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Study of atmospheric conditions using CAN-SAT

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ABSTRACT: Design and development of small can sized satellite called CAN-SATis proposed in this paper to study the low altitude atmospheric weather condition in an economical way. The primary work is to analyze the temperature, air pressure and humidity in the space. Zigbee transmitter and receiver module is coded and dumped along with sensors. These components are embedded to Arduino-nano making up a size of CAN-SAT. At ground monitoring station the above the weather parameter in a device may be done using laptop or pc. The CAN-SAT is launched to a height of approximately 200 m using helium balloon. The parachute must be precisely designed in order to withstand in space.

Keywords: CAN-SAT, Weather monitoring,Arduino, Parachute, Zigbee.

I INDRODUCTION

The need for weather monitoring and atmospheric conditions are growing day by day. Measuring these parameters at high altitude constantly is difficult. By using low altitude satellites these parameters are easily calculated and the real time data is readily available to the users.A CAN-SAT is a simulation of a real satellite, integrated withinthe volume and shape of a soft drink can. The aim is to fit allthe major subsystems found in a satellite, such as power,sensors and communication system, into this minimalvolume.

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Zigbee series module act as both transmitter and receiver for communication from ground station to the space.The measured data are stored in SD-Card Module. The CAN-SAT is then launched to an altitude of a few hundred meters by a helium balloon dropped from a platform and its mission begins to carry out a scientific experiment and achieve a safe landing. The CAN-SAT must be cautiously developed in order to sustain some time in space at few hundred meters. Present CAN-SAT power system involves Li-ion battery. It uses a power supply to the CAN-SAT module.The entire system is designed ensuring the weight is less than 650 grams.The modules used in the CAN-SAT systems are sensitive in order to monitor the minimum variation in temperature.

Mustafa EmreAydemir[1]proposed a ground station design procedure for CAN-SAT. Efren Bautista Linares[2] proposed a concept of designing an advanced telimentry mission using CAN-SAT. Andres YarceBotero[3] constructed an design and testing procedure of a data transmission system for mid-power rocketmodel. Mansur Celebi[4] presents the design and navigation control of an advanced level comeback CAN-SAT. MuhteremOzgurKizilkaya[5] proposed an design of descent control system for CAN-SAT that simulates a sensor payload travelling and sampling the atmospheric composition during flight. Pedro Henrique DoriaNehme[6] proposed an design to build and launch a high altitude balloon CAN-SAT with meteorology and remote sensing application. SuleymanSoyer[7] proposed a design procedure for Nano scale satellite model. Mehmet ErtanUmit[8]developed a fly-back CAN-SAT within a short period.

II CONSTRUCTION OF CAN-SAT

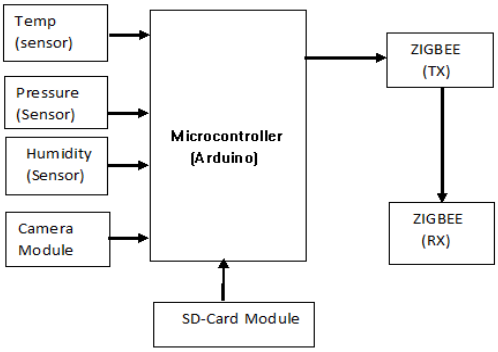

Figure 1:CAN-SAT Module

The block diagram for the proposed system is shown in Figure 1. All the components are embedded in a can sized object.Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read input and turn it into an output. The boards are equipped with sets of digital and analog input/output pins that may be interfaced to various expansion boards and other circuits. The temperature, humidity, pressure in the atmosphere is monitored by thespecificsensor(DHT11&BMP180).Zigbee series 2 module act as both transmitter and receiver for communication from ground station to the space.Satellites normally return to Earth using a parachute.Present CAN-SAT power system involves Li-ion battery. The entire system is designed ensuring the weight is less than 650 grams.

Humidity and Temperature Sensor generate calibrated digital output. This sensor can be interfaced with any microcontroller like Arduino, Raspberry Pi, etc. and get instantaneous results. DHT11 is a low cost humidity and temperature sensor which provides high reliability and long term stability. In this project, we will build a small circuit to interface Arduino with DHT11 Temperature and Humidity Sensor. It uses a capacitive humidity sensor and thermistor to measure the surrounding air, and gives a digital signal on the data pin. It's fairly simple to use, but requires careful timing to grab data.

