2 KM GROUND CONTROL RANGE FOR UAV IN DISASTER RECOVERY

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ABSTRACT

Natural disasters are natural events that cannot be predicted. Each occurrence of natural disasters will cause damage can even eliminate human lives. The success of the recovery process and help victims of natural disasters (disaster recovery) depends on the accuracy of the information condition affected area. Currently has developed several technology tools that can provide information and direct assistance to victims of natural disasters, one of which is the Unmanned Aerial Vehicle (UAV). UAV is an aircraft type that has the ability to fly without a crew and pilots, process control is done directly by the operator or automatically by the device that has been standardized. So that UAVs can be applied for monitoring and search and rescue operations or special use in the military. Distance is one of the obstacles using UAVs, because when the magnitude of the distance exceeds the ability of the central control system will cause the UAV control process cannot be performed due to the loss of data communications. In this study, will be developed a control system for a UAV which has the capability of data communication up to 2 km. The process of research is concerned with the optimization of the ground control station consisting of the antenna and the transceiver system and the development of the type of UAV that will be used.

Keywords: disaster recovery, ground control station, UAV.

INTRODUCTION

Accurate information is crucial in the event of a natural disaster when it will be the provision of direct assistance. Often times the area of natural disasters picks rugged terrain and difficult access, consequently to determine the field of information and provide assistance directly be difficult. One way to overcome these obstacles by developing a UAV aircraft.

Various types of UAVs have been developed one of which is a quadcopter which has the advantages of easy to maneuver and control air because of its resemblance to a helicopter. The Table-1 below is a comparison of system specifications with existing systems:

Table-1. Comparison of system specifications.

Name	Stability	Description	Utility
Colorado university	• Stabil • Longer light time • Good maneuver	Well design and software controller	disaster
Parth N. Patel team	• Strong airframe • Good maneuver • High resolution IR camera	Using fix rotor blade	agriculture
TASS,Telkom university	• Long range • Good maneuver • Precision navigation	Using auto tracking antenna and biquad Parabolic + Yagi antenna	disaster

The distance to the UAV ground control station is a constraint in terms of process control. When the distance exceeds the distance of UAV coverage is owned by the control system, the ability to control the UAV will be lost. Generally non-military UAV systems that exist today within 100 m to 1 km, so that when the search for information and provide disaster relief for distances exceeding 1 km will not do.

In this study, will be developed a control system for a UAV which has a data communication capability of about 2 km. The process of research is concerned with the optimization of the ground control station consisting of the antenna and the transceiver system and the development of the type of UAV that will be used. Block diagram of the system to be developed as shown below:

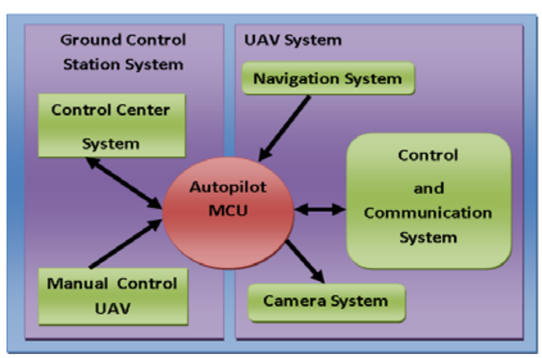

Figure-1. General system for GCS and UAV to be developed.

GROUND CONTROL STATION SYSTEM (GCS)

General description

GCS system serves as the central control and visualization of UAV control activities in the air. There are two basic functions: control over the flight controls and the ease to obtain information UAV activities. To achieve these functions, GCS should be designed to be able to communicate with UAV continuously; it will facilitate the process of UAV control and data analysis simultaneously. Block diagram of the system GCS made as shown below:

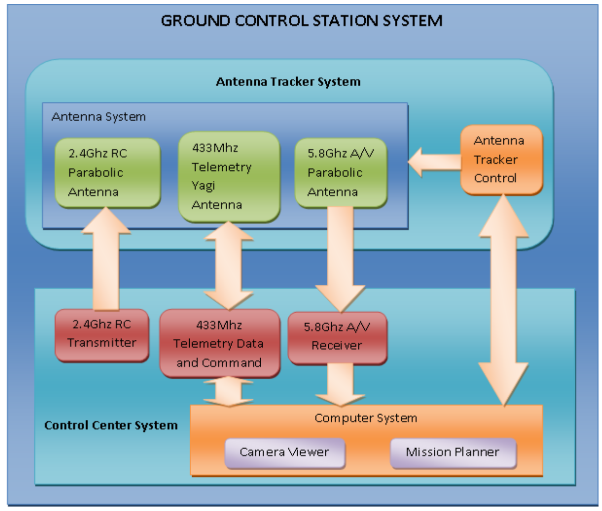

Figure-2. Ground stasion control system block diagram.

Ground station control system is constructed of several instruments to the specifications as outlined in Table-2.

Table-2. Ground stasion control spesification.

