



Integrated Complex Advanced Robotic Unmanned System

Ground Control Station Interface (GCSI)

User Manual

Software: Beta ver .1

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Description

The GCS Interface is a fully featured and Open Source tool for enabling the use of multiple ground and aerial vehicles in a useful and expandable package. The GCSI is programmed primarily in National Instruments LabView, a graphical programming language. Some of the many features of the GCSI include:

Table 1: GCSI Features

Vehicle Health System helps monitor Vehicle
Debugger Mode helps in Vehicle development
Intelligent Error Handler deals with ICARUS defined Error Codes and informs User
Save Map files for later analysis
Manual Control (keyboard/joystick) of any ground or aerial robotic vehicle.
Autonomous Control of any ground or aerial robotic vehicle.
Google Earth real-time continuous mapping of robotic vehicles.
Multiple communication network types (XBee,Wi-Fi,Cellular, SATCOM).
Audio Feedback
Various Sensors Reporting
User Configurable
Monitor Communication Status

Requirements

LabView Software Requirements

LabView requires a LV Run-Time Engine for your Operating System. Current Operating Systems supported by LV:

Table 2: LV Supported Operating Systems

Operating System	Run-Time Engine Link
Windows (2000,XP,Vista,Vista x64)	http://ftp.ni.com/support/softlib/labview/labview_runtime/8.5/windows/LabVIEW85RuntimeEngineFull.exe
Linux	http://ftp.ni.com/support/softlib/labview/labview_runtime/8.5.1/Linux/labview85-rte-8.5.1-1.i386.rpm
Mac	http://ftp.ni.com/support/softlib/labview/labview_runtime/8.5.1/LabVIEW851RunTimeEngine.dmg

NOTE: All Development has been performed in a Windows environment. While LV may be compatible with other Operating Systems, the GCSI in no way guarantees interoperability with other Operating Systems.

GCSI Hardware and Software Recommendations

Besides the requirements listed in the [LabView Software Requirements](#) Section, the following are Recommendations for optimal performance and capability with the GCSI.

Table 3: Hardware and Software Recommendations

Recommendation	Justification
2 Displays	Optimal simultaneous viewing of LV and GE Interface's.

Serial Port	Used for Communications. If no Serial Port is available, GCSI Software will be able to use USB Port.
Joystick	Easier Manual Control of Vehicle.

ICARUS System Requirements

Communications

The GCSI Interface requires at least one of the following Communications Networks to exist:

Table 4: Communications Network Requirements

Communication Network	Status
XBee	Supported
Wi-Fi	Not Supported (yet)
Cellular	Not Supported (yet)
Satellite Communications	Not Supported (yet)

The ICARUS Communications Protocol must also be followed, which can be found in Appendix XX: ICARUS Communications Protocol Specifications. For information regarding the implementation of the ICARUS Communications Protocol, see Appendix XX: ICARUS Communications Protocol Guide.

Bug Reporting and Feature Requests

As this software is currently in BETA Release, please use the following link to report any bug or feature that you feel is absent from the software:

<http://code.google.com/p/robot-chopper/issues/list>

Installation

1. Download the Labview Run-Time Engine for your Operating System (See [LabView Software Requirements](#))
2. Download the most recent version of the GCSI Interface:
<http://dgitz.ipower.com/projects/robocopper/Ground%20Station/Interface/Release/build.1.zip>

Overview

The GCSI has two main screens, the LabView Interface and the Google Earth Interface.

