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INTERNATIONAL CONFERENCE of SCIENTIFIC PAPER
AFASES 2013
Brasov, 23-25 May 2013

COMMAND AND CONTROL SYSTEM BASED ON ARDUPILOT MEGA 1.0 AUTOPILOT

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Abstract: *This paper focuses on the design and implementation of command and control system for unmanned aerial vehicle. The controller is based on an Ardupilot Mega 1.0 board which is a custom PCB with an embedded processor ATMega168. The ground station software's purpose is to provide an easy-to-use graphical interface to the autopilot. Software is written in Borland Delphi language.*

Keywords: *Ardupilot, UAV, Mavlink*

1. INTRODUCTION

Unmanned aerial vehicles (UAVs) have become a hot research topic in the last decade worldwide. Their great potential has been explored in numerous military and civil implementations.

The command and control systems for UAV include the autopilot which is responsible for the autonomous operation of the aircraft and ground station. The autopilot is managed via a ground station laptop, with dedicate software, which allows the operator to control the aircraft, upload flight plans, and view aircraft data navigation and telemetry.

2. ARDUPILOT 1.0 AUTOPILOT

The autopilot board is the most important and complex piece of hardware in the command and control systems for UAV. The function of the autopilot is to stabilize the aircraft and to execute the user programmed mission and the pre-programmed fail-safe functions.

The ArduPilot Controller board, shown in figure 1, was used as the main platform for the flight control system due to the functionality and availability of open source support.

Fig. 1 ArduPilot Controller Board and IMU.

The ArduPilot is a full-featured autopilot using an Inertial Measurement Unit (IMU) for stabilization and GPS for navigation. The ArduPilot features are: built-in hardware failsafe, multiple 3D waypoints, altitude controlled with the elevator and throttle, a GPS connector and six spare digital input/outputs for additional sensors. The autopilot system use the GS407 U-Blox5 GPS, operating at 2Hz.

The UAV navigates from one waypoint to another make by comparing its present location to the next location. Depending on this comparison and the PID values set for the Roll, Yaw and the Pitch servos, the Ardupilot calculates the movement required for the corresponding control surfaces to reach the destination.

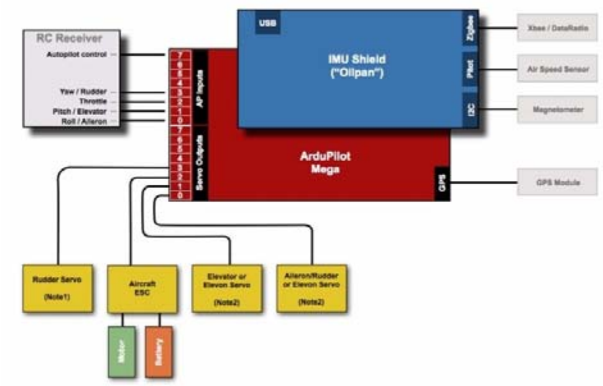

Fig. 2 Ardupilot block diagram.

Figure 2 shows the Ardupilot block diagram and how to connect the servo and sensors.

3. GROUND STATION

The second component of the command and control systems for UAV is ground station. The ground station for the autopilot system has a laptop connected with a "XBEE PRO 900 XSC" modem through a USB cable working at a baud rate of 57600 and at a frequency of 900MHz.

The software running on the ground station laptop is developed in Borland Delphi. This software implements communication protocol Mavlink (Micro Air Vehicle Comunication Protocol). MAVLink was developed specifically for unmanned aircraft on board and is an open source protocol.

The ground station software is responsible for attitude estimation, processing sensor data, parsing GPS data, controlling the aircraft, and handling communications with the ground station. The ground station software's purpose is to provide an easy-to-use graphical interface to the autopilot. The ground station software runs on a Windows based laptop computer.

The ground station software is written with optimization, functionality, development, and compactness in mind. The software is divided into two sections. The code for first section is responsible for initialization of the autopilot hardware, declaration of global variables, and initialization of global variables and structures. The second section of the autopilot code is the main loop. The main loop runs continuously and is responsible for gathering and processing sensor data and computing the low-level control algorithms.

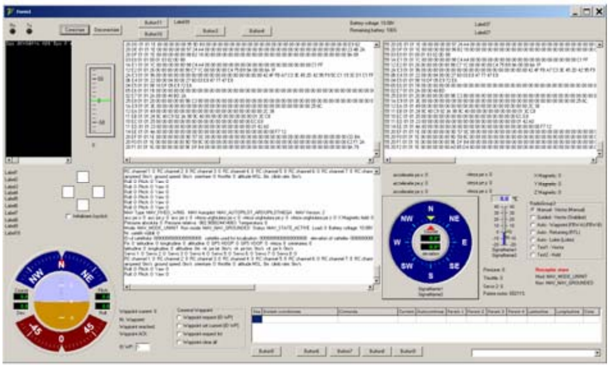
Fig. 3 The graphical user interface.

The graphical user interface (figure 3) displays aircraft attitude, altitude, location, and other information like battery voltage, throttle percentage and airspeed. This allows complete situational awareness and helps the operator to communicate with the autopilot to ensure the safety of the system.

4. CONCLUSIONS

The ArduPilot autopilot has all the functionality necessary to operate the aircraft without human interaction. The ArduPilot has complete control over the engine and all onboard servo motors as long as the mode of operation was autonomous. The human pilot from the ground station has control of the aircraft, trough developed software, selecting manual or automatic mode.

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