No.	Instrument	Feature
1	Mission planner	• Point-and-click waypoint entry, using Google Maps/Bing/Open street maps/Custom WMS. • Select mission commands from drop-down menus • Download mission log files and analyze them • Interface with a PC flight simulator to create a full hardware-in-the-loop UAV simulator. • See the output from APM's serial terminal
2	Telemetry transceiver	• 433MHz Wireless Transmission • 500 mW maximum output power • -118 dBm receive sensitivity • 2-way full-duplex communication through adaptive TDM • MAVLink protocol framing • Frequency Hopping Spread Spectrum (FHSS) • Configurable through Mission Planner and APM Planner
3	Video receiver	• Antenna impedance: 50 • Video impedance: 75 • Video format: NTSC/PAL auto
4	RC transmitter	• Encoding PCM 9 channel and 8 channel PPM PPM (2.4Ghz). • 167x34mm LCD 8 lines, Combines the programming for aircraft, glider, helicopter • Doubles deflections (D / R) and a timer.
5	Antenna tracker system	• Dual servo control system for operation tracks 360 horizontally and 90 vertically • Pan and tilt kit for antenna system • Baterei system for power module • Tripod • 3 antenna system for communication: o Prabolic biquad for 5.8Ghz for video o Parabolic biquad for 2.4 Ghz for RC o Yagi 433Mhz for telemetry

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GCS parts consist of a radio telecommunications system to send control data and activities such as video data communications, remote control and telemetry separately. Computer section serves as a processing center, arrangements and flight data storage and display streaming video. Antenna tracker system to improve reception due to differences in the position and the distance between the UAV with Ground Control Stations.

General GCS command flight control

In manual mode the UAV can receive commands via remote control from the GCS, to make a move to change the direction of flight or pointing the camera at the target. When the UAV is in the sky operator can do several things such as:

- Directs UAV appropriate where the primary mission waypoints and navigation coordinates are known to the source to the target.
- To monitor the process of flying through the instruments available to detect the possibility of system failure or error.
- Changing parameters such as waypoint navigation if necessary to change the new mission.

Autopilot modes contained in the UAV system allows automatic flight control when the remote control is not used as a source of control. Autopilot mode has previously been configured by GCS based on the incoming data, then sent to the UAV configuration instructions as a reference for the waypoint and flight control. In general, the function of the configuration is as follows:

- Mission planning is used to identify and prioritize targets. It facilitates the identification of potential threats and failures when developing flight plans.
- Mission Control is a process that required intervention when UAVs perform missions, such as navigation data and process adjustments to flight activity readjustment based on the selected target in the mission planning.
- Data manipulation is the activity of collecting, processing, analyzing and archiving either during flight or after flight.

Antenna tracker system

Navigation process can be held properly when data communication performance both in terms of signal strength and continuity maintained at a high level, the direction of the quadcopter and the antenna is not obstructed. This condition can be obtained by modifying the antenna on the transceiver on the GCS so that we can adjust antenna direction.

The modification is to make the antenna can move automatically to follow the quadcopter. This automatic antenna work pattern is originated from the position deviation between the instantaneous quadcopter positions obtained from the GPS with initial antenna position. The parameters that determine the quality of antena's performance is antenna height and direction the level of precision and suitability between antenna and quadcopter assumed linear with signal strength.

UAV QUADCOPTER SYSTEM

Description of general system

Quadcopter structure is equipped with data communication for telemetry and video, controller unit (MCU), the camera system for visual data and four motors and multiple sensors to provide a stable autonomous system. General block diagram of the architecture as shown below:

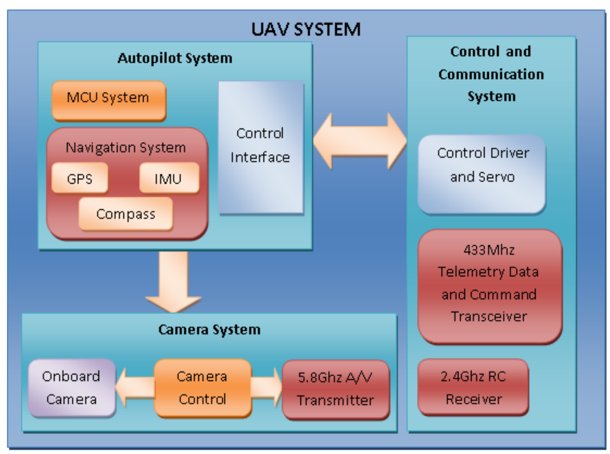

Figure-3. General block diagram of the architecture of UAV.

UAV system is constructed of several instruments to the specifications as outlined in Table-3.

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Table-3. UAV spesification.

