AntennaX

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Abstract

• Traditional antennas have fixed geometries that limit frequency adaptability and signal performance.

• **AntennaX** proposes an adaptive origami-inspired helical antenna integrated with SDR analysis.

• The system uses origami folding to dynamically change antenna geometry and resonant frequency.

• MATLAB and FFT-based SNR analysis are used for real-time frequency detection and optimization.

• The proposed design aims to improve signal reception, frequency alignment, and antenna efficiency.

Introduction / Background

- Modern antennas require adaptive tuning for changing signal environments.
- Traditional antennas use fixed geometries with limited flexibility.
- Origami-inspired antennas provide compact and reconfigurable structures.
- SDR and FFT analysis enable real-time signal detection and optimization.
- **AntennaX** combines adaptive origami geometry with intelligent SDR analysis.

System Model / Methodology

• Origami folding changes the antenna geometry and resonant frequency dynamically.

• SDR performs real-time FFT and SNR analysis for signal monitoring.

• The system detects dominant frequencies and adapts the antenna configuration accordingly.

• Performance is evaluated using SDR-based SNR, FFT peak power, frequency spectrum, and S11 analysis.

Table 1. Simulation Results for Different Antenna Geometries

Frequency (GHz)	SNR (dB)	FFT Peak Power (dB)	Antenna Geometry
1.36 — 1.38	24 – 30	-12 <—> -8	Fully Expanded
1.40 — 1.43	20 – 24	-18 <—> -14	Normal State
1.46 — 1.48	14 – 18	-26 <—> -20	Folded

Conclusions

- **AntennaX** demonstrates the potential of adaptive origami-based antennas for dynamic frequency tuning.
- **Integrating** SDR, FFT, and SNR analysis improves signal monitoring and antenna adaptability.
- The proposed system offers a compact and reconfigurable solution for intelligent radio telescope applications.
- The design demonstrates stable performance across multiple antenna states.
- **Future** work includes CST validation, physical prototyping, and AI-based automatic optimization.

Proposed Solution / Main Idea

- AntennaX proposes an adaptive origami-inspired helical antenna capable of expanding and retracting to dynamically tune resonant frequency and improve signal reception.
- Traditional antennas suffer from fixed geometries that limit adaptability, while existing reconfigurable systems often depend on complex electronic switching with higher power loss.
- To address these limitations, CST Studio Suite is used for antenna modeling and electromagnetic simulation, while MATLAB performs FFT and SNR analysis to evaluate signal behavior and system performance.

