of MPCs in critical applications where lightweighting and high performance are crucial.

OBJECTIVES / GOALS

The primary objective of **HYBRISONIC** is to overcome the limitations of existing MPC joining techniques. Goals include: developing a reliable and efficient welding process for MPCs, achieving high bond strength and durability, minimizing thermal damage to the polymer core, creating a cost-effective and scalable solution for industrial applications.

METHODOLOGY

HYBRISONIC, developed at Wroclaw University of Science and Technology, employs ultrasonic-supported resistance welding. This innovative approach combines the benefits of resistance welding with the precision and control of ultrasonic energy. The ultrasonic vibrations facilitate localized heating and material softening, enabling the formation of a strong metallurgical bond between the metal and polymer components without causing excessive heat damage to the polymer. Key aspects of the methodology include: optimized ultrasonic parameters for different MPC combinations and precise control of welding pressure and current.

EXPECTED OUTCOMES

- Strong and durable MPC joints: Improved bond strength compared to conventional methods.
- Reduced thermal damage: Minimized heat-affected zone in the polymer component.
- Enhanced process efficiency: Faster welding times and lower energy consumption.
- Scalable manufacturing: Adaptable to high-volume production environments.
- Expanded material compatibility: Welding of diverse MPC combinations.

IMPACT / SIGNIFICANCE

Automotive: Lightweight vehicle structures for improved fuel efficiency and performance.
Aerospace: High-strength, lightweight components for aircraft and spacecraft.
Space: Durable and reliable joints for extreme environments.
Civil Engineering: Lightweight structures for demanding construction environments.

CONCLUSION

HYBRISONIC technology offers a promising solution for joining Metal Polymer Composites, addressing the limitations of traditional methods and unlocking new possibilities for lightweight and high-performance applications. Its innovative approach, combining ultrasonic energy with resistance welding, provides a pathway to strong, durable, and efficient MPC joints, poised to revolutionize manufacturing in automotive, aerospace, and space industries. Further research and development will focus on optimizing the process for specific material combinations and scaling up for industrial implementation.

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hiPower Institute of Materials (IoM)

Breakthrough functional nano-layers for hydrogen storage and sustainable packaging

Company Overview

IoM develops and commercializes advanced functional nano-layers that enhance surfaces in hydrogen storage tanks, packaging, and many other applications. These technologies, with market-proven performance improvements and significant cost reductions, address fundamental challenges in the hydrogen economy and packaging sector.

Technology functional properties include:

- Complete protection against H_2, O_2 and water vapor permeation
- Fully recyclable alternative to multi-material packaging (aseptic packaging)
- Double-use thermal insulation
- Resistance to corrosion and aggressive chemicals
- Self-healing, hydrophobic and antibacterial properties

Market Opportunity

IoM targets fast-growing, high-value industrial markets:

- Hydrogen storage tanks and pipelines: $1.5B in 2023 → $6.3B by 2030 (CAGR 21.5%)
- Barrier carton and packaging: $40.3B by 2030

Ongoing R&D collaborations with global leaders position IoM for rapid market entry.
Engaged industry partners include:

- Hydrogen: Faurecia, Plastic Omnium, Toyota, Alstom
- Packaging: Huber Group, Chespa

Business Model & Financials

Revenue will be generated through licensing of proprietary technologies, R&D services, and applied innovation projects.
Target: $20M+ in annual revenue by year 3 with 30%+ annual growth.

Funding Needs

Seed Round Target: $5M – tests, certifications, IP protection, marketing

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The undertaking is funded by
Minister of Science and Higher Education Republic of Poland
Ministry of Science and Higher Education Republic of Poland

BREAKTHROUGH BIOMATERIALS for SMALL BONE DEFECTS REGENERATION

Wrocław University of Science and Technology

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Department of Polymer Engineering and Technology
Wroclaw University of Science and Technology, Poland

Introduction / Background

Currently, in case of patients after craniotomy or cranioplasty (e.g. after removal of a brain aneurysm and brain tumours), the small bone defects in flat skull bones are left empty or metallic meshes hindering postoperative diagnostics are used. Moreover, implantation materials available on the market are stiff and brittle, and difficult to precisely adjust to the shape of the bone defect. Furthermore, commercial implants do not provide comprehensive performance The challenge for tissue engineering is therefore the regeneration of the flat bones of the skull.

