



A Smart Nano Radio Telescope: Integrating Meta-Surface and IoT Technology

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Abstract

In an effort to design a Smart Nano Telescope to enhance traditional telescopes' ability to detect weak radio signals, many times, conventional telescopes face obstacles posed by signal variability and hardware limitations that affect the quality of observations. Therefore, we designed a compact telescope based on nanotechnology; this telescope has a smart meta-surface layer and is equipped with IoT connectivity. The system is designed to send and receive signals and run on a battery, while wireless connections are made to the main observatories either via LoRa or Wi-Fi. 3D models were developed in SolidWorks, and MATLAB simulations were performed to demonstrate the feasibility of the concept. It has successfully demonstrated that the suggested design will provide increased signal precision, less operating cost, and flexible deployment on drones or satellites composed of a distributed observation network. Furthermore, AI-based signal processing is integrated to enhance data interpretation and provide effective and efficient observation.

Introduction / Background

Telescope is fundamental tool used for observing the distant objects by using mirrors that gather and focus light from the sky [1]. Over time, advancements in telescope technology such as integration of nanomaterials, meta surface, and internet of things (IoT) connectivity have significantly expanded the ability to explore and study the universe [2,3,4]. However, these large telescopes may often face challenges because of the weak or variable signals, it could limit their observation efficiency [1]. Recently, some studies highlighted the potential of new materials and digital system to enhance the telescopes working by improving multispectral data collection, expanding data storage capabilities, and enabling advanced signal [1,5]. To address current gaps, we developed a novel solution called nano telescope, by integrating nanomaterials with meta surface and (IoT). This will enhance the signals quality, accuracy, and will improve our ability to capture all relevant signals.

System Model / Methodology

Conceptual and Literature Review

We started with the inquiry of how radio telescopes work and how they're built, and read a lot of papers to build a solid underlying theoretical knowledge.

Consultations with the Experts

We consulted mentors, professors, and researchers specializing in the field of radio astronomy to understand aspects of the design process and the significant considerations to take into account.

Site Visit

A visit to the university's radio telescope provided opportunities to see how the signal was received, and how the data was processed into an observable output. There was also some inspiration for small units, and using Meta-Surfaces to acquire better signals.

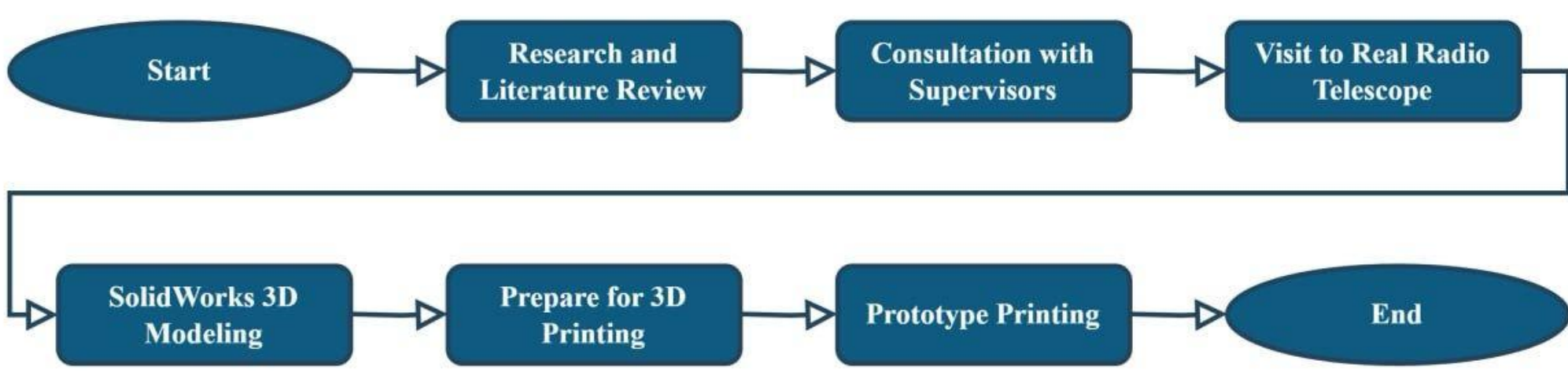
3D Design and Modeling

We defined the unit size as 10×10×70 cm and moved onto an introductory/abstract 3D modelling in SolidWorks, to create concepts displaying structure and the internal layout.

Prototyping

Non-functioning prototypes were made to experiment with a structure for a distributed telescope network. Each unit connects through IoT connectivity and signal data is processed using AI algorithms that aims to improve accuracy through checks with external data sources.

