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27 March 2026

TO WHOM IT MAY CONCERN;

REVIEW OF MS. GULSAYA NURZHAUBAYEVA'S PH.D. DISSERTATION
Thesis: Research and Development of Wearable Microstrip Antennas on Textile Substrate

The dissertation addresses the critical need for conformal and flexible radiating structures for Internet of Things (IoT) applications operating in the 2.45 GHz ISM band. While conventional antennas on rigid substrates are poorly suited for wearable use, this work develops solutions that remain robust, flexible, and electromagnetically safe under real-world conditions.

The key technical contribution of the dissertation is the systematic investigation of textile electrophysical properties—such as relative permittivity, dielectric loss tangent, and substrate thickness—and their direct impact on resonant characteristics. Building upon this analysis, the author successfully develops two complementary topologies: a two-element linear microstrip array and a full-size microstrip Yagi–Uda antenna implemented entirely on a textile substrate. By utilizing CST Studio Suite for electromagnetic modeling across felt, denim, polyester, and cotton, the methodology proves highly accurate, with frequency errors remaining below 1.22%.

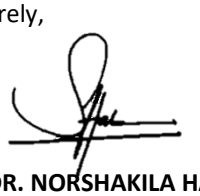
Crucially, the research rigorously evaluates both mechanical deformation and electromagnetic safety, which are decisive for wearable devices. The developed antennas demonstrate stable matching and resonance preservation under bending radii of 55 to 90 mm, corresponding to human limb curvature. Furthermore, the calculated Specific Absorption Rate (SAR) values (ranging from 0.005 to 0.0231 W/kg) remain substantially below the FCC and ICNIRP limits, achieving this exceptional safety profile without the need for additional Artificial Magnetic Conductor (AMC) or Electromagnetic Band Gap (EBG) shielding structures.

The proposed designs are verified through physical prototyping and experimental measurement using a portable vector network analyzer with Open–Short–Load calibration. The strong agreement between the measured reflection coefficients and the simulated behavior confirms the validity of the numerical approach and the proposed design methodology.

The problem is clearly scoped, the analytical treatment is logically sequenced, and the work exhibits substantial practical significance for the telecommunications industry. This is further confirmed by a strong portfolio of Scopus-indexed publications and conference reports.

From these observations, I consider that the dissertation meets all requirements imposed on dissertations submitted for the specialty 8D06201 – "Radio Engineering, Electronics and Telecommunications," and I highly recommend Ms. Gulsaya Nurzhaubayeva's dissertation for defense and the award of the degree of Doctor of Philosophy.

Sincerely,



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