Objectives / Goals

The goal is to use the developed biomaterials as a filling material in the regeneration of small bone defects. The innovative biomaterials are elastomeric polymer-ceramic biocomposites. Their application has been verified in *in vitro* and *in vivo* tests on a flat skull bone model of rat. Due to the very good results, proven biocompatibility and pro-regenerative activity, our goal is to further develop these biomaterials towards their introduction to the medical market.

Methodology / Approach

We developed polymer-ceramic biocomposites that, unlike metallic meshes, will not hinder any postoperative medical tests necessary for patient monitoring. The use of these materials to fill a bone defect is also more advantageous than leaving the defect empty, without filling. The biocomposites protect and accelerate bone tissue regeneration. The elastomeric nature of the matrix ensures easy adaptation of the material to the shape of the bone defect. They do not cause mechanical stress at the implantation site. The biocomposites have proven osteoinductive properties and are cytocompatible at the cellular level *in vitro* and *in vivo* with respect to bone and normative cells, are proadhesive for bone cells. The developed biomaterials are prototypes of Class III medical devices. Before market introduction, pre-clinical and clinical trials, as well as certification of the Class III medical device, are required.

Expected Outcomes

Our prototype implants are a result of an interdisciplinary collaboration between the best materials engineers, biologists and molecular chemists from universities in Poland. Our mission is to support the regeneration of the skull bone tissue, secure the space under the skull bone defect, and accelerate the bone tissue regeneration of the flat bones of the skull in patients after craniotomy and cranioplasty. Further research and development of biomaterials into medical devices and their introduction to the medical market may be of critical importance for patients.

Impact / Significance

The developed biomaterials will have a significant impact on the medical device market. We envision the application of our biomaterials for patients after removal of a brain aneurysm and brain tumours, as well as for elderly patients whose bone tissue does not regenerate spontaneously. Developed prototype implants will ensure safe and faster regeneration and reconstruction of skull bone. The developed biomaterials may also have wider applications in the regeneration of other small bone defects.

Conclusion

Since there is currently no good solution for patients after craniotomy and cranioplasty, the introduction of these biomaterials to the market as medical devices is essential for the well-being of patients.

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RECOVERY OF METALS FROM LI-ION BATTERY WASTE

Wrocław University of Science and Technology

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Introduction/Background

The accelerating global deployment of lithium-ion batteries (LIBs) underscores the need for sustainable recycling technologies that recover critical metals with high purity and minimal environmental impact. Conventional hydrometallurgical processes, based on acidic leaching, generate toxic multi-metal solutions that require energy-intensive purification. This challenge calls for new, highly selective, low-carbon metal-extraction strategies that minimise chemical consumption while improving process efficiency.

Objectives/Goals

This research aims to develop breakthrough membrane-based technologies for the precise recovery of transition metals from LIB waste. Specifically, the project seeks to: (1) achieve high-purity separation of Co^{2+}, Ni^{2+}, Mn^{2+} and Li^{+} via ultra-selective electrodialysis (ED), (2) integrate reverse electrodialysis (RED) with metal fractionation to create a partially self-powered process, (3) reduce chemical and energy demand, and (4) demonstrate technological and environmental advantages relevant to industrial adoption and circular-economy frameworks.

