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Weather Monitoring Unmanned Aerial Vehicle

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Abstract: **Although mankind has proliferated in the 20th century, it has caused a substantial level of damage to the environment. The technology which was built for the convenience of mankind has indirectly put enormous stress on the environment and has contributed significantly to global warming which itself plays as a catalyst for oncoming disasters. Hence, it is imperative that we ensure effective surveillance of the environment in order to contain the damage caused to it, and also effectively deal with any incoming disaster through proper monitoring, one way of doing this is through Unmanned Aerial Vehicles (UAVs). UAVs offer countless advantages over manned aircrafts, minimizing the risks and the costs involved in having a live crew onboard. In this contribution, we have created a cost effective and expandable UAV, which can be used to monitor the weather. Pollution control departments in countries can even fly such a machine over industrial areas in order to keep a check on the emission levels of the industries. This would surely help us in the long run in tackling with global warming, and help reduce the carbon footprint of a country. The paper concludes by discussing the importance of UAVs in the future.**

1. INTRODUCTION

Unmanned Aerial Vehicles are highly valued for their ability to remotely search wide areas without the risks of traditional manned aircraft and have high potential for use in remote sensing applications, surveillance, and scientific research. The focus of this project was to explore the capability of a cost effective UAV in scanning a large area and sending back the data back to operator at the ground. The aircraft is equipped with multiple sensors that take readings of temperature, humidity, gas (CO) levels. It is also equipped with a wireless camera to provide visual inputs to the operator, making it easier for the operator to be in a safe and secure location. Such systems can be useful for inspecting an area that may be inaccessible to humans, for example in the event of a nuclear disaster, it would be suitable to send such type of a UAV to measure the radiation levels in the air than sending a team of people into the affected region.

Different pollutants can be detected and identified from an airborne platform by their appearance in visible color or in the infrared spectrum. One application would involve using a similar UAV equipped with an array of specific chemical ‘sniffers’. In fact, the kind of Unmanned Aerial Vehicle made here can be of use in case of a forest fire as well, with a few more sensors (for wind speed and direction) it can effectively help fire fighting officials monitor and tackle the spread of the fire through the jungle.

2. MOTIVATION

Around mid September 2005, just weeks following the hurricane Katrina, another hurricane named Ophelia was tracked off the Atlantic seaboard of the United States. Although it was smaller than the Katrina, in a way it was quite significant. It was during this time when a company named AAI (based in the United States of America) launched the Aerosonde, a UAV. It was the first time when an unmanned aircraft penetrated a cyclonic storm. A UAV like the Aerosonde, which during the storm sent back measurements quickly to scientists and operators safely on firm ground hundreds of miles away, lessens any chance of danger to people involved in storm research. And with real-time transmission of data, even if the plane goes down, researchers at least have all measurements up to the moment the data transmitter in the aircraft fails. Although weather satellites can already take images of storm systems from above, researchers can position a UAV directly over the eye of the storm at will (as well as off to the side, for oblique images), and the UAV can measure atmospheric conditions near the storm in addition to gathering imagery, something that is impossible for a satellite in orbit above the earth's atmosphere.

3. HARDWARE DESCRIPTION

3.1 RC Plane

The project is based on a Hobbyking Bixler 2.0 plane (as shown if Fig.1) which runs on Mode 2 controls. The bixler 2.0 is the preferred option for beginners, as it is made from the super tough Expanded PolyOlefin (EPO) foam and strong enough to bear the mistakes of a novice pilot. The plane makes use of 4 servos, 2 placed at its wings for its flaps, 2 placed at the back (one for the rudder and the other for the elevator flaps). A 20A Electronic Speed Control (ESC) to control the speed of the plane. For the motor we have used a Brushless Outrunner Motor, as they produce a lower rpm, but produce more torque and can drive their propellers directly. This eliminates the weight and complexity of a gear box. The size of the motor is determined by the weight of your model airplane, which determines the size of the propeller.

A 5 channel, 2.4 Ghz Receiver – transmitter is used here for providing RC capability. The battery used here is a combination of three 3.7V Lithium polymer batteries which provide a 12v supply of power.

3.2 Chipset

The chipset i.e. the circuitry for monitoring the weather parameters consist of a wireless camera(for visual input) and a Bluetooth module (BC417), to view the sensor readings on a phone using the BlueTerm (app on android). It also contains Printed Circuit Board created on ARES software. The sensors used here are as follows:

3.2.1 Temperature Sensor (LM35) The LM35 series are precision integrated-circuit temperature sensors, with an output voltage linearly proportional to the Centigrade temperature. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55°C to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The low output impedance, linear output, and precise inherent calibration of the LM35 make interfacing to readout or control circuitry especially easy. The device is used with single power supplies, or with plus and minus supplies.