No.	Instrument	Feature
1	Ardupilot	Universal Autopilot Mission planning and two-way telemetry Dataflash memory, with SD card slot The system can be integrated with GPS Built in camera control
2	Telemetry transceiver	433MHz Wireless Transmission 500 mW maximum output power -118 dBm receive sensitivity 2-way full-duplex communication through adaptive TDM MAVLink protocol framing Frequency Hopping Spread Spectrum (FHSS)
3	RC receiver	Encoding PCM 9 channel and 8 channel PPM PPM (2.4Ghz). 8 channels plus a battery socket.
4	Video transmitter	Transmitting power: 600mA Working current: 220mA at 12V Video bandwidth: 8M Audio bandwidth : 6.5M

Navigation system

In this study, the IMU sensor is used as a navigation system and will be combined with the Global Position System (GPS) and compass sensors as Inertial Navigation System (INS). INS system is necessary for guidance, navigation, and control (GNC) UAV motion in the air.

Input parameters of the navigation system is derived from the data IMU, GPS and compass. GPS and compass data is used as reference data for error correction IMU data readout. The INS data such as position, acceleration and behaviors that have been corrected. These results can then be used as feedback to the control system, meaning that if the output of the INS is not in accordance with the desired direction of motion of the UAV, then the control system (flight control) will move the actuator in the direction of motion of the UAV so that the UAV be as expected, this process called the INS loop as shown in the image below:

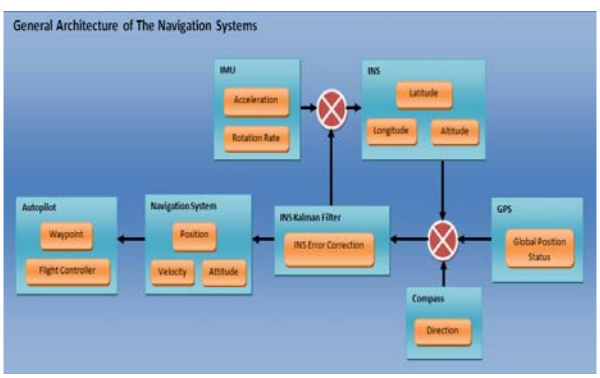

Figure-4. General architecture of the navigation system.

The core of the INS loopis strapdown INS and the Kalman filter. Strapdown INS provides position, velocity and attitude of continuous reliable with a high enough speed. Kalman filter estimates the navigation errors mixing observations through GPS and compass as reference data and back-ups.

General flight control UAV

Flight mode command is sent using the wireless system to the Quadcopter. While the remote control signal is a signal in the form of PPM (Pulse Modulation Potition) read by the MCU aotupilot control system will then be used for data movement of the motor. Telemetry signals received by the transceiver is a data telemetry autopilot mode. MCU signals by aotupilot to be converted into PWM signal to control four motors for movement trottle, hover, pitch, roll and yaw.

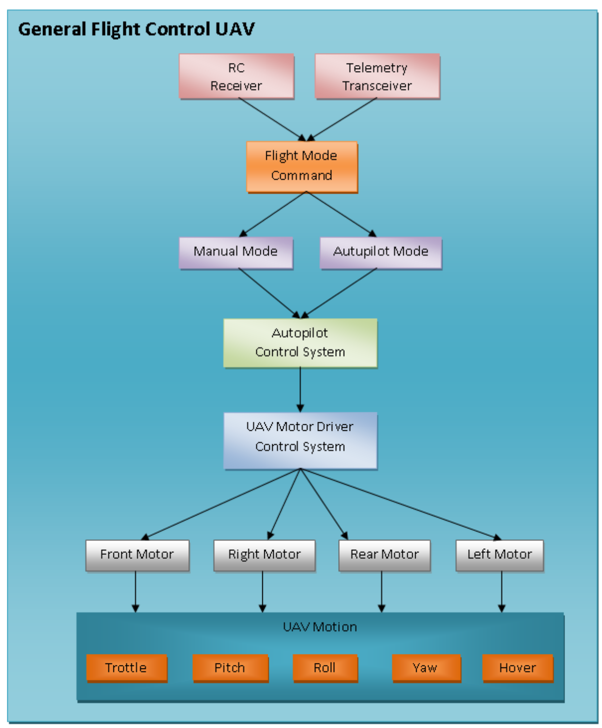

Figure-5. General flight control UAV for movement.

CONCLUSIONS AND FUTURE WORK

UAVs can be a supporting medium in the process of search and rescue operations at a disaster occurrence. To achieve these objectives should take into account all the parameters that can affect the flight of the UAV sensor

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systems such as quality, environmental constraints and especially data communication systems.

GCS is the control center of activities during the planning and execution of UAV missions. The system incorporates several technologies, such as communication systems, computer hardware / software, systems engineering and human. Each of these technologies is critical to the success of the process of search and rescue operations in the event of a disaster.

By using UAV technology and GSC we can establish procedures for the collection of information and disaster plan. So we had effective information at the right time and provide reference data for natural disaster management phases.

Based on the performance tests and results of the performed experiments within the developed system we have decided to develop further our work by building GCS system for portable system, so it can be used on cars or motorcycles.

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