IIT Indore's Trailblazing Innovations: Advancing Defence and Military Technology with DRDO Collaboration

In a groundbreaking development, the Indian Institute of Technology (IIT) Indore has successfully delivered 10 pairs of innovative tribo-electric nanogenerator (TENG) based shoe sole energy harvesting units to the Defence Research and Development Organization (DRDO) under the Ministry of Defence, Government of India. This milestone showcases a significant leap in integrating sustainable energy solutions with advanced tracking technologies. The shoes, developed under the expert guidance of Prof. I. A. Palani, are designed to harness energy from human motion to power electronic devices.

The TENG system in these shoes utilizes advanced tribo-pairs—Fluorinated Ethylene Propylene (FEP) and Aluminum—to generate power with each step. This energy is stored in a central device within the shoe sole, ensuring a reliable power source for small-scale electronic circuits. Additionally, the shoes feature sophisticated tracking technology, including RFID with a 50-meter range and a satellite-based GPS module for precise live location tracking.

The military applications of this technology are particularly noteworthy. The real-time location tracking capabilities enhance the safety and coordination of military personnel, boosting operational efficiency and security. The TENG-powered shoes can support essential GPS and RFID systems, providing a self-sustaining and dependable solution for various military needs.

Beyond military use, these TENG-powered shoes hold promise for civilian and industrial applications. For families with elderly members, especially those with Alzheimer’s disease, the shoes offer peace of mind through reliable location tracking. Working parents can monitor their children’s whereabouts throughout the school day, and schools can use RFID technology to maintain accurate attendance records. In industrial settings, the shoes are useful for attendance tracking and worker monitoring.

The athletic industry can benefit from these shoes by analysing athletes' foot movements, which can help improve performance and training techniques. For trekking and mountaineering enthusiasts, the shoes provide reliable tracking during expeditions with their self-powered GPS feature, ensuring safety and efficient navigation.

IIT Indore has also made significant strides in other DRDO-funded projects, showcasing a wide array of innovations in various technological domains. These projects, undertaken by various professors at IIT Indore, reflect the institute's broad expertise and commitment to advancing defence technology.

One notable project enables the optical imaging of high-speed particles traveling up to 2000 m/s. This technique is being developed under the guidance of Prof. Devendra Deshmukh and it is crucial for applications in aerospace, defence, and industry, aiding in the understanding of phenomena such as spray patterns, impact

mechanisms, and detonation gas clouds, thereby enhancing both safety and efficiency.

In the domain of morphing aeronautical structures, Prof. I. A. Palani and his team is developing pretrained post buckled shape memory alloy (SMA) composite to develop adaptive flappers for missiles. Under this project, lightweight, shape memory alloy integrated intelligent composite structures are being designed and fabricated that serve as an alternative to traditional electro-hydraulic systems, particularly benefiting lightweight aircraft. Another remarkable project involves design and fabrication of shape memory alloy (SMA) based actuators for underwater soft robotics systems using smart materials. Also developing biomimicking robots like jellyfish and turtles for underwater surveillance. These robots, integrated with shape memory alloys, can perform vertical and horizontal diving and move both on land and water.

In the field of applied electromagnetics, lightweight cost-effective microwave absorbers and radomes based on Three-Dimensional (3-D) printing technology is getting designed and developed by Dr. Saptarshi Ghosh. It consists of lightweight, cost-effective surfaces that can reflect or absorb microwave radiation, protecting electronic devices that are vulnerable to such radiation. Additionally, he has made strides in stealth technology by starting research that aims to create a special surface using a 3D printer. This metamaterial-based electromagnetics designs enhance the stealth capabilities of fighter aircraft, making them invisible to enemy radar and significantly improving security in defence operations.

Dr. Indrasen Singh from the Mechanical Engineering Department is working on three different projects for defence and military technology advancements.

One of his projects focuses on the rotating band, a crucial component of artillery shells that imparts a spin and prevents the leakage of burnt propellant gases during firing. For the 155mm x 52 caliber gun system, it is essential that these bands remain intact and function properly both inside and outside the gun barrel. To understand and improve their performance, Dr. Singh used computer simulations to study the failure behaviour of these bands under various conditions. The findings aim to ensure the reliability and effectiveness of rotating bands in real-world scenarios.

Since World War II, gilding metal has been the standard material for making rotating bands on artillery shells. However, increasing the amount of propellant to extend the range of the shells often causes these bands to fail. To address this issue, the second project explored alternative materials for manufacturing rotating bands using 3D printing technology. By testing different materials, he aims to find a more durable option that can withstand higher propellant quantities, ensuring better performance and safety.

His third project focuses on the design of a honeycomb sandwich structure for the soles of anti-mine boots, intended to protect soldiers from blasts caused by anti-personnel mines. By developing a simulation model, he can test and refine this design to create a sole that effectively absorbs and disperses the force of a blast. This technology has the potential to save lives and reduce injuries for soldiers in the field, offering a significant advancement in protective gear.

As the demand for efficient and portable power sources continues to rise, IIT Indore's innovations, including the TENG-based shoe sole technology and other advanced DRDO projects, are set to revolutionize energy harvesting, real-time tracking, and

various defence and industrial applications. These advancements offer sustainable and practical solutions for a wide range of needs, highlighting IIT Indore's pivotal role in pioneering the future of defence technology.

To further enhance its capabilities, the institute has also established a dedicated Centre of Futuristic Defence and Space Technology (CFDST), committed to providing a platform for students and researchers to contribute to "Nation-Building" by developing various advanced and innovative technologies for the Defence and Space sectors towards "Aatmanirbhar Bharat." The centre is actively providing technological solutions to various research problems of the premier laboratories of defence and space institutions in the country. It also offers specialized and dedicated M. Tech. and Ph.D. programs in Defence Technology for highly motivated candidates sponsored by reputed defence R&D organizations.

For industries interested in commercializing these innovative technologies, they are available through IIT Indore. The institute is actively seeking partnerships and collaborations to bring these technologies to market. Interested parties are encouraged to contact IIT Indore for more information on licensing and collaboration opportunities.

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