EcoCFTrack: Advanced Diagnostic, Monitoring, and Tracking Device for Affordable Cystic Fibrosis Care

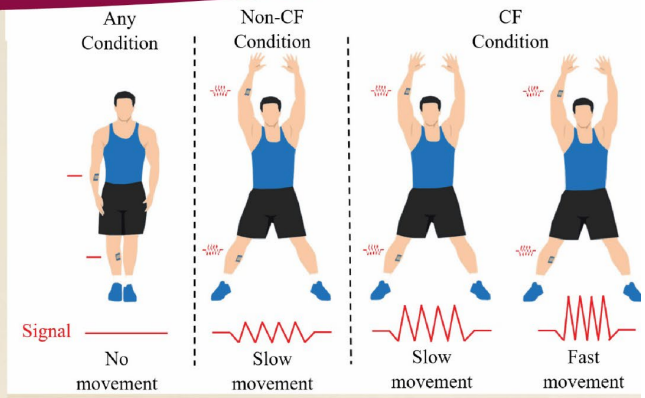
A flexible, self-energy harvesting wearable sensor, using Triboelectric Nanogenerator (TENG) technology, that diagnoses and monitors cystic fibrosis (CF) using sweat ion concentration and motion tracking

Innovation & Solution

First-of-its-kind, self-powered wearable sensor named EcoCFTrack, designed for the diagnosis and monitoring of Cystic Fibrosis (CF) using sweat analysis and fitness activity tracking. This sensor leverages the Triboelectric Nanogenerator (TENG) technology to harness energy from body motion, featuring a flexible three-layer architecture conducive to mass production. The layers consist of Thermoplastic Polyurethane (TPU) for the base and outer protection, with an embedded electrode made of conductive Polylactic Acid (PLA), offering a robust and skin-friendly interface. Unlike previous wearable energy harvesters that suffered from fabrication complexities, poor flexibility, and user inconvenience, EcoCFTrack stands out by utilizing the single-electrode mode of TENGs, efficiently generating power through the biomechanical motion of the user. This enables continuous, non-invasive monitoring of ion concentration in sweat—a critical indicator for CF diagnosis—alongside motion tracking to monitor fitness activities relevant for CF patients' treatment. This approach not only addresses the need for a rapid, efficient, and cost-effective system for CF diagnosis and monitoring but also overcomes the limitations of existing energy-harvesting wearables in terms of simplicity, flexibility, and user comfort.

Benefits

- Non-invasive, efficient CF diagnosis using ion concentration in sweat
- Portable and flexible design suitable for continuous wear
- Power-efficient design using TENG technology for sustainable operation
- Real-time fitness activity tracking for better health management
- Direct integration with established sweat test methods for CF diagnosis



Background & Problem

Cystic fibrosis (CF) is a genetic disorder affecting multiple body systems, including the respiratory, digestive, and reproductive systems. Approximately 32,000 children and adults in the U.S. currently suffer from CF and there are about 1,000 new diagnoses each year. Despite available methods for diagnosing and monitoring CF, there is a pressing need for a rapid, efficient, and cost-effective system to diagnose and monitor the treatment process of CF patients.

The most accurate method of diagnosing CF is the sweat test, yet it requires a medical laboratory and professionals to undertake. Meanwhile, high energy consumption is considered a critical problem for wearable health monitoring devices. This makes wearable devices a promising, yet challenging approach for continuous monitoring and diagnosing of CF. Existing wearable energy harvesters often face issues of complex fabrication procedures, poor flexibility, and inconvenient operation, limiting their practical use.

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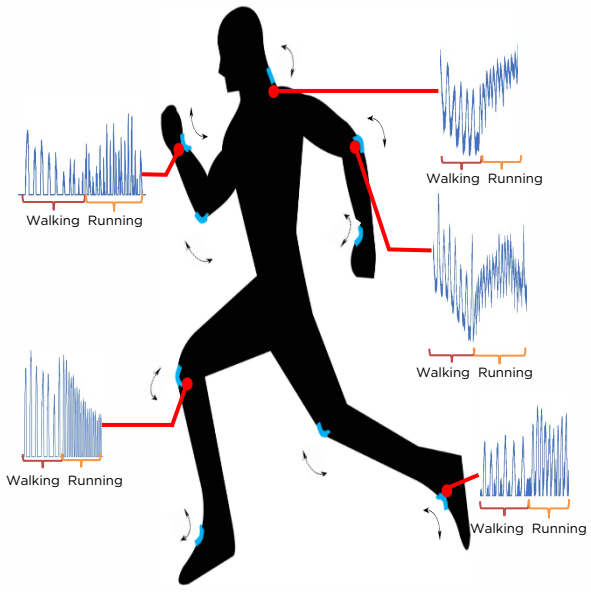
Novel Features

- **Non-invasive Health Monitoring:** Traditional methods for CF diagnosis, like sweat chloride tests or genetic testing, require clinical visits and can be invasive or uncomfortable. Wearable sweat biosensors offer a non-invasive and continuous monitoring capability which is significantly more patient-friendly compared to existing approaches like the Gibson-Cooke sweat test or blood tests.
- **Sustainable Energy Utilization:** Most wearable devices for health monitoring require regular charging or battery replacements. The incorporation of a Triboelectric Nanogenerator (TENG) for energy harvesting from human motion into the wearable sensor signifies a competitive edge over other wearables that rely on conventional lithium-ion batteries, ensuring sustainability and less environmental impact.
- **Flexible and User-Friendly Design:** Current wearable sensors or energy harvesters often suffer from rigidity and can be uncomfortable to wear for extended periods. This proposed CF TENG-based wearable sensor, being flexible and mass-producible, would provide a higher comfort level and better user adoption compared to less flexible options like conventional chest straps or rigid health monitoring devices.
- **Integrated Fitness Activity Tracking:** Existing approaches for CF typically separate diagnosis and treatment monitoring (e.g., exercise tracking). The integration of fitness activity tracking with CF diagnosis in a single device provides added value over separate fitness trackers (like Fitbit or Garmin devices) and diagnostic tools, which simplifies the patient's routine and potentially improves compliance.
- **Real-time Diagnostic and Monitoring Capability:** Existing sweat test methods require laboratory analysis and do not provide real-time feedback. This wearable sensor uses ion concentration in sweat for immediate CF diagnosis, granting a significant advantage over traditional delayed-feedback diagnostics like the Wescor Macroduct Sweat Collection System, which requires lab analysis post-sample collection.

Applications

- Personal health monitoring for individuals diagnosed with CF, providing real-time sweat analysis and motion tracking
- Physical therapists and medical professionals could use the sensor to make informed decisions on treatment plans
- Medical researchers can collect data about the management and progression of CF in a less invasive, more efficient manner
- Sports and fitness training industries to track human motion and health status
- Consumer grade health and fitness trackers, offering non-invasive CF testing



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