Unmmaned Air Vehical

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ABSTRACT

Security of any kind today has become a key issue in our lives. We need safety for everything. Along with the safety reasons we now-a-days also require something that can be controlled remotely without manually operating it is having physically present over here. So what are the major solutions that we can have and can afford is the primary question in our minds. We all want full proof safety systems but at a low cost and ease of implementation and working. It is this very thought and this very question to which we have tried to find an answer. This paper deals with building an autonomous navigation system for a model aircraft which will control the aircraft and navigated through user define locations using GPS (Global Positioning System).

We have built an autonomous UAV i.e. an Unmanned Air Vehicle, which is not remotely operated. For navigation we are using a GPS receiver which provides current GPS locations. The way points will be provided by the user as per his requirement. The foundation of any UAV is control system which maintains a stable flight. Environmental factors which are build affect the flight greatly for aircraft control we are using a 3D MEMS ACCELEROMETER. We have used servo motors port directing the aircraft's control surfaces. The control methodology we have used is PID based and individual PID loops are used for each of the controller surfaces. This system is very critical both in terms of functionality and accuracy. It also poses other challenges such as size, weight and power constraints on the control electronics.

1. INTRODUCTION AND MOTIVATION

UAVs (Unmanned Aerial Vehicles) are, by common definition, re-usable, heavier than-air craft without a pilot. Traditionally these aircraft have been controlled in real time from a remote location; hence the term remote controlled aircraft. Given this, one could argue they are still not really unmanned; the persistent need for human piloting, albeit remotely, negates their benefits in many scenarios.

More recently, however, autonomous control has been slowly introduced, where control systems onboard the aircraft help pilot the craft, with the aim of replacing human control altogether. Autonomous control of aircraft provides faster responses and allows operation in electrically noisy environments, over ranges limited only by flight time, and in areas where standard remote control systems may not be able to operate (e.g. in mountainous terrain).

The purpose of this project is to create an inexpensive autonomous UAV using off the shelf components, including a hobbyist model plane, a GPS receiver, a magnetometer and accelerometers. Using these primary sensors a microcontroller onboard the aircraft should be able to pilot the aircraft between multiple predetermined waypoints without remote intervention.

While the UAV operates, it will record data from various sensors, ranging from avionics to arbitrary payloads such as temperature sensors, cameras, etc. This data will be stored onboard in non-volatile memory, for transfer to a PC once the UAV lands.

2. Overview of the project :

Our project aims to design a control system for autonomous navigation of a model aircraft, capable of traversing a given path through waypoints fed to it by the user upto a range of 5Km from initial point. The aircraft navigation will be done through GPS, whereas takeoff and landing will be done manually using a radio controller. While in autonomous mode, the aircraft will capture images at predetermined points and will store the images on an onboard memory.

The major advantage that our system has is that this system can be mounted on any other compatible aircraft so that even commercially available aircrafts can be easily used.

This can be broken down into module-wise objectives as follows:-

- Design of aircraft navigation and control system
- Selection of suitable microcontroller.
- Interfacing of GPS receiver and Accelerometers.
- Interfacing with other peripherals.
- Software to follow pre-determined flight plan.

2.1 Block Diagram of project :

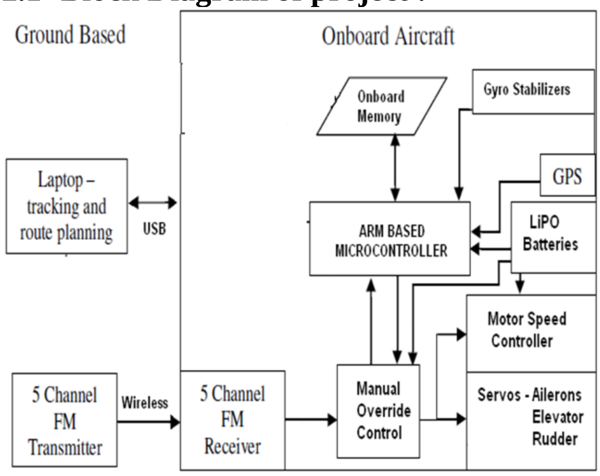


Fig 1: UAV Block Diagram

2.2 Working of the system:

2.2.1 The UAV system consists of the following modules:

- Autopilot control Board
- GPS Module

- Accelerometer
- Motor and controller
- Battery
- RC Receiver and antenna

Autopilot control Board:

The Autopilot control board will control the maneuvers of the aircraft. The heart of this system will be LPC2148 microcontroller.