Figure 1. Origami Helix Folding Process

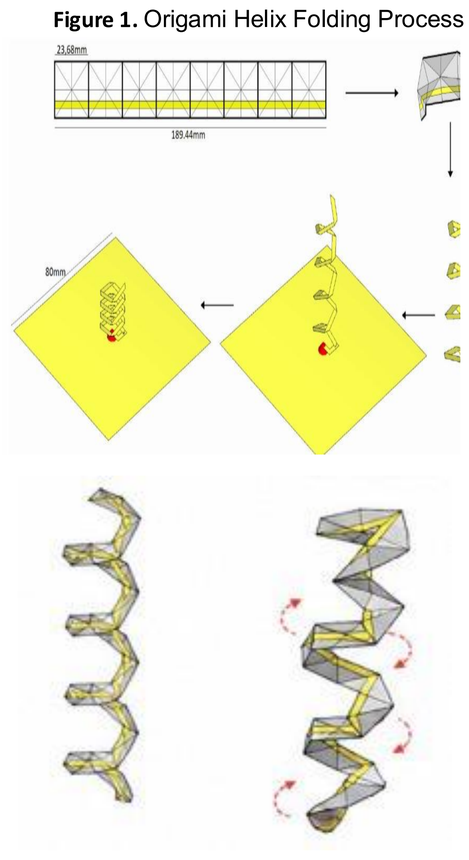


Chart 1. Dynamic Frequency Adaptation Performance

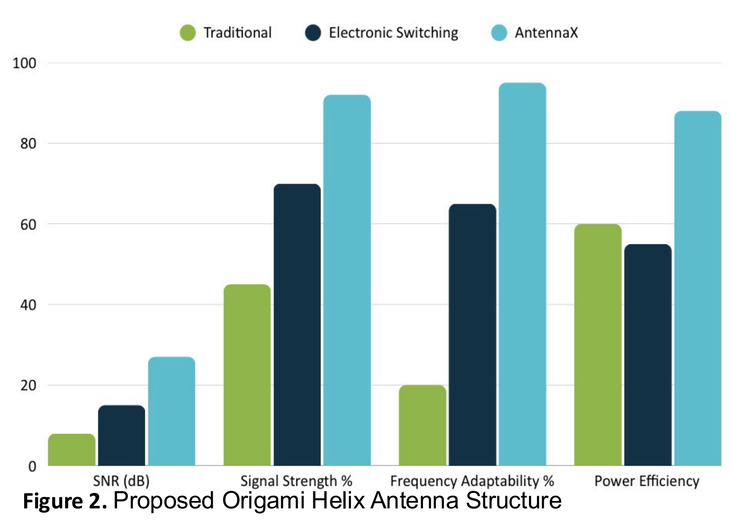
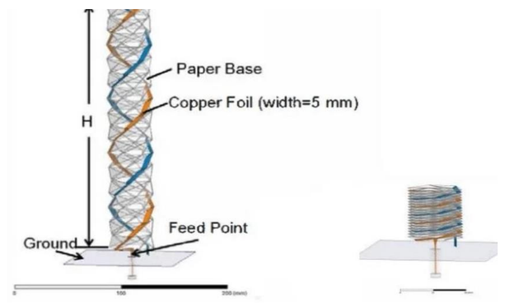


Figure 2. Proposed Origami Helix Antenna Structure



Results / Simulation / Discussion

- The antenna was designed using an origami-inspired flexible helix structure.
- The antenna geometry changes according to the required frequency range.
- Three antenna States are proposed for CST as shown in Figure 3:
- ❖ Folded : 105 mm height
- ❖ Normal State : 240 mm height
- ❖ Expanded : 315 mm height
- Figures 4-6 show the SDR analysis, S11 response, frequency spectrum, and antenna radiation results for different antenna states.
- The results confirm that changing the antenna geometry shifts the resonant frequency and affects antenna performance..

Figure 3. Origami Helix Antenna States

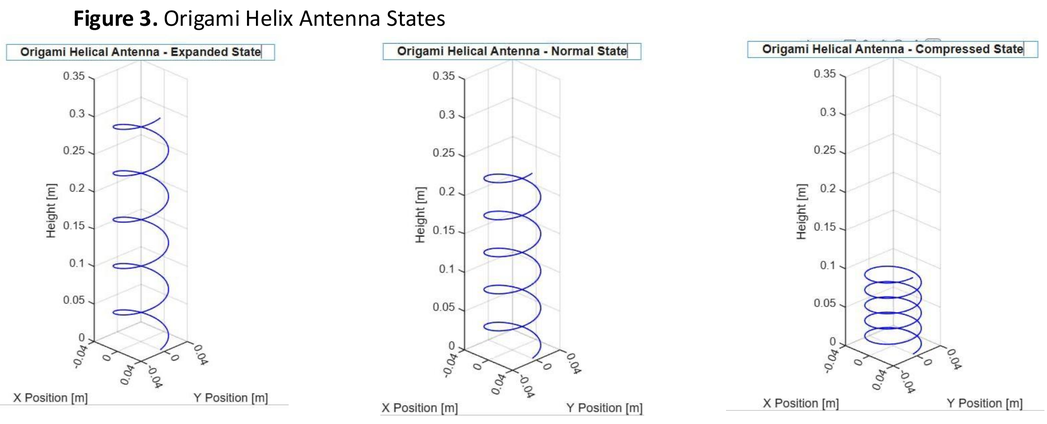
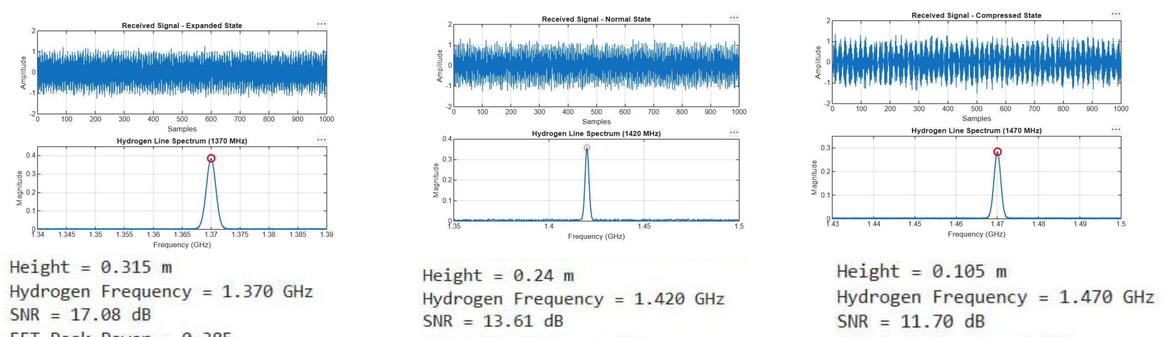