Fig.2: Nano Radio Telescope Signal Methodology



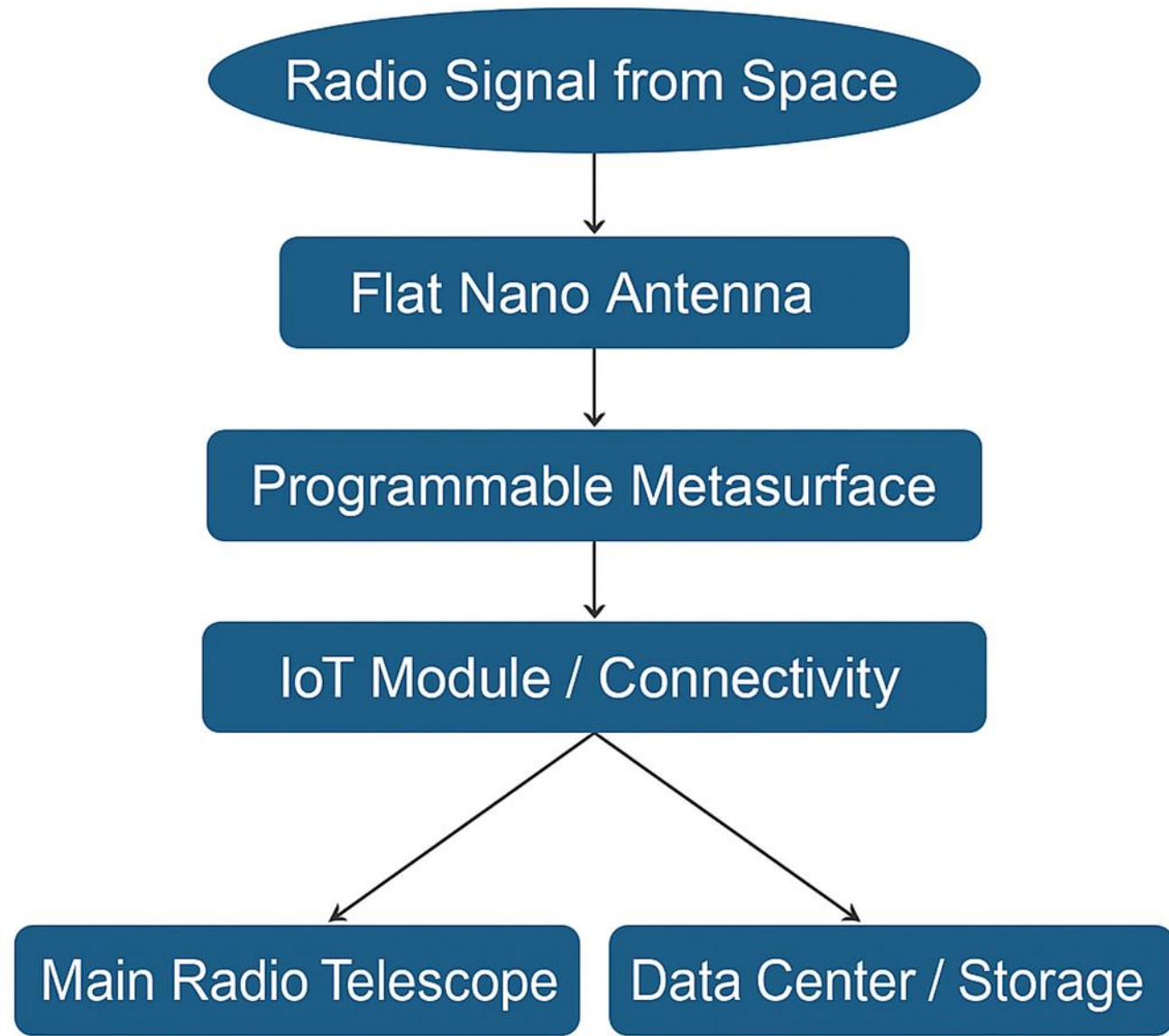
Conclusions

The smart nano-radio telescope is an exciting option for upgrade traditional ways of observing space. The design takes advantage of advances in nanotechnology, Meta-Surface, and IoT connectivity to improve signal detection, precision, and flexibility. Simulation results have verified that it works and can scale or part of a distributed networks of telescopes or an array of drones or satellites. The next iteration will prioritize real-time AI and functional prototype building.