Methodology/ Approach

The research employs two complementary membrane-based systems:
Ultra-selective electrodialysis (ED). Tailored cation-exchange membranes functionalised with 5-chloro-8-hydroxyquinoline enable targeted transport of Co^{2+}, Ni^{2+} and Li^{+} under an applied electric field. The resulting enriched streams are subjected to intensified, low-impact precipitation, reducing reagent consumption while achieving high-purity metal recovery.
Reverse electrodialysis (RED). An innovative RED system exploits the salinity gradient between post-leaching battery effluents and dilute acids. A single membrane stack enables simultaneous: (i) selective separation of Co, Ni and Mn, (ii) electricity generation, and (iii) green hydrogen production via water electrolysis. A new generation of ultra-selective cation-exchange membranes maximises both ion-specific transport and harvested electrical potential.

Expected Outcomes

The project delivers high-purity metal streams from chemically complex LIB waste while significantly reducing energy and chemical consumption compared with conventional leaching, enabled by robust, scalable membranes exhibiting high selectivity and operational stability. It also demonstrates the feasibility of RED-driven electricity generation with simultaneous hydrogen production. It provides a flexible process configuration adaptable to a wide range of LIB chemistries and recycling scenarios.

Impact/ Significance

These technologies enable the transformation of hazardous LIB waste into valuable metal resources, clean energy, and green hydrogen. Reduced environmental impact, lower operational costs, and partial energy self-sufficiency position the approach as a key enabler of low-carbon, circular battery value chains. The scalability and compatibility with existing industrial infrastructure make this work highly attractive for future-oriented industrial partners and investors.

Conclusion

By integrating ultra-selective ED with energy-harvesting RED, the ReHeal4Waste framework establishes a novel, resource-efficient pathway for LIB metal recovery. The synergy of precise metal separation, reduced chemical input, electricity generation, and hydrogen co-production positions this research at the forefront of next-generation battery-recycling technologies, offering substantial scientific, environmental, and economic benefits.

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Tower of Life - intelligent rescue system

Wrocław University of Science and Technology

Jaroslaw Sowizdraniuk, founder, Head of Medical Simulation Centre
Faculty of Medicine, Wroclaw University of Science and Technology,

Introduction / Background

Out of Hospital Cardiac Arrest in USA touch 379 per 100k population. Survival rate to hospital discharge is now 10.5%. Only 12.6% of bystanders use AED.

Limitations in the public access to defibrillation (PAD) program hold back the increase in survival rates in cases of cardiac arrest and do not contribute to reducing neurological complications in patients after spontaneous return of circulation. Therefore, PAD does not fully exploit the great potential of defibrillation.

Objectives / Goals

Significantly reducing time to first defibrillation and increasing survival rates from 10% to 30%. Making access to public defibrillation truly universal, not just illusory.

Methodology / Approach

Tower of Life uses stands placed in public spaces to notify people about cardiac arrests. By activating an alarm, it reduces the time needed to find an AED and encourages passersby to deliver the device to the scene. This significantly reduces time to first defibrillation, which, when performed within 4 minutes, brings back to life up to 80% of patients!

Expected Outcomes

Tower of Life system and early defibrillation can bring to life 140,000 people every year in Europe and 270,000 in USA. It will enable patients after cardiac arrest to remain physically fit, able to communicate, get to know their loved ones, meet friends, and go to work.

Impact / Significance

Social: people live, families have loved ones, they build stories together
Healthcare: shorter treatment times and lower costs, better rehabilitation
Government: increase the quality of life and care for the community
Business: improving safety, warming up the reputation, making good use of CSR

Conclusion

The solution could be a game changer in treating patients with cardiac arrest.

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TeraERC: Chip-based room-temperature terahertz frequency comb spectrometers

Wrocław University of Science and Technology

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Introduction / Background

Infrared light interacting with matter reveals some of the essential chemical and physical properties of the sample. It allows for drug authenticity verification, detection of hazardous compounds or evaluation of material degradation, and most recently, health monitoring. Unfortunately, access to the relevant, longwave infrared and terahertz part of the electromagnetic spectrum at room temperature remains a technological challenge.