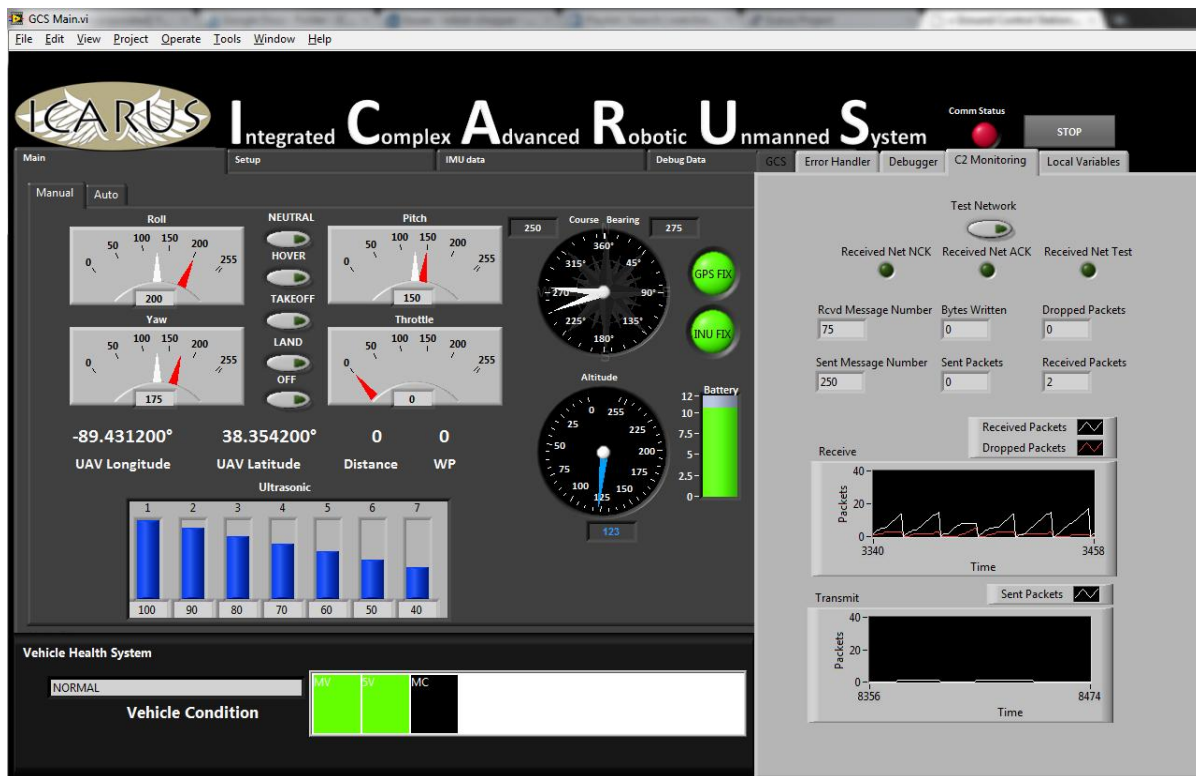


Figure 1: LabView Interface

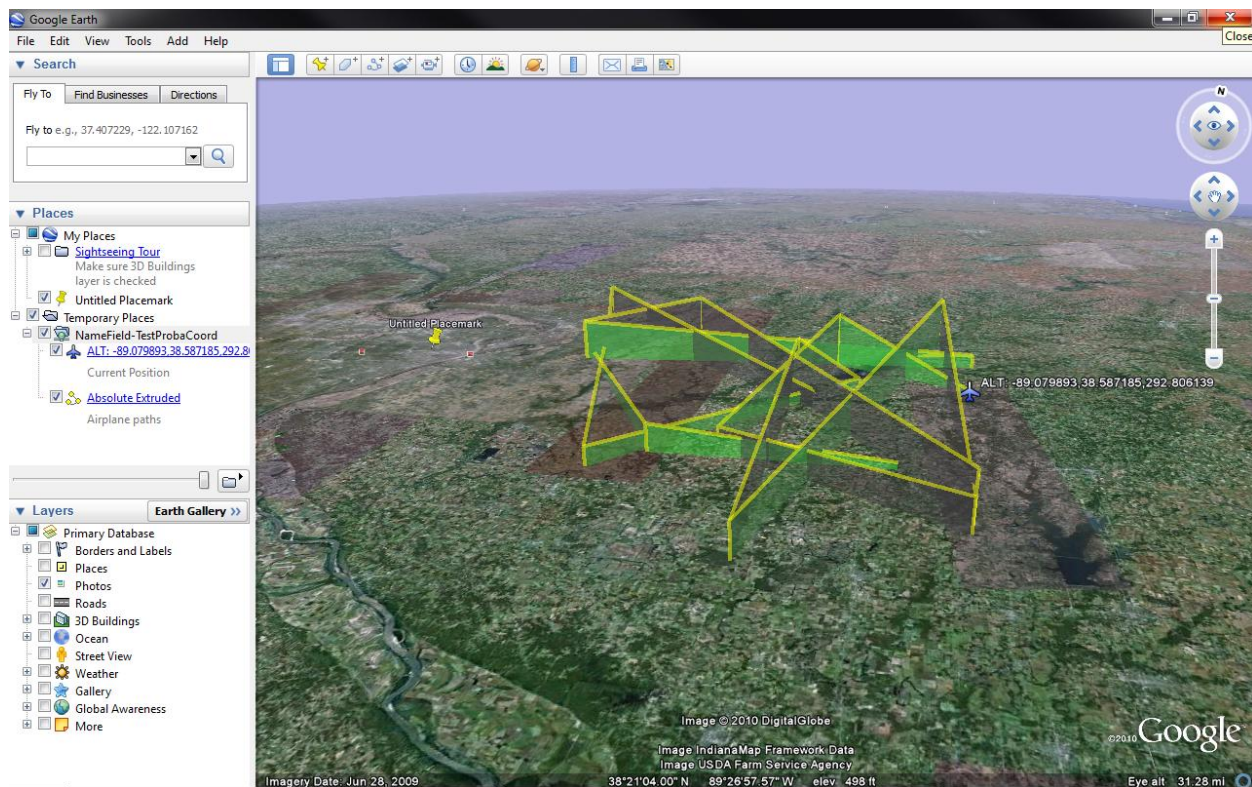


Figure 2: Google Earth Interface

Configuration

Setup Tab

Connectivity Tab

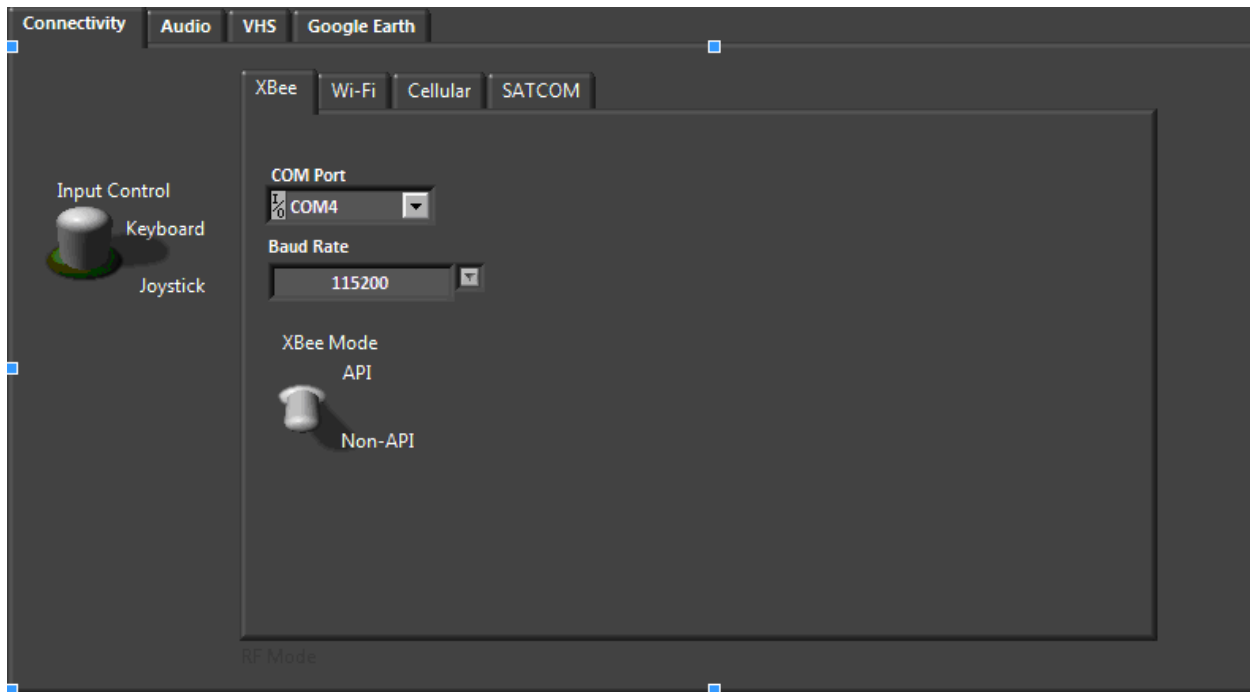


Figure 3: Connectivity Configuration Tab

XBee

The GCSI Software will default to XBee, Non-API Mode with no COM Port specified, which will immediately halt the operation of the GCSI Software. Specify a COM Port and a Baud Rate for your System.

Non-API Mode:

The Non-API Mode of the XBee acts as a transparent UART, whatever is sent out to the transmitting XBee is received at the receiving XBee. There are limitations to the Non-API Mode, one of which is the ability to transmit to different XBee Radio's at different times without going into the Command Mode of the Radio. If more than 2 XBee Radio's are desired for operation at the same time, API Mode should be used.

API Mode:

Currently not supported.

Wi-Fi

Currently not supported.

Cellular

Currently not supported.

SATCOM

Currently not supported.