Proposed Solution / Main Idea

This project proposes the design and development of a smart nano telescope intended to complement existing large-scale observatories. The proposed system integrates several key innovations. At first the **Nano technology** is utilized in a compact, flat Nanotenna that enhances the capture of weak cosmic radio signals. And for the **smart Meta-surface** technology processes incoming signals directly at the antenna layer, improving signal quality. With using **IoT** it will enable the Nano telescope to communicate wirelessly with a central observatory via LoRa or Wi-Fi, and to be synchronized. These lightweight telescope can be attached to drones or artificial satellites, creating a distributed observation network in space. Network would improve the spatial coverage and sensitivity of astronomical observation. The prototype design modelled using SolidWorks, and simulation were conducted using MATLAB. This flexible and scalable approach offers numerous benefits, including increasing in observation accuracy, reduces costs, allows the system to be easily deployed in multiple locations.

Fig.1: Nano Radio Telescope Signal Processing



Results / Simulation / Discussion

We presents the outcomes of the system simulation conducted using MATLAB, the results are summarized in two key points:

1) Accuracy and Number of IoT Devices:

the results shows that the system accuracy improves as we add more IoT. However, the improvement starts to become constant after five devices, by that adding more beyond this point brings minimal benefit shown in Fig.3.

2) Signal Strength:

Adding more number of nano telescope will increases the signal strength then become stronger and more stable. Even though the frequency remains the same, the combined input leads to a clear and more reliable signal shown in Fig.4.