Objectives / Goals

Our objective is to democratize access to longwave and far-infrared spectroscopy for sample analysis. Instead of large and bulky tabletop optical instruments, we propose a shoebox-sized instrument that allows for room-temperature operation using low-power infrared sources without the risk of thermal damage of the sample. In the era of an aging population, broadband infrared spectroscopy may be an essential tool for early stage disease detection.

Methodology / Approach

Although at the core of our instrument lies an invention from the XIXth century – the Michelson interferometer – it is merged with novel infrared sources with an enhanced far-infrared response and proprietary photodetectors. We can measure the optical spectrum (a fingerprint) across unprecedentedly broad spectral ranges for one instrument. With help from artificial intelligence (AI), it may be possible to extract health-related information from exhaled breath, saliva or urine for point-of-care diagnostics on a large scale.

Expected Outcomes

Our spectrometer is a result of an interdisciplinary collaboration between leading European photonic enterprises and academic researchers, termed “People’s FTIR”. Our mission is to tailor the instrument to point-of-care diagnostics of important diseases in rural and remote areas. For instance, in eastern Germany in the near future it may be difficult to access to a physician. Therefore, photonics-assisted screening for patients who need to undergo conventional laboratory testing (involving travel) may be of critical importance.

Impact / Significance

The impact of our work is multidimensional. We envision the application of our spectrometers in scenarios ranging from health diagnostics through non-destructive analysis to threat detection. With miniaturization in mind, we develop chip-based solutions for both coherent (laser) and incoherent (thermal) systems. Our infrared spectrometers can also be useful in environmental monitoring of non-methane volatile organic compounds (NMVOCs) or persistent organic pollutants (POPs), which pose a threat to human health in areas where air quality is not prioritized.

Conclusion

What is essential, is invisible to the eye. This is why we need to see in the infrared.

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Liquid Technologies

Wrocław University of Science and Technology

VALUE PROPOSITION

We deliver **next-generation fragrance and functional molecules** engineered for extreme chemical environments where conventional scents fail. Our patented **platform** offers unmatched **stability in high-alkaline products**.

Our first commercialized molecule - **LiquaniTe™** - is already implemented in **HVAC Universal**, a high-performance industrial cleaner distributed internationally. This confirms full **TRL9 readiness** and strong industrial demand for high-stability, functional fragrances.

TECHNOLOGY & INNOVATION

- Patented molecules (PL 243494 B1) with **unique chemical structures** not available on the market.
- Breakthrough **sensory and hydrolytic stability** under pH > 12.
- Broad application potential: HVAC, I&I cleaning, detergents, antimicrobial products, functional FMCG.
- Verified **safety, antimicrobial features, and performance** through peer-reviewed studies and semi-technical testing.

MARKET OPPORTUNITY

Industries relying on stable fragrance performance - household chemistry, industrial cleaning, air care, detergents, and selected cosmetics - lack effective high-pH-resistant molecules.

The global scent and functional additives market exceeds **USD 30+ billion**, with strong growth driven by:

- rising regulatory pressure on traditional fragrance allergens,
- demand for safer and more stable ingredients,
- need for differentiation in commodity chemical products,
- accelerated product innovation cycles in FMCG and industrial chemistry.

Our technology provides a **scalable solution** to this unmet need.

CORE TEAM

Dr. Daniel Strub - Applied Chemistry, Functional Fragrance Design, FMCG Innovation
Dr. Arkadiusz Szydełko - Process Chemistry, Scale-Up, Regulatory Compliance
Dr. Bartosz Urbanek - Thermodynamics, HVAC Systems Engineering, Application Testing

Ask/Expectations

We are open to:

- **academic and industrial research partnerships**,
- joint R&D projects and grant consortia,
- applications in detergents, HVAC, I&I cleaning, and niche perfumery,
- licensing and technology-transfer collaborations.