Figure 4. SDR Signal Analysis for Different Antenna States



Height = 0.315 m
Hydrogen Frequency = 1.370 GHz
SNR = 17.08 dB
FFT Peak Power = 0.385
Peak Frequency = 1.370 GHz

Height = 0.24 m
Hydrogen Frequency = 1.420 GHz
SNR = 13.61 dB
FFT Peak Power = 0.357
Peak Frequency = 1.420 GHz

Height = 0.105 m
Hydrogen Frequency = 1.470 GHz
SNR = 11.70 dB
FFT Peak Power = 0.284
Peak Frequency = 1.470 GHz

Figure 5. S11 Comparison for Different Origami Helix States

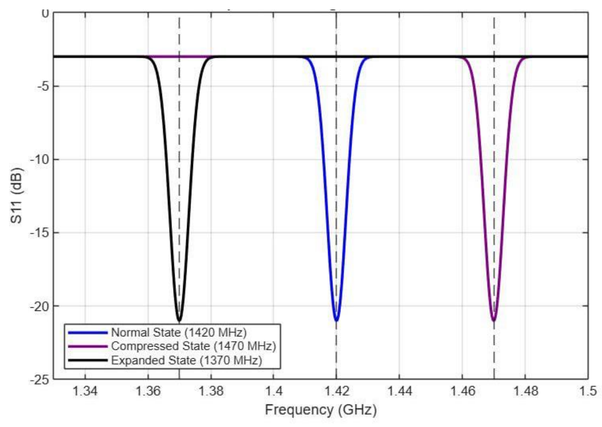
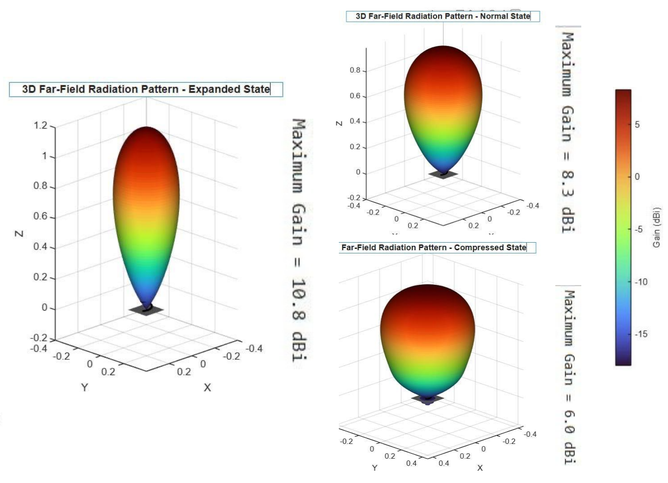


Figure 6. Radiation Pattern for Different Antenna States



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