Fig.3: Accuracy and number of IoT Devices

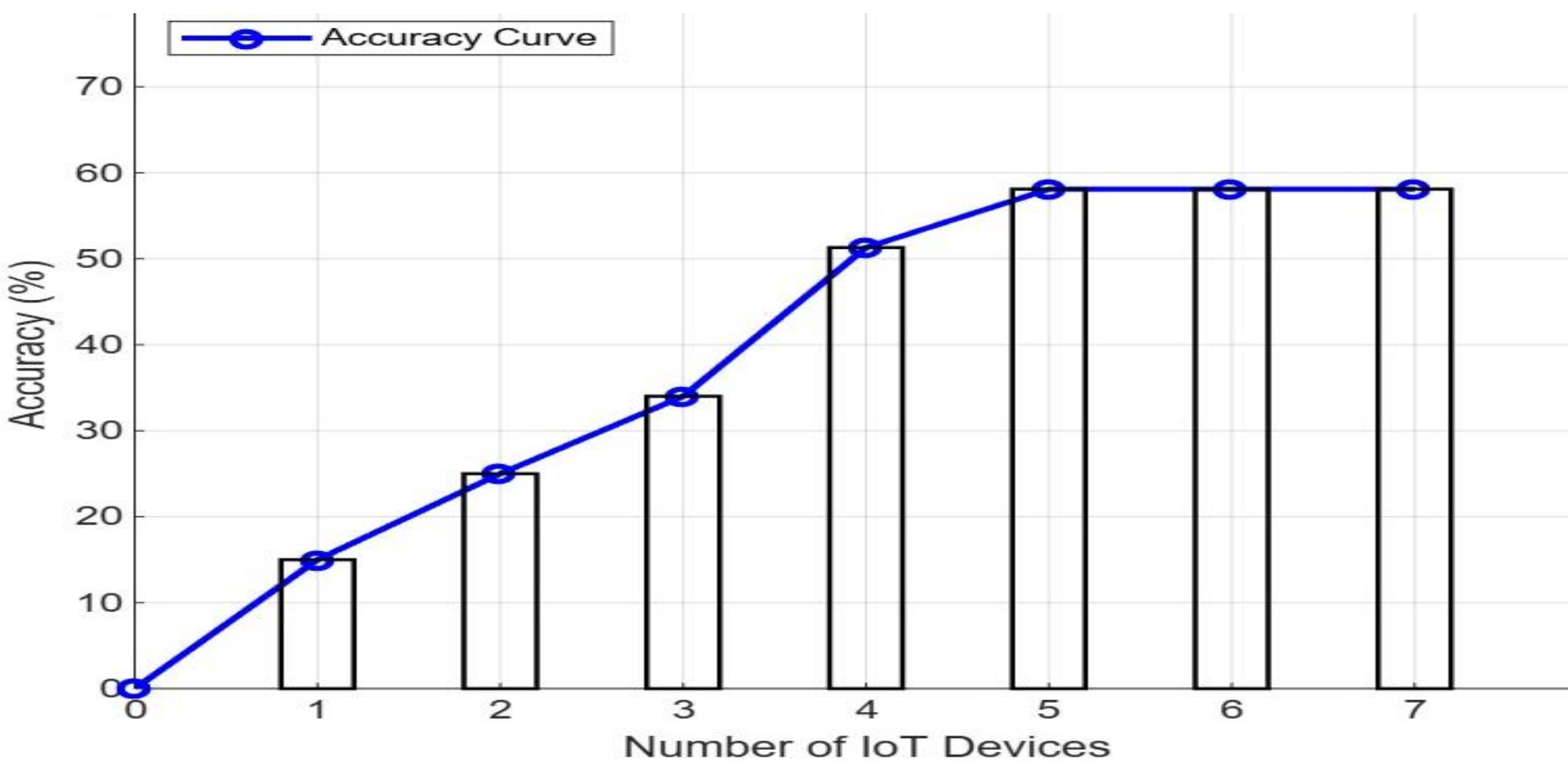
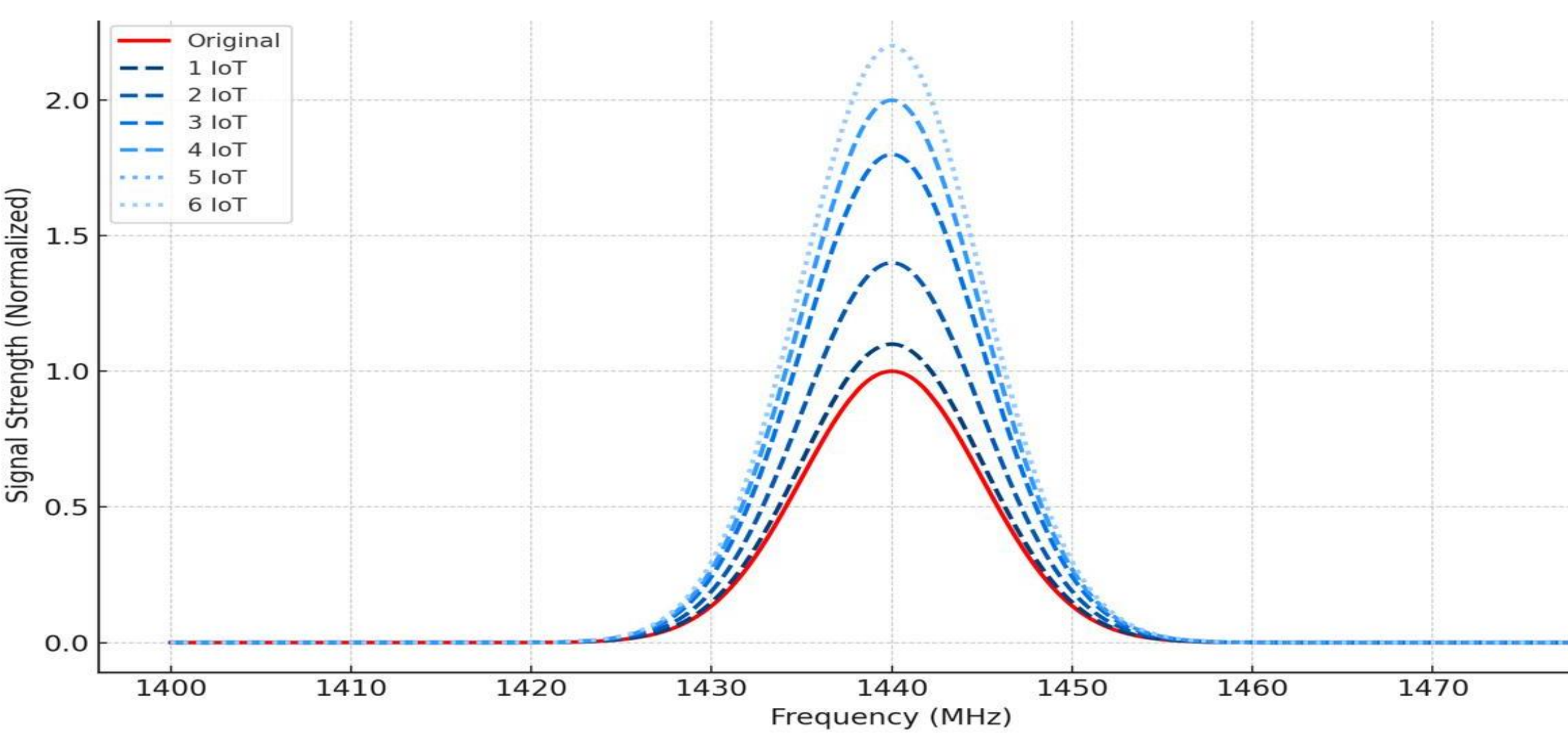


Fig.4: Signal Strength at 1440 MHz with up to 6 IoT Devices



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References



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