International Journal of Innovative Research in Advanced Engineering (IJIRAE)
Volume 1 Issue 1 (April 2014)

Study of M.A.R.S.

(**M**ultifunctional **A**ero-drone for **R**emote **S**urveillance)

Supriya Bhuran[1], Rohit V. Agrawal[2], Kiran D. Bombe[2], Somiran T. Karmakar[2], Ninad V. Bapat[2]
[1] *Assistant Professor, Dept. Instrumentation, V.C.E.T., Mumbai University, India*
[2] *B.E. (Instrumentation), Student, V.C.E.T., Mumbai University, India*
rohitagrawal297@gmail.com, kdbombe@gmail.com, supriyakyadav@gmail.com

Abstract—***Vertical Take-Off and Landing (VTOL) airplanes do not need sizeable area for take-off and landing. They are able to take-off just like helicopters while maintaining efficiency and speed of conventional aeroplane. Due to these features, they can land almost anywhere on ground and have longer range. They are very useful for delivering supplies in remote location. Taking all these features into account, VTOL planes are better option available for surveillance purpose.***

Also the plane can be upgraded further for larger area of applications such as measurement of temperature, pressure, recording weather and forest monitoring and reconnaissance missions.

Keywords— UAV, VTOL, Arduino, servo motor, surveillance

I. INTRODUCTION

We were interested in building some kind of UAV, a drone, small size plane. The UAVs are used in different kind of applications like military, surveillance, security service, riot control, hostage situation, police, law enforcement, border patrol.

They work more effectively in environmental extremes such as heat, cold, or nuclear, chemical and biological contamination in the warfare. Thus, UAV can be used to augment the soldier's capability in the field of military operations.

Salient features about this plane cum robot:-

- Vertical Take-Off and Landing.
- Surveillance system using camera.
- Military application.
- Sensors for measurement.

II. BLOCK DIAGRAM

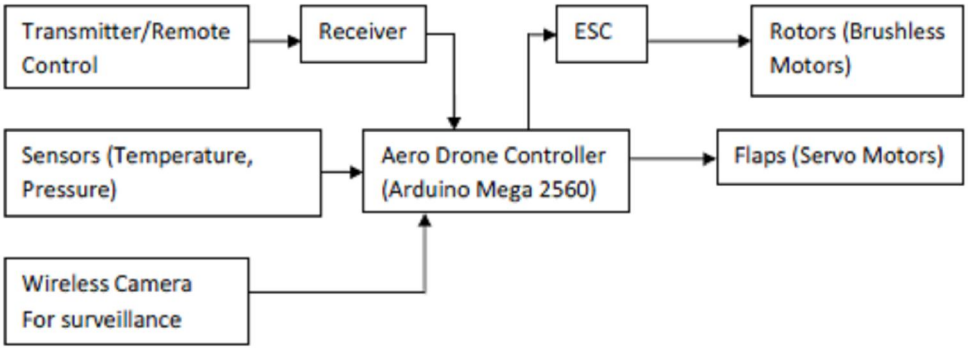

Fig. 1 Block diagram of M.A.R.S.

III. COMPONENTS

A. *Transmitter and receiver (A434 MHz ASK module)*

The 434 MHz transmitter will work with the RF Links at 434 MHz at either baud rate. Only one 434 MHz transmitter will work within the same location. The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.

This receiver type is good for data rates up to 4800bps and will only work with the 434 MHz transmitter. Multiple 434MHz receivers can listen to one 434 MHz transmitter. These modules have up to 500 ft range in open space. We have used these modules and have been very impressed with their ease of use and direct interface to an MCU. This wireless data is the easiest to use, lowest cost RF link.[9]

Specifications:-

- Frequency 434 MHz
- Transmitter: Saw filter based ASK hybrid transmitter.

- Transmitter supply voltage: 3~12V.
- Receiver: ASK super heterodyne receiver with PLL synthesizer and crystal oscillator.
- Receiver Supply voltage: 5V.
- Receiver IF frequency: 500 KHz.
- Turn on time: 20mS from power is switched on.
- Data rate 200bps to 3Kbps depending on the supply.
- Operating temperature range: -40 to 80 °C

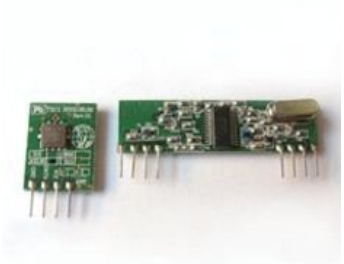

Fig. 2 Transmitter and Receiver (A434 ASK module)

B. *Microcontroller P89V51RD2*

The P89V51RD2 is 80C51 microcontroller with 64 kB flash and 1024 B of data RAM.

Specifications:-

- 80C51 CPU
- 5 V operating voltage from 0 MHz to 40 MHz
- 16/32/64 kB of on-chip flash user code memory with ISP and IAP
- Supports 12-clock (default) or 6-clock mode selection via software or ISP
- Four 8-bit I/O ports with three high-current port 1 pins (16 mA each)

C. *Controller (Arduino Mega 2560)*

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.[8]

Specifications:-

- Microcontroller: ATmega2560
- Operating Voltage: 5V
- Digital I/O Pins: 54 (of which 15 provide PWM output)
- Analog Input Pins: 16
- Flash Memory: 256 KB of which 8 KB used by bootloader
- Clock Speed: 16 MHz

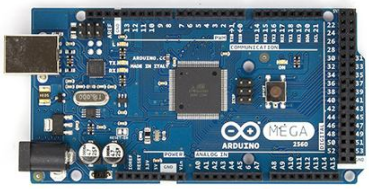

Fig. 3 Arduino Mega 2560

D. *Brushless Motor (EMAX BL2220/07)*

Emax BL2220 Brushless Motors are designed to provide both quality and performance at an affordable price.