Figure 1

3.2.2 Gas Sensor (MQ-7) They are used in gas detecting equipment for carbon monoxide(CO) in family and industry or car. The MQ-7 can detect CO-gas concentrations anywhere from 20 to 2000ppm. This sensor has a high sensitivity and fast response time and the sensor's output is an analog resistance. The drive circuit is very simple; all you need to do is power the heater coil with 5V, add a load resistance, and connect the output to an ADC.

3.2.3 Humidity Sensor (HS220) This sensor module converts relative humidity(30-90%RH) to voltage and is useful for weather monitoring applications. This sensor has an operating range of 0-60°C and gives an accuracy of ± 5% RH (at 25°C, 60%RH) where RH is the relative humidity.

3.2.4 Light Sensor(LDR) LDRs or Light Dependent Resistors are very useful especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as 1000 000 ohms, but when they are illuminated with light resistance drops dramatically.

4. SOFTWARE DESCRIPTION

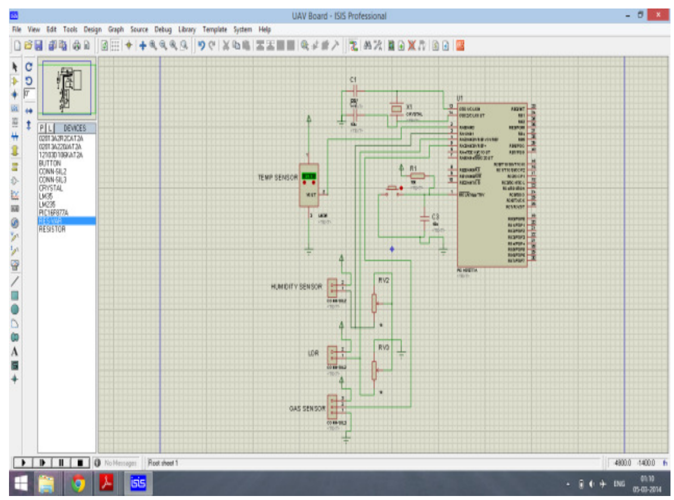

Figure 2

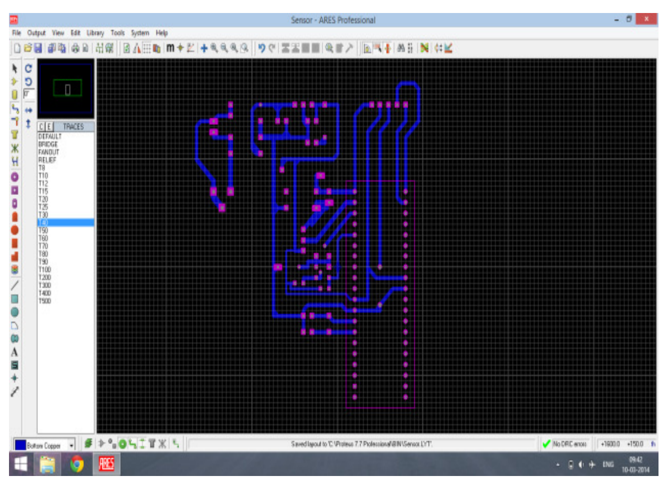

Figure 3

The PCB was created with the help of Proteus 7.7 Professional software. Here we used ISIS for making the schematic diagram as shown in Fig. 2 and for making the PCB we used ARES software as shown in Fig 3. In order to view our output on a phone we used the BlueTerm app available in android.

5. FIELD TEST

The testing of the plane was done on a field in our college. As the range for the Bluetooth module isn't much, we had to fly the plane in a circular path around the phone and the reading we got back in our phone was as shown in Fig. 4. It can be seen from figure 5 that the weather was pretty hot and sunny that day with a clear sky. One might feel looking at the screenshot that the gas sensor is inactive, but the fact is that the gas sensor gives a reading only when it detects a smoke. To demonstrate this, we lit an incense stick close to the sensor and the reading we got is as shown in Fig. 6. Note: the Gas sensor only gives a reading in BlueTerm when it detects a smoke and when it doesn't detect it simply doesn't figure in the display at all, as can be figured in the screenshot.