The BMP180 is the new digital barometric pressure sensor of Bosch Sensor etc., with a very high performance, which enables applications in advanced mobile devices, such as smartphones, tablet PCs and sports devices. It follows the BMP085 and brings many improvements, like the smaller size and the expansion of digital interfaces.The ultra-low power consumption down to 3 μA makes the BMP180 the leader in power saving for your mobile devices. BMP180 is also distinguished by its very stable behavior performance with regard to the independency of the supply voltage.

The OV7670 is a low cost image sensor + DSP that can operate at a maximum of 30 fps and 640 x 480 ("VGA") resolutions, equivalent to 0.3 Megapixels. The captured image can be pre-processed by the DSP before sending it out. This preprocessing can be configured via the Serial Camera Control Bus (SCCB). This OV7670 VGA Camera Module Arduino is small size, low operating voltage, and provides all the features of the single-chip VGA camera and image processor.Through the SCCB bus control,we can output the entire frame, sub-sampled, take the window way affect the data resolution of 8 bits. VGA image of the product is up to 30 frames / sec. Users can fully control the image quality, data format and transmission mode. The process of image processing functions including gamma curves, white balance, saturation, chrom, and so can be programmed through the SCCB interface. Omni Vision image sensor applications unique sensor technology to improve image quality by reducing or eliminating the optical or electronic defect, such as fixed pattern noise, tail-blooming, clear and stable color image.

The SD Card Module is a simple solution for transferring data to and from a standard SD card. The pin out is directly compatible with Arduino, but can also be used with other microcontrollers. This module has SPI interface which is compatible with any SD card and it use 5V or 3.3V power supply which is compatible with Arduino UNO/Nano. SD module has various applications such as data logger, audio, video, graphics.To create sensor networking and weather station monitoring system without human mediation, Wireless Zigbee Technology is used. Zigbee is the most recent remote climate checking method. Arduino based system for weather monitoring is used in this project, as Arduino is compact in size, less weight and easy to use.Communication part of the arrangement consists of a Zigbee network, which is employed with Zigbee S2 RF module. Communication is established with one module attached to the CAN-SAT and another module connected to the ground station terminal. Transmitter on the CAN-SAT receives all the sampled data via serial interface from microcontroller, and transmits it to the receiver on ground station using radio waves. The frequency band for operation is 2.4 GHz. Communication range can extend up to 40m indoors and up to 120m outdoors. parameter farmers must know the weather and climate at real time.

Arduino-Nano is a surface mount breadboard embedded version with integrated USB.

It is a smallest, complete, and breadboard friendly. Physically, it is missing power jack.

The Nano is automatically sense and switch to the higher potential source of power, there is no need for the power select jumper. Nano's got the breadboard-ability of the Board UNO and the Mini+USB with smaller footprint than either, so users have more breadboard space. It's got a pin layout that works well with the Mini or the Basic Stamp (TX, RX, ATN, GND on one top, power and ground on the other). This new version 3.0 comes with ATMEGA328 which offer more programming and data memory space. It is two layers. That make it easier to hack and affordable.The open-source Arduino software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X and Linux. The environment is written in java and based on processing and other open source-software. In fact the Arduino language is merely asset of c/c++ function. It provides comprehensive facilities to computer programmers for software development.

Programs written using Arduino software (IDE) are called sketches. These sketches are written in the text editor and are save with the file extension.These programs can be uploaded into the Arduino board using this software having the facilities of compiling and uploading. This software can be used with any Arduino board. In this system, Arduino IDE helps to upload the program developed using embedded C language into the board for the processing of the system.

X-CTU is free software provided by Digi which we use to configure and manage Zigbee, and test Zigbee networks.X-CTU is a free software tool available from Digi International to interface with Zigbee modules. The tool provides a GUI and terminal interface to configure the modules as well as a built in tool to test the Zigbee range and reliability of packet transmissions.Zigbee Voltage Supply is 2.8V - 3.4V. All units will need matching PAN ID, Channel and Sleep Mode settings to function together as one network. All nodes must have the Coordinators address to know it is the end destination for data transmission. Nodes must have an analog to digital converter (ADC) enabled and a sample rate set. Coordinator must be in API mode to see data from node I/O pins Configuration transparent Mode with API.Frames generator is used which easily generate any kind of API frame to save its valuerange test**t**is done to perform a range test between 2 radio modules of the same network.

