Plan Overview

A Data Management Plan created using DMPTool

Title: LoRa Quake - An Emergency Mesh Network to Locate the Victims in Disaster Scenarios

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Template: NSF-CISE: Computer and Information Science and Engineering

Project abstract:

The recent disasters occurring across the globe in 2023, such as the Turkey–Syria Earthquake, the Hawaii wildfires, and the Libya Floods, have repeatedly shown that today's communication technologies designed for high data rates are insufficient when we need them the most. Most importantly, they are inefficient in locating the victims in emergency scenarios in a timely manner. To significantly reduce our losses in the future, we need a new generation and unique communication and sensing technology. In this regard, the overarching goal of this project is to build a large-scale mesh network that can work in very harsh conditions, communicate and locate the victims, and provide situational awareness to the first responders and a framework for sensing the potential hazards before they occur. Instead of an external wireless system, this project proposes deploying many devices (in particular, Long-Range (LoRa) nodes) to the buildings, the existing infrastructure, and many personal nodes. In particular, these nodes and the devices deployed by the first responders will form a mesh network to allow first responders to establish timely contact with the victims. The nodes will exploit the computing and sensing power of the smart devices while being capable of sensing the environment and locating themselves without Global Positioning System (GPS) signals.

Start date: 08-01-2024

End date: 08-01-2027

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(1) Link-level and system-level data: In this category, MATLAB and its toolboxes (e.g., Communications Toolbox, Deep Learning Toolbox available at no additional charge to NSF) and Python-based scripts will be utilized to assess the mesh network, positional awareness, and sensing performance described in the project description. The obtained data at this level include MATLAB and Python scripts in the form of .m, .mat, and .py files. The data will include mesh communication performance metrics (e.g., packet-delivery and collision rates and synthetic in-phase and quadrature data), sensing-related data (e.g., audio recordings and temperature), and localization data (e.g., ranging between nodes and coordinates acquired from GPS signals). The wireless channel models and hardware impairment for the simulations will be made available in the MATLAB scripts. MATLAB, PyTorch, and TinyML will be utilized to obtain the semantic information or inference for sensing. The data generated at this level can include neural network topology and weights that will be captured as text files. We will use Swift and Xcode to develop apps on smart devices. The obtained data in this category will be utilized to create the materials, e.g., plots and tables, for presentations, technical documents, papers, and course contents.

(2) Hardware-level data: To program LoRa modules, we will use Visual Studio Code and PlatformIO, and the generated files will be .cpp or .h files. For Adalm Pluto software-defined radios, we will acquire/generate the IQ data in MATLAB, Python, and GNURadio for spectrum monitoring. If we need to modify the FPGA of Adalm Pluto SDRs, the MATLAB HDL coder toolbox will be utilized to generate FPGA codes. We will use KiCad, a free software suite for designing and simulating the electronic hardware for PCB manufacturing, to develop the daughterboards for mesh connectivity and sensing. The software will generate Gerber and drill files. We will record the milestones and demonstrations as .avi or .mpeg files.

The generated data (scripts, course materials, application files, papers) will be made available in standard, accessible formats such as mat, py, xlsx, cpp, h, docx, pdf, txt, m, xls, tex, jpg, png, mp3, v, vhdl, avi, mpeg. These formats were selected because they correlate with the current industry standards for computer software frameworks. The information about the type of software used to access and analyze the data, obtain results from data, and prepare graphics will be stored along with the data in repositories associated with each publication.

The project aims to provide access to the data by those who require the materials by sharing a project's website's specific link on Google Site, YouTube, and GitHub. The project data will be accessible publicly to the researchers upon request. They will be made available through the proposed project website. This project does not contain any factors that limit the ability to manage and share data, e.g., legal and ethical restrictions on access to human subject data.

The reusability of the material will be ensured through rigorously written technical reports, conference papers, journals, and patents. The simulation codes, PCB layouts, and schematics will be shared through GitHub under the project repository for the replicability of the results. The datasets will be made available on IEEE Dataport. Data items produced may be subject to copyright per established policies of NSF and the publishing entity of the conference/journal contents.

Archives on Dropbox will be updated quarterly. Upon project completion, zip files of complete information will be archived internally at the University of South Carolina, along with versions of the development tools used to create them so that they may be accessed later, as needed. Moreover, related information to the project will continue to be deposited, including reports, budgetary information, expenditures, audit trails, supporting authorizations, and compliance documents on the USC research website. This data is maintained indefinitely for record-keeping purposes.

The PI will disseminate the outcomes of this project on a public webpage on Google Sites and YouTube to share the exciting outcomes of the project in the public domain. The website will include three main sections: (1) Research level (mesh network formation, positional awareness, and sensing) (2) Hardware and simulation level (outlining how to build the prototype discussed in the project description, access sensing data, and perform simulations theoretically), and (3) Outreach (demonstration videos and installation manuals). The PI will manage and retain research data for all sections.

PI's graduate students will each have their dedicated storage capacity in the project repository. To manage the research data and avoid possible data loss due to miscommunication, only the PI will have access to the entire repository, and only the graduate students will have access to their storage. Like the website, the project repository on GitHub will be categorized into the three sections mentioned above. PI will maintain the metadata necessary for future use and discovery. The data management plan will be implemented at no additional charge to NSF.
