Wireless Sensor Networks for High Altitude Balloons

AHAC 2015 - DePaul University

Make to Innovate
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Project Overview

Like so many things, we often get inspiration from other media such as movies.
Project Overview

It turns out, the movie *Twister* did have some basis on a real project done within the National Severe Storms Laboratory (NSSL) called the TOtable TOrnado Observatory (TOTO).
Project Overview

TOTO was a white metal barrel, weighing from 250-350 lbs and was outfitted with anemometers, pressure sensors and humidity sensors. Unlike the movie however, the sensors were fixed to the platform.
The NSSL attempted to deploy TOTO several times in the 1980s. The closest it got was on 29 April 1984 near Ardmore OK by Steve Smith and Lou Wicker of the NSSL. However, TOTO’s center of gravity was too high and it tipped in the high winds. TOTO was retired in 1987 due to safety concerns.
Project Overview

So the idea came about how we could possibly deploy sensor(s) into a thunderstorm and do so safely.
Wireless Sensor Networks

The idea
Deploy several small payloads that utilize wireless sensor networks to relay sensor data to the ground.
What is Wireless Sensor Networks (WSN)?

A wireless sensor network are spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a main location.
What makes WSNs unique is that they use a network topology that is very robust and allows for self-healing if a node(s) goes offline or out of range. In addition, WSNs are designed for low power operation and is well suited for this application.
How is WSN Implemented

IEEE 802.15.14 is the current standard used in most wireless sensor networks for the PHY and some of the MAC layer in the OSI model. The ZigBee Alliance is an organization that oversees the higher levels such as network and application layers.
Have you already used a WSN?

Many of you have probably already used a WSN device. The xBee! Some of the xBee models (usually the Pro series) do have APIs that allow it to function like a WSN.
Another option we are looking into is Synaptic’s Synapse modules. These modules include a 802.15.14 radio and an on board processor, but no sensors. However, they run a scaled down version of Python which makes them easy to program.
Other WSN devices

Many WSN devices are referred to as "motes". These motes are often fully integrated devices that includes a 802.15.14 radio, on board sensors, and a microcontroller (such as an Atmel) to control everything. They often run a special operating system such as TinyOS.
Other WSN devices

AdvanticSys makes clones of the popular TelosB motes. Cost is between $100 to $120 per mote. Includes sensors, processor and runs off AA batteries. Can use TinyOS, a popular operating system designed for WSNs.
What about durability?

In addition to the hardware, we have also been giving thought to durability to the both the payload and the balloon. One option is NOAA’s smart balloon.
What about durability?

This balloon design is a constant volume, variable density balloon that uses a high strength fabric for the outer shell.
Project Plan

Currently our plan is to

- Test the feasibility of WSN on balloons
- Test durability of the system in a harsh environment
- Obtain sample data from a test run in calm conditions
- Obtain sample data from a mild storm
Where are we now

- We have obtained some hardware for testing
- A spring 2015 launch was planned, however we did not get it off the ground (pun intended)
- Students have began looking into options for increasing the durability of our payloads
What needs to be done

- Hardware locked down and tested
- Development of deployment plan
- Testing
- More testing
- Just a little bit more...testing
- Profit
In closing, we hope to have more information and some actual data for AHAC 2016. We would also be open on working on any other group that is interested in this project.
Questions?