CAN-SAT BODY DESIGN

The CAN-SAT body is made in the shape of a cylinder with displaced inside the cylinder with the help of channelComponents can be glued onto the disc using epoxy glue forstability and protection of the system. The body is fabricatedusing acrylate plastic which is known for its strength, lightweight and durability. The entire system is designed ensuringthe weight is less than 650 grams.Balloons are fun, but the helium ones are always more entertaining. So today, we're going to learn how to make hydrogen gas by combining drain cleaner with aluminum foil.With hydrogen, you get the same lighter-than-air properties of helium, plus it will explode.

- Drain cleaner
- Aluminum foil
- Balloon
- Glass bottle

$$2Al + 2NaOH + 6H_2O \rightarrow 2Na[Al(OH)_4] + 3H_2\uparrow$$

Figure 2: Balloon Design

PARACHUTE DESIGN

A parachute is an umbrella-shaped device of light fabric used especially for making a safe jump from CAN-SAT. During its descent, due to its weight the gravitationalforce accelerates the CAN-SAT downwards. Parachute is requiredto counteract this force with a drag force caused by airresistance. This negates the acceleration due to gravity and thesystem descends with a steady velocity called descent velocity.Satellites normally do not return to Earth in a parachute. At the end of their useful life, a satellite

will be put in a different orbit. For satellites orbiting at a low altitude this could mean they will burn up in the atmosphere. Satellites further away will end up in a much more distant parking orbit and will circle our planet forever shown in Figure 3.

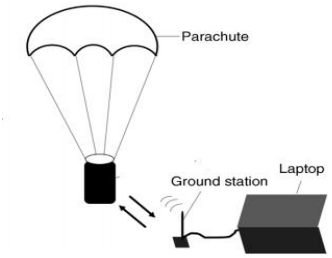

Figure 3: Parachute Design

Sometimes however the spacecraft has to return to earth with samples or astronauts. One of the solutions is then to descend in a parachute. When the CAN-SAT is deployed it must have a device to slow it down, otherwise it will crash into the surface. The parachute also helps ensure that the CAN-SAT stays in an upright position. This is particularly important because it helps to maintain proper antenna orientation.

III EXPERIMENTAL SETUP

A Zigbee Personal Area Network (PAN) consists of one coordinator and one or more routers and/or end devices. A Zigbee Personal Area Network (PAN) is created when a coordinator selects a channel and PANS ID to start on. Once the coordinator has started a PAN, it can allow router and end device nodes to join the PAN. When a router or end device joins a PAN, it receives a 16-bit network address and can transmit data to or receive data from other devices in the PAN.

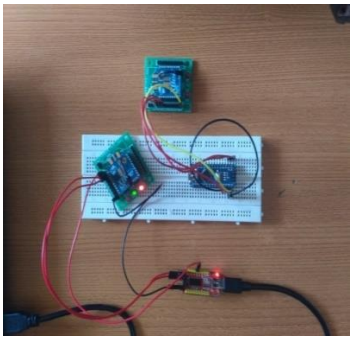

Figure 4: Zigbee Configuration

Routers and the coordinator can allow other devices to join the PAN, and can assist in sending data through the network to ensure data is routed correctly to the intended recipient device. When a router or coordinator allows an end device to join the PAN, the end device that joined becomes a child of the router or coordinator that allowed the join. End devices, however can transmit or receive data but cannot route data from one node to another, nor can they allow devices to join the PAN. End devices must always communicate directly to the parent they joined to. The parent router or coordinator can route data on behalf of an end device child to ensure it reaches the correct destination. End devices are intended to be battery powered and can support low power modes.

IV RESULT AND DISCUSSION

The CAN-SAT is used mainly for analysing weather parameters, for a shorter
Time withstanding in space. CAN-SAT is launched using helium balloon up to the height of 250m. The sensors which are interfaced with a CAN-SAT module continuously sense the data's which is then transmitted to the ground station using Zigbee the analysed sensor data's are stored in a SD card module. Balloon is guided by using thread.In below table1 we have compared variable parameters such as temperature, pressure, humidity with respect to altitude. We have plotted the graph for altitude and humidity, if altitude varies value of humidity also gets varies which shown in figure5.Similarly for temperature and pressure the values get varies with respect to the variation of altitude which shown in below figure 6 & figure7.These CAN-SAT will be very useful for farmers who can able to predict the weather for future cultivation process. Since weather is not a non-variable