Audio Tab

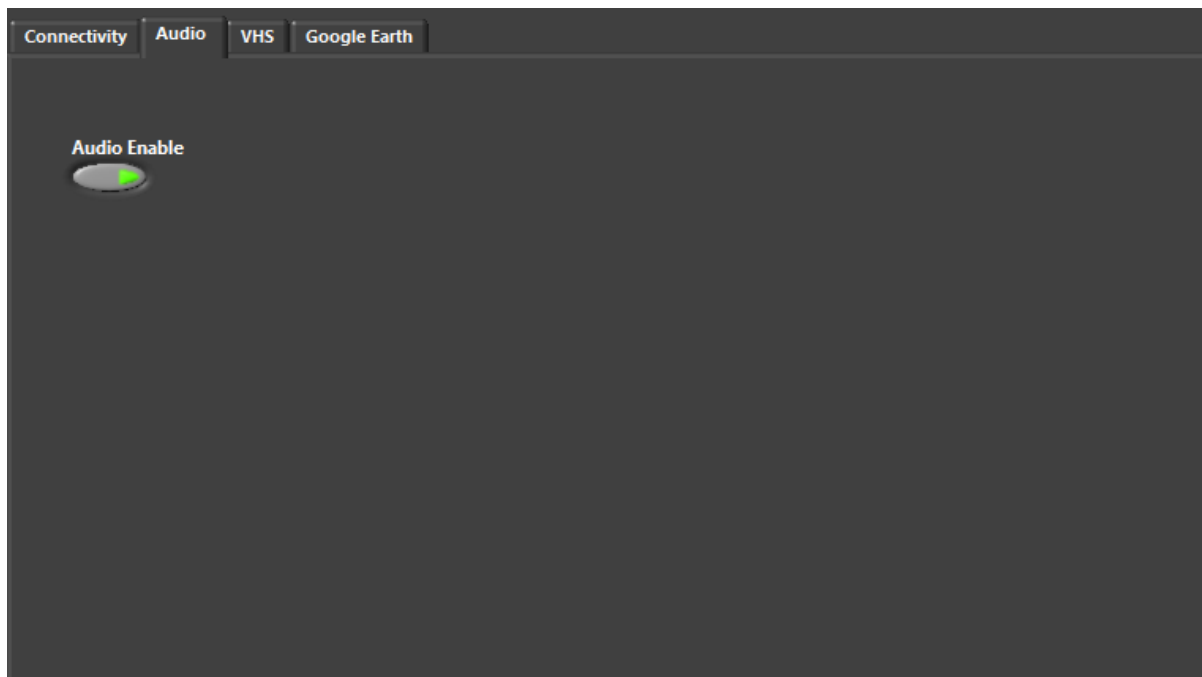


Figure 4: Audio Configuration Tab

Controls/Indicators

1. Audio Enable: Enables/Disables Audio.

Future Expansion

1. Control different Voice.

Vehicle Health System Tab

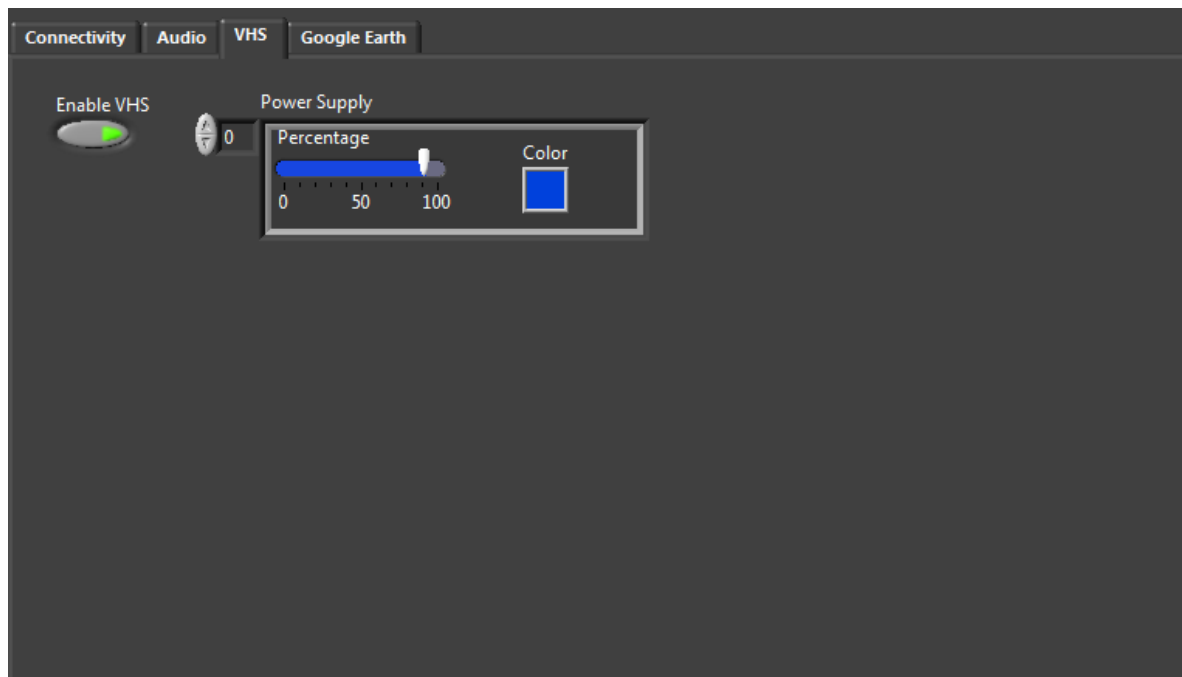


Figure 5: VHS Configuration Tab

Controls/Indicators

1. Enable VHS: Enables/Disables VHS.
2. Power Supply: Configures different parameters for different levels for every Power Supply parameter (Main Voltage, Main Current, 5V Supply)
 - a. Percentage: Sensor value must be over this value.
 - b. Color: Displays as this Color.

Future Expansion

Google Earth Tab

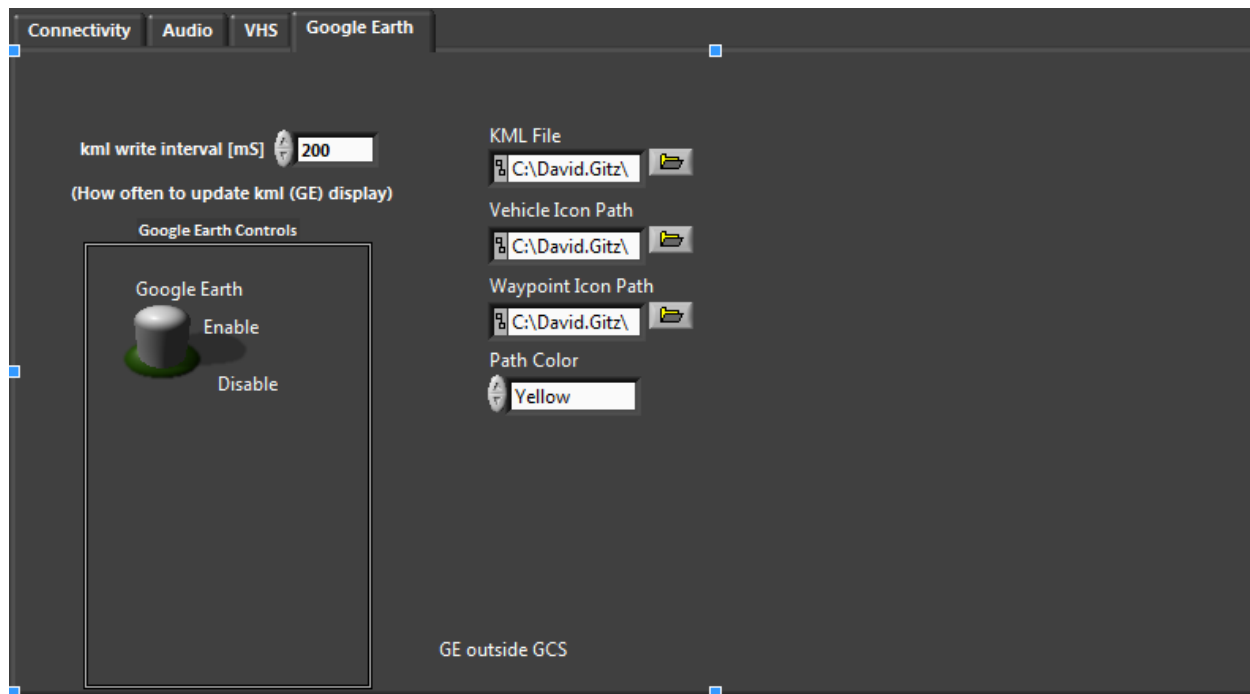


Figure 6: Google Earth Configuration Tab

Controls/Indicators

1. kml write interval (mS): How often the KML file used by Google Earth is updated, in milli-Seconds.
2. Google Earth Enable/Disable: Controls whether or not Google Earth is opened on startup of GCSI. Use to improve communication speed during Manual Control.
3. KML File: File Path of KML File used by Google Earth.
4. Vehicle Icon Path: File Path of representation of Vehicle in Google Earth.
5. Waypoint icon Path: File Path of representation of Waypoint in Google Earth.
6. Path Color: Path color of Vehicle path in Google Earth. Current colors supported: Yellow,Blue,Gray.

Future Expansion

1. Select different Vehicle Icons, Waypoint Icons, Path Colors for multiple Vehicles.
2. Google Earth Enable/Disable closes Google Earth if currently running.

Operation

Main Tab

Manual Tab