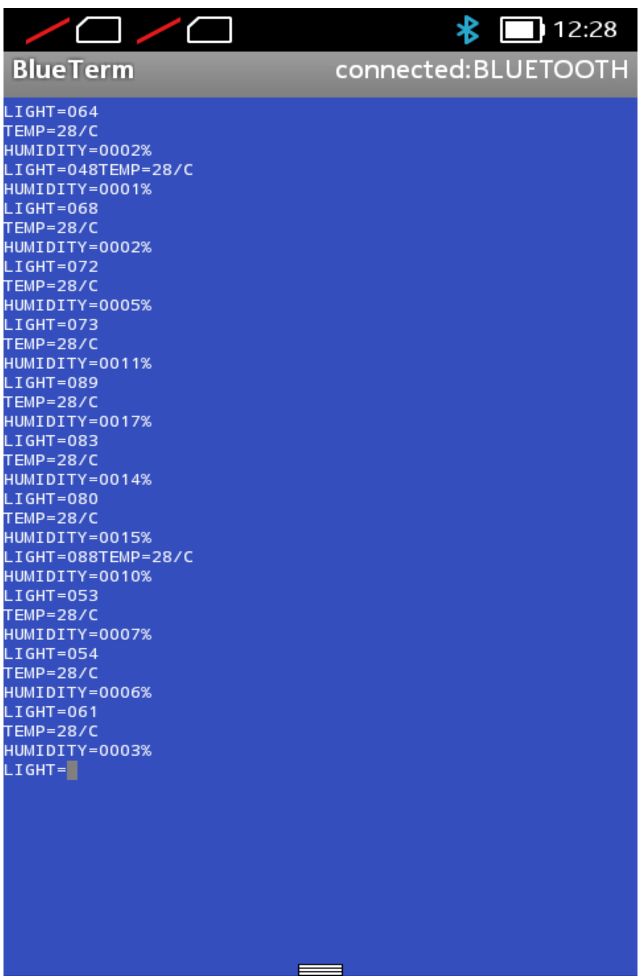

Figure 4

Figure 5

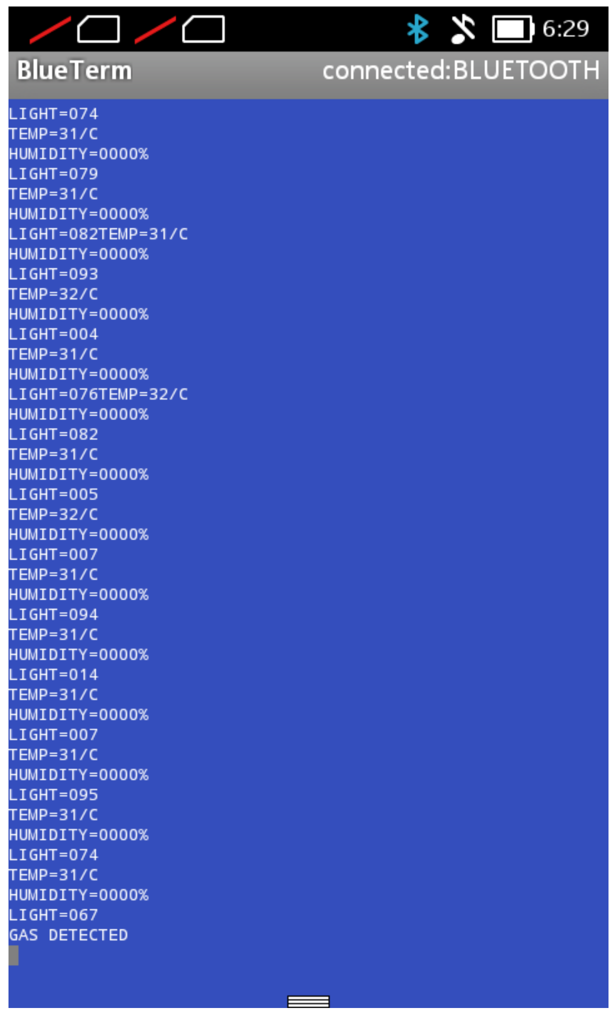

Figure 6

6. CONCLUSION AND FUTURE WORKS

In this paper a brief description of the hardware and software of cost effective weather monitoring UAV was given, along with its on-field test results. Here the aim was to create a low cost weather monitoring UAV that served the purpose. However, it is also possible to use advanced instruments such as a finer camera, a longer range Transmitter- receiver, infrared scanner etc. over this model so as to achieve its true potential.

A major advantage of such a cost effective UAV will be its use by the pollution control departments of developing countries, as it would enable them to keep a check on the emissions of industries into the atmosphere. This would help them in a big way in reducing the carbon footprint of their country as well, and hence benefit the earth as whole. UAVs are undoubtedly, a thing of the future, they are not only used for military applications but also for countless other applications such as this one. This is primarily due to the fact that the operator stays safe in controlled conditions, out of harm's way. In fact, they can even be sent far out in the ocean to study the "atmospheric rivers", long arms of moisture from ocean storms that bring heavy rain to the coast. This would be better than the data received from a satellite and would effectively save valuable lives and property.

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