2.2.2 The Microcontroller will have to perform the tasks:

- Sensor Interfacing
- Interfacing with the GPS
- Path Navigation
- Aircraft Control

2.2.3 GPS Module:

The GPS module will determine the position of the aircraft and will be instrumental in tracking the waypoints. It will be the feedback system to check whether the aircraft is on the proper course or not. The GPS modules used for these purpose are readily available in the market. They provide GPS location of the device with accuracy of 3-5m.

For our project, we have chosen *GR-301R* because of its low weight, low power consumption, fast start-up and availability.

2.2.4 Specifications of GR-301R :

GPS receiver type:- 20 channels

Frequency : 1575.42Mhz

Sensitivity: 159dbm

Current Consumption:-42mA

O/P Update Rate:- 1-5 Hz (variable)

Operating temperature : - -40c to +85 c

Weight : 20gram

Cost : Around 60 dollars

2.2.5 GPS Interfacing:

- GPS is interfaced to LPC2148 using serial UART protocol.
- GR301-R has facilities for both TTL level and RS-232 levels for interfacing.

2.2.6 Sensor Interfacing:

Accelerometer:

The major task of determining the attitude of the aircraft is going to be done through a 3-Axis accelerometer.

2.2.7 Motor and Controller:

The aircraft is propelled by using a brushless DC motor. This motor needs to be controlled by both a Radio controller as well as the autopilot. Hence we have opted to use an off the shelf Electronic speed controller.

2.2.8 Aircraft Control:

The entire system will be powered by an onboard battery. The trust to the aircraft will be provided by a brushless DC motor and associated speed control system. The control surfaces (viz. ailerons, elevators and rudder) will be controlled by servo motor.

2.2.9 Navigation:-

The aircraft is designed to be capable of following flight paths of arbitrary complexity, within the physical limits of it's operation. Flight paths are laid out on a computer prior to the flight, using specially developed software, and uploaded to the UAV via Bluetooth or the MMC/SD card.

At any point during the flight, the UAV can be switched off manual control to autonomous operation, at which point it begins following the prescribed path. At the end of the path, the UAV return to radio range (if necessary) and then adopts a holding pattern awaiting further instruction, or a return to manual control.

There are additional failsafe mechanisms built into the design. For example, if during manual control of the plane radio contact is lost for a significant period (several seconds), the UAV automatically switches to autonomous operation. Because the microcontroller is able to operate even under manual control, passively observing sensor inputs, it is able to determine the aircraft's position where it still had radio contact, and return the aircraft to that position. It continues retracing the aircraft's steps until it regains radio contact.

2.3 Brief Discussion of basework:

The software interfacing of the UAV autonomous navigation has been done using KEIL uVISION3 compiler.

Keil µVision3 is an IDE (Integrated Development Environment) that helps you write, compile, and debug embedded programs. It encapsulates the following components:

- A project manager.
- A make facility.
- Tool configuration.
- Editor.
- A powerful debugger.

For the autonomous navigation various algorithms are studied and the feasibility are verified.

Similar work is done for GPS, microcontroller, servo motors etc.

3. PRE-STUDY OF THE PROJECT

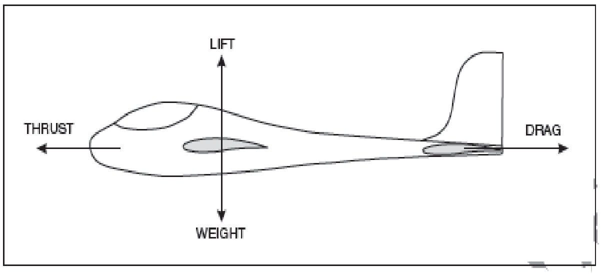
3.1 FLIGHT THEORY

- For a fixed wing aircraft it must be made to move forward. The wings are designed to convert part of the falling motion into a forward motion.
- As the wings move forward they produce lift, which acts against the weight of the aircraft, effectively making it lighter. The lighter aircraft in turn requires less forward speed so it settles into stable forward flight.

- The main forces acting on a aircraft in stable flight are:
- Lift force generated by the wings(upward)
- Weight of the glider and control electronics (downwards)
- Drag or retardation force as the glider tries to move
- through the air(backward)
- Propulsive forces which for gliders is supplied by gravity (forward).

The following diagram clearly illustrates these forces:

- In stable flight, the lift force is just less than the weight force means the glider will slowly decent and thrust force is greater then the drag force, means the glider will slowly move forward.

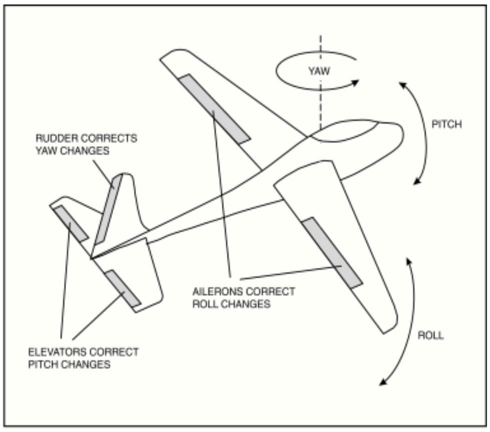


3.2 . FLIGHT CONTROL:-

An aircraft travelling in space can move in the following ways:

- PITCH:- It is a rotation about an axis that passes through the wings,it looks like raising or lowering the nose. To correct alterations in pitch , the elevators located on the tail surfaces are adjusted in unison (i.e. both elevators or both down)

- ROLL:- it is rotation through the center line of the fuselage looks like one wing rise whilst the other falls. To correct alterations in roll, the ailerons located on the wings are adjusted in opposition(i.e. one aileron moves up whilst other moves down)
- YAW:- It is a rotation about an axis perpendicular to fuselage to correct alterations in Yaw, the rudder located on the tail is adjusted.



3.3 Testing and Troubleshooting

3.3.1 Software testing:

We divided the entire code into small modules such as:

- GPS interfacing,
- ACCELEROMETER interfacing,
- EEPROM interfacing,

Testing of individual modules is done separately. The coding for EEPROM, GPS and ACCELEROMETR are done using KEIL uVISION3.

The very basic software testing started in how to program the device using a computer. We had used UART for ISP mode of programming of LPC2148. During circuit design we have developed a boot loader circuit and test indicators were provided in the design itself. These test points were great help in checking whether the code was been downloaded or not. Since we might need to program the device on field, we could not always guarantee availability of a desktop computer. So, we considered connecting it to a laptop. For that we decided to go for a USB to Serial converter cable which is commercially available.

Accelerometer Testing:

Once the hardware was ready, we started testing the code which we developed for it's working. The accelerometer has so many functionalities, one should be really cautious while configuring the device otherwise it becomes difficult to have a set of configuration that works for desired functionality

3.4 EEPROM:

The EEPROM is interfaced with LPC2148 using I2C interface. I2c is two wire Interface. The Code is written in KEIL.

4. DISCUSSIONS, OBSERVATIONS AND RESULTS

GPS testing was primarily done using a LCD. The below screenshots display successful captured data from the GPS.

Following is one such sample set:

TIME181933.0

LAT1830.3772N

LONG07348.8414E

TIME06933.0LAT2.0.3772553LONGM348.841
4-6TIME6933.0

TIME181949.0

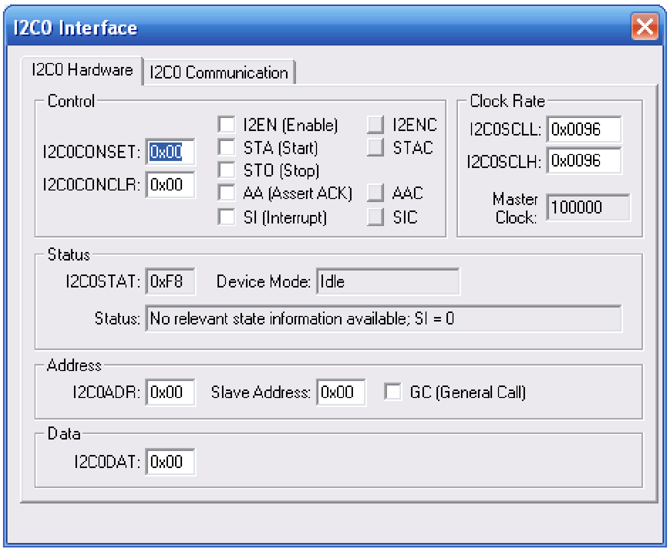
LAT1830.3772N

LONG07348.8414ES

Actually, the problem with such a code was that some of the strings were missed. We understood this from the timestamp.Such error is evident in the middle line where the string synchronization is lost.

To solve this problem, we went ahead with on-line capturing and parsing of the data. i.e. parsing the data as soon as it is received rather than storing the entire string and then parsing the data.

The results obtained through this method were quite satisfactory and no strings were lost. The code also became more efficient in terms of time required for its execution.



5. CONCLUSION

The overall UAV system is working in different modules. The GPS data capturing, Navigation algorithms, accelerometer interfacing and stability control algorithms are considered to be the major part of our project.

6. REFERENCES

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