Spintronics-Driven Radar for Ultra-Accurate Positioning

Breif Background

Conventional radar systems face challenges in balancing sensitivity, size, and energy efficiency, especially for compact and low-power designs. Traditional EM-based radars struggle to detect weak signals in complex electromagnetic environments. With rising demands from defense, aerospace, and autonomous navigation sectors, there is a need for a more precise, miniaturized, and power-efficient solution. Spintronics—leveraging electron spin and charge—offers this potential. Using Magnetic Tunnel Junction (MTJ) devices integrated with electromagnetic theory

Application Sectors

- Defense and Surveillance
- Autonomous Navigation Systems
- Industrial and Infrastructure Monitoring

TRL 4

Tech/Prod. Summary

An innovative radar detection and positioning system leveraging microwave spintronics sensors, electromagnetic (EM) wave direction-finding, and magnetic tunnel junction (MTJ) technology. This fusion enables ultra-sensitive signal detection, compact architecture, and high-frequency response, making it ideal for next-generation defense, navigation, and industrial sensing applications

Tech/ Product Description

The radar detection and positioning system integrates microwave spintronics sensors with EM signal processing to achieve ultra-sensitive detection and accurate positioning. Using Magnetic Tunnel Junction (MTJ) devices, it detects microwave radiation through spin-dependent tunneling, enhancing range and direction finding. The system fuses EM wave direction-finding algorithms with RADAR principles to determine azimuth, elevation, and distance with high precision. It supports multi-frequency operation, adaptive calibration, and modular integration for UAVs, vehicles, or fixed installations. Compact, low-power, and resilient to noise, it delivers next-generation radar capabilities suitable for defense, navigation, and industrial sensing applications.
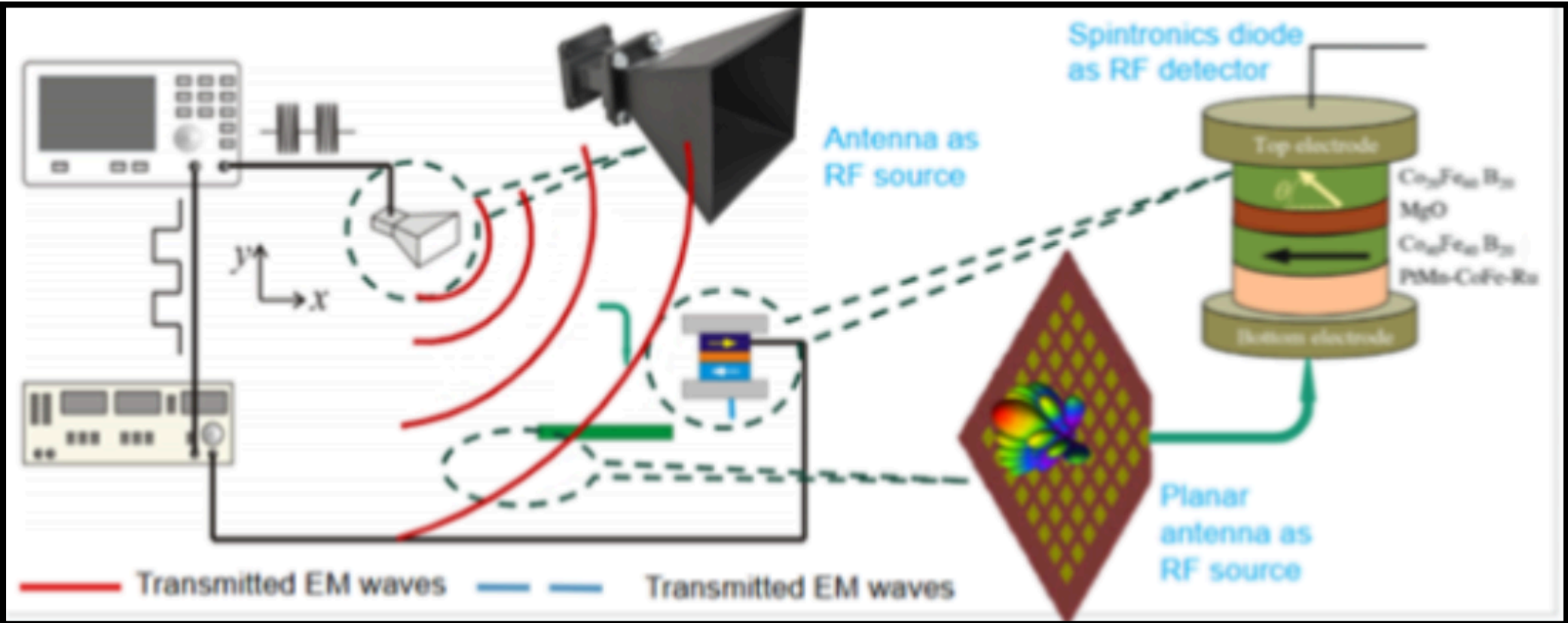
Market Potential

Global radar sensor market: USD 8.5 billion in 2025 to → USD 18 billion by 2030 (CAGR ~16%).

Impact - SDG:

SDG 9 – Industry, Innovation & Infrastructure

Value Proposition

1. Use of Spintronics and EM Technology to Improve the Detection of RADAR signals
2. Development of Small Footprint Direction Finding Electromagnetic-cum-Spintronics Sensors

Spintronics diode as RF detector
Antenna as RF source
Top electrode
$Co_{40}Fe_{40}B_{20}$
MgO
$Co_{40}Fe_{40}B_{20}$
PtMn-CoFe-Ru
Bottom electrode
Planar antenna as RF source
y x
— Transmitted EM waves   – – – Transmitted EM waves

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