altitude(meter)	temp	humidity	pressuer
2	30	29	1008.93
3	33	29	1008.93
4	33	29	1008.89
5	33	29	1008.9
6	33	32	1008.89
7	33	32	1008.9
8	33	32	1008.97
9	33	33	1008.88
10	33	33	1008.92
11	33	33	1008.88
12	33	33	1008.93
13	33	35	1008.92
14	34	35	1009.01
15	34	35	1008.92
16	34	35	1008.89
17	33	35	1008.87
18	33	35	1008.92
19	33	35	1008.92
20	33	35	1008.89
21	33	35	1008.86
22	33	33	1008.91
23	33	33	1008.96
24	33	33	1008.95

Table 1: Data acquired from different sensors

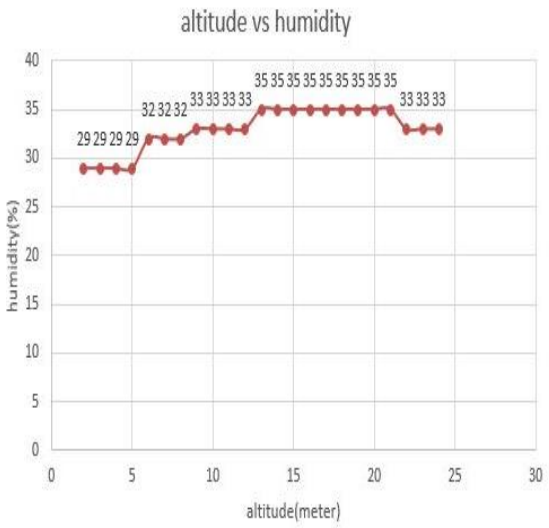

Figure 5: VariableHumidity

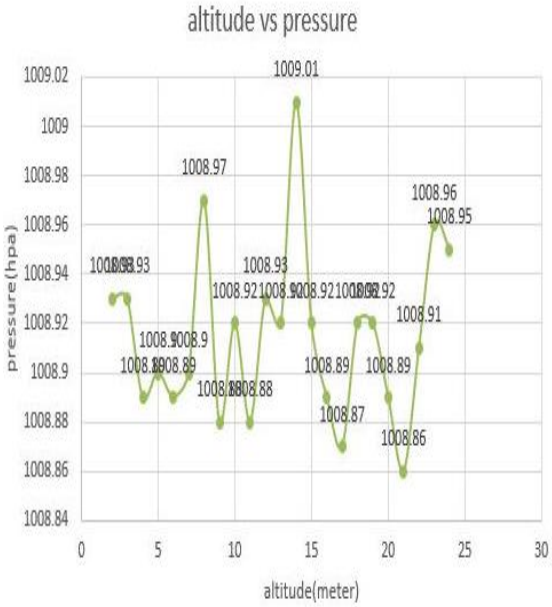

Figure 7: Variable Pressure

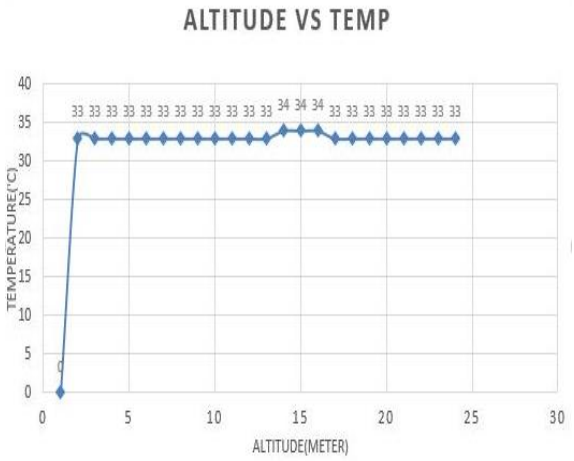

Figure 6: Variable Temperature

parameter farmers must know the weather and climate at real time.

Zigbee-based agriculture monitoring system serves as a reliable and efficient system for efficiently monitor the environmental parameters. CAN-SAT is able to predict the weather parameters such as temperature, pressure, humidity etc.

FUTURE SCOPE

Future scope involves the launching of CAN-SAT using mini-rocket to stimulate the CAN-SAT for higher altitude upto 1.5km for calculating accurate weather reporting.

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