CONTACT

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The undertaking is funded by

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Republic of Poland

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SkyNav: Advanced Fuzzy Logic Autopilot for Unstable Payloads

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Co-founder & CTO at Sky Tronic sp. z o.o. (University Spin-off)

Introduction / Background

Unmanned Aerial Vehicles (UAVs) are transforming industries, but they hit a critical safety barrier when transporting unstable payloads. While standard drones fly well with rigid cameras, they fail when carrying liquids (which slosh in tanks) or cargo suspended on cables (slung loads). In these scenarios, the center of gravity shifts randomly and rapidly during flight. Standard control systems (PID) cannot cope with these chaotic dynamics, leading to instability, mission failure, or catastrophic crashes.

Objectives / Goals

Our objective is to unlock "impossible" missions for commercial drones by solving the stability problem. Our goal is to enable the safe aerial transport of hazardous fluids, firefighting agents, and heavy industrial cargo without the need for complex, heavy mechanical stabilization systems. We strive to make autonomous logistics safe and routine, even under unpredictable payload conditions.

Methodology / Approach

At the core of our solution lies a paradigm shift from classical control theory to artificial intelligence. Instead of standard PID regulators, SkyNav utilizes our own Fuzzy Logic controller (Hardware & Software). This system mimics the reasoning of an expert human pilot rather than a rigid mathematical model. It processes imprecise, real-time data to anticipate and counter random forces caused by payload movement. This approach allows SkyNav to maintain stability where others fail, managing non-linear dynamics without requiring perfect mathematical models of the payload.

Expected Outcomes

SkyNav is the result of years of research at Wroclaw University of Science and Technology, now commercialized through the spin-off Sky Tronic. We have already validated the technology on platforms ranging from small multirotors to a massive 350 kg hoverbike. We expect to deploy SkyNav in pilot programs for precision agriculture (AgriTech) and aerial logistics. The immediate outcome will be a commercial-ready autopilot capable of stabilizing drones carrying liquid tanks larger than the drone itself.

Impact / Significance

The impact of this technology extends to safety, economy, and efficiency. In agriculture, SkyNav enables precision crop spraying using standard tanks (without internal baffles), significantly reducing pesticide use and environmental impact. In logistics and emergency services, it allows for the rapid, safe delivery of supplies via slung loads to hard-to-reach areas. By mastering the chaos of unstable payloads, we are removing the primary technological bottleneck preventing the mass adoption of heavy-duty transport drones.

Conclusion

To master the flight, one must first master the chaos of the payload. SkyNav brings human-like stability to autonomous machines.

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Wrocław University of Science and Technology

Intelligent technologies for concrete production based on waste copper slag enriched with CO2 captured from industrial production for zeroemission construction (SPHERE)

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Wrocław University of Science and Technology, Poland

Introduction / Background

In the SPHERE project, innovative technologies are being developed to transform waste copper slag into a functional raw material for sustainable construction. Through controlled CO_2 mineralization, the project addresses the need for permanent CO_2 binding and waste valorisation within the circular economy.

Objectives / Goals

The main objective is to develop and validate a CO_2-mineralized copper slag technology that enables permanent CO_2 sequestration while improving the microstructure and performance of cementitious materials. The project aims to create a scalable, low-carbon material for zero-emission construction applications.

Methodology / Approach

The project combines industrial CO_2 capture with a controlled mineral carbonation process applied to copper slag. Advanced analytical tools such as SEM/EDS, environmental analysis, and microstructural characterization support the optimization of the mineralization process. Laboratory-scale CO_2 treatment systems and mechanical performance testing validate the resulting materials.

Expected Outcomes

Key expected results include a CO_2-enriched copper slag with enhanced structural features, improved performance in cementitious composites, and permanent binding of captured CO_2. The project anticipates generating a patent-protected, scalable technology with high application potential.

Impact / Significance

The technology supports the transition toward zero-emission construction by transforming industrial waste into valuable raw materials while reducing CO_2 emissions. Construction companies, material producers, and environmental stakeholders will benefit from sustainable material solutions and reduced carbon footprints.

Conclusion

The SPHERE project provides an innovative pathway for combining waste valorisation with CO_2 sequestration. It represents a significant step toward developing advanced low-carbon construction materials aligned with global sustainability goals.

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