**EARS: Enabling Opportunistic Environmental Monitoring with Non-Uniform Sampling and Processing Circuits**

**NSF Org:** ECS  
Div Of Electrical, Commun & Cyber Sys  

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**ABSTRACT**

The ultimate vision of this project is to help address global climate change issues, which have caused environmental conditions to become much less predictable with potentially dire consequences for the human society. The proposed project aims to provide an alternative solution to expensive, complex monitoring equipment operating in dedicated radio-frequency (RF) bands through inexpensive spectrum sensing equipment that requires no dedicated transmitters or bandwidth. In the US, government agencies spend billions of dollars every year to develop, maintain, and operate their remote sensing assets, but are still unable to achieve continuous environmental monitoring. This project addresses the Grand Challenge of continuous and ubiquitous global environmental monitoring, making progress towards the vision of a crowd-sourced, global environmental sensing system by investigating the key enabling technologies. Meanwhile, this project plans to integrate the research into K-12 outreach programs, and educate students at both the undergraduate and graduate levels. The research outcomes will be shared with the community via academic dissemination and educational videos.

The technical objective of this research is to enable opportunistic environmental monitoring via a novel RF sensing modality exploiting aspects of active and passive remote sensing, as well as low-cost on-demand spectrum sensing hardware and algorithms. The sensing hardware aims to provide signal-of-opportunity (SoOo) reflectometry over a wide spectrum of ambient signals from 100 MHz to 5 GHz. In addition, the research outcomes are applicable to other spectrum sensing challenges in wireless communications due to the similarity of required functionalities. The intellectual merit is to demonstrate new capabilities in environmental monitoring via application, algorithm, and hardware level innovations. At the application level, the proposed research will leverage free ambient signals to perform reflectometry, using ScOps from 100MHz (FM radio) to 5GHz (WiFi) with GPS/GNSS, Military Communication Satellite (MilComSat), XM, LTE, GSM in between with the goal of unprecedented on-demand sensing of environmental properties. At the hardware level, an agile receiver architecture will leverage non-uniformly sampled (NUS) analog-to-digital converters (ADCs) that automatically adjust the sample rate depending on the input signal content. This potentially will enable more efficient spectrum sensing hardware relative to existing designs, as the samples are generated only when necessary. Based on this receiver architecture, this project will further explore novel NUS digital signal processing algorithms that operate directly on the non-uniform samples at the output of the NUS-ADC, thus avoiding the power-hungry interpolation circuitry required in existing NUS designs.