Project Proposal

Title:

Data integration in Smart Sensors for analyzing faults in transmission lines.

Group List:

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Introduction & Motivation

Smart Sensors using the Multi Carrier Spread Spectrum system (MCSS) can locate faults on a single live transmission lines. These sensors have been demonstrated in the Center of Excellence for Smart Sensors for location of intermittent faults on live aircraft wires carrying 400 Hz power or 1 MHz data (MilStd 1553). Particularly for the power lines, many of these systems have multiple branches; however, at the current time it is not possible to accurately analyze branches of transmission lines. My project will extend the capability of these sensors to locate faults on branched power networks by establishing a method for these sensors to communicate with each other. This way, multiple sensors can be placed within a branched network, and the data they obtain can be collaboratively processed to determine where the fault has occurred.

The purpose of this project is to add data capabilities to spread spectrum wire fault location sensors. Data will be modulated with pseudo noise in order to increase the randomness of the synthesized wave and increase the signal to noise ratio of the communication system. Then the modulated data will vary the phase shift of the transmitted signal which is used for the fault detection on the transmission line. All of these test signals will remain below the noise margin of the original system in question (power distribution or data network).

Once the data is transmitted successfully from one sensor to another, then it is possible to work on the proto-controls and set up a network between these sensors to communicate with each other. At this point, systems to analyze the branches of transmission lines can be designed.

Project Tasks

There are five main project tasks involved in this project. Each task is briefly described below. Most of the analysis and testing will be preformed on Matlab.

Analysis on data transmittivity between smart sensors on Aircraft wires:

In this task, the analysis of the transmission wires, signals, noises is preformed to evaluate the reflection and transmission of data across the medium. In addition, some basic parameters such as maximum data rate and allocated bandwidth are calculated.

Analysis of data modulation in the MCSS system:

In this task, the undergoing system is studied and evaluated. In addition, different types of data modulations are considered. These considerations are based on the implemented system and acceptable error-rates in presence of external signals while keeping in mind the feasibility of implementations.

Design and implementation of data modulation in the MCSS system:

In this task, the hardware and software to implement the data modulation in the previous step are considered. Upon deciding the modulation technique and the requirements for it, the hardware and software are selected that best suit the requirements. The hardware is possibly an FPGA based system in order to easily modify system and fabricate ICs from it in the future. The system will be integrated with the MCSS in order to modulate data for transmission and extract data upon reception

Testing:

The test will be preformed in each step as the project is progressing in order to minimize the risks and surprises in the future. However, upon completion, the data should successfully be transmitted from one node to the other in presence of external signal.

Documentation:

Finally all the tasks need to be evaluated and documented accordingly. The design, analysis, results, and tests will be documented for each task.

Specific Task Interfaces

There is a lot of research involved in this project before designing it. Since the tasks are layout in a way that is different that a normal hardware/software design, it is difficult to define inputs/outputs for each task and use that to come up with specific task interface between these tasks. When there is clear method established for data modulations and hardware implementations, it is possible to create task list for the system design and define interfaces for hardware/software modules.

Generally speaking, each task is dependent on the previous task thus they are needed to be done sequentially. However, some study of the system can be done in parallel while testing the data modulation. At this point the hardware can be selected and ordered before all of the analyses are completed.

The overall goal is to create an integrated circuit from all of the components. This is in order to fit the sensors in a small area. The ICs need to have a low power consumption which is critical if the sensor is not allowed to use the power in the line and has to run on batteries. In addition, to be able to convert the design to an IC without redesigning the whole project, we will use FPGA/CPLD. ICs can be created much easier in this format versus embedded systems or other commercially available systems. The design will be more complex but it will payoff in efficiency and ease of converting to ICs in the future.

Testing and Integration Strategy

As mentioned previously, the testing will be done through out the analysis and system design in each task to reduce the risk involved and to give a better idea about possibilities and feasibilities of the system. Most of the tests would involve Matlab simulations in order to see if the system is possible in theory before progressing and going to the next task. The final test would involve successful data transmission from one node to the other in presence of other existing signals on the line.

Group communication plan

There will be weekly meeting with Dr. Furse to track the progress of the project and make necessary adjustments. All of the group members will report directly to her and she will manage and coordination different project parts.

Starting the fall semester, the website will reflect the details of the project and the meetings.

Schedule and Milestones

The overall goal is to successfully transmit data across the aircraft wires using MCSS system. Hopefully, the different analyses can be finished by the end of the fall semester and the hardware/software design, implementation, and testing can be done in the following spring semester.

As soon as the coming summer semester, I will be starting on the project. This is mainly to educate myself on the overall system design and the signal processing involved. Doing so can help me to know the challenges better and design more efficiently.

In the first month of the fall semester, I am hoping to get the primary analysis of the environment and transmittivity of the data finished, and for the remainder of the semester, work on an effective data modulation and simulation. At this point, there should be a clear path for implementation and testing. Of course documentation and testing will be included as the project progresses. In addition, the project goals and methods can be adjusted weekly to accommodate the problems that arises or possibility of new methods for more efficient implementation.

Risk Assessment

The methods to realize the current project are not completely known. Overall the plan is to research, design, simulate, and adjust the goal as the progress is made through the project. Because of the uncertainty on the project, it has a large amount of risks associated with it. This is partly due to the fact that it is still a research area and there are no systems implement yet with the functionality. With that in mind a lot of surprises and problems are expected to arise.

Bill of Materials

The bill of materials is unknown at this point. My focus will be more toward the research and design this section of the system. There are no extraordinary parts that are difficult to obtain or has a great lead time for my part. At the point of integration, preferably I would be able to use their existing system (MCSS) and make modifications to it for data integration. However, if an FPGA is to be used, a Xilinx FPGA is a good choice because it can be tested with the current XSA boards available before making a separate hardware for it. Also the Xilinx provide free software development tools and the parts are widely available and easy to purchase.

Vendor List

At this time there is no active vendor list. In the later stages, some online vendor such as Mouser and/or local vendor such as Standard Supply can be used for common parts. In case of purchasing an FPGA, some specific vendors can be used such as Xilinx or Altera.