Specifications:-

- No. of cells:- 3 Li-xx cells
- Stator dimension:-22x20mm
- Shaft diameter :- 4mm
- Weight:- 85g
- Recommended propeller size (in inches):-10x4.7, 11x3.8

Fig. 4 Brushless motor

E. Electronic Speed Controller (EMAX ESC 35A)

ESCs take in DC voltage and convert it into 3 phase AC voltage. Select ESC whose current is 1.5 times the max current of motor or at least 5 Amp more than the max current. This will ensure that it won't damage ESC if motor is slightly overloaded.

Specifications:-

EMAX ESC 35A

- Continuous current: 35A
- Burst current (10 s):- 45A
- Li-xx battery (cells):- 2-4
- Dimension (mm) L*W*H:-59x28x12
- BEC-5V/3A
- Programmable: - Yes
- Weight: - 38g

Fig. 5 Electronic Speed Controller (ESC)

F. Battery

11.1V 2200mAh 3cell Tiger Lithium-Polymer battery

Fig. 6 Lithium-Polymer Battery

G. Propellers

Specifications:-

- Material:- carbon fiber
- Size (diameter x pitch):- 11" x 4.7"

H. Servo Motor

Specifications:-

- Operating Voltage: 4.8-6.0V
- PWM Input Range: Pulse Cycle 20±2ms, Positive Pulse 1~2ms
- STD Direction: Counter Clockwise / Pulse Traveling 1500 to 1900μsec
- Stall Torque: 0.8 kg (11 oz/in) at 4.8V, 1 Kgf.cm(12 oz/in) at 6V
- Weight: 6 g (0.2 oz)
- Size: 22*12.5*20*26.6
- Special Feature: Heavy Duty Plastic Gears, Economy Servo

I. Sensor (Temperature LM35)

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature.

Specifications:-

- Calibrated directly in˚ Celsius (Centigrade)
- Linear + 10.0 mV/˚C scale factor
- 0.5˚C accuracy guarantee able (at +25˚C)
- Rated for full −55˚ to +150˚C range
- Suitable for remote applications
- Operates from 4 to 30 volts

J. HT12E(encoder) and HT12D(decoder)

HT12E and HT12D are encoder and decoder ICs (Integrated Circuit) used for remote control applications. They are commonly used for radio frequency (RF) applications. By using the paired HT12E encoder and HT12D decoder we can easily transmit and receive 12 bits of parallel data serially. HT12E simply converts 12 bit parallel data in to serial output which can be transmitted through a RF transmitter. These 12 bit parallel data is divided in to 8 address bits and 4 data bits. By using these address pins we can provide 8 bit security code for data transmission and multiple receivers may be addressed using the same transmitter.[10][11]

IV. WORKING

For remote control, we have used microcontroller 8051 with HT12E encoder and 434 MHz transmitter. We have used port 1, port2, port3 of microcontroller as input ports and port 0 as an output port. We have connected normally open push buttons to these input ports. The output port is connected to the encoder and encoder data pin is connected to the transmitter. When any push button is pressed, microcontroller sends a 4 bit data to port 0 which is connected to an encoder. The encoder then converts this data into a serial data and gives it to the transmitter. The transmitter sends this data serially at 434 MHz's. At the receiver end, the receiver is connected to HT12D decoder. It receives data serially and passes to the decoder. The decoder converts serial data back into a 4 bit data. This decoder is connected to Arduino Mega 2560.We have used 4 digital pins of Arduino as input pins which are connected to decoder. When Arduino receives data, it performs the operation according to the commands written in the program.

The 8 address pins of encoder and decoder must to the same state. If their states are not same then decoder will not accept the data received. We have used this concept to provide security to the signal. For takeoff and landing, plane typically operates as a helicopter with the motors vertical and rotors horizontal. Once airborne, the motors rotate forward 90° in few seconds with the help of servo motors for horizontal flight, converting the plane to a more efficient, higher speed aircraft. Servo motors are attached to the Arduino. We have used PWM pins of Arduino to give signal to servo motors. So controlling the servo motors became very easy. We can watch live video on PC; captured by the wireless camera mounted on the plane. The sensors attached to plane use similar transmitter module to send data wirelessly. We can see that data on PC by interfacing receiver and Arduino to the PC. The receiver is attached to one of the analog pins of Arduino. The Arduino then reads the analog value and we can see the output on a serial monitor.

V. CONCLUSION

By the study of the above project one can get knowledge of many aspects of:-

- Plane Modeling
- Robotics

VI. FUTURE SCOPE

By controlling a plane via satellite, we can eliminate the problem of range and by using a higher rating mAh battery; we can increase the flight time.

REFERENCES

[1] http://en.wikipedia.org/wiki/V-22_Osprey
[2] http://airfieldmodels.com/information_source/index.htm
[3] http://www.freepatentsonline.com/6732972.pdf
[4] www.stefanv.com
[5] http://nootropicdesign.com/projectlab/2010/12/26/rf-wireless-temperature-sensor/
[6] http://www.radiocontrolinfo.com/RCcalculator/AirplaneCalculator.php#Torque
[7] http://www.flyrc.com/index.php/wing-load-calculator/
[8] http://arduino.cc/en/Main/arduinoBoardMega2560
[9] http://www.engineersgarage.com/electronic-components/rf-module-transmitter-receiver
[10] http://electrosome.com/ht12d-decoder-ic-remote-control-systems/
[11] http://electrosome.com/ht12e-encoder-ic-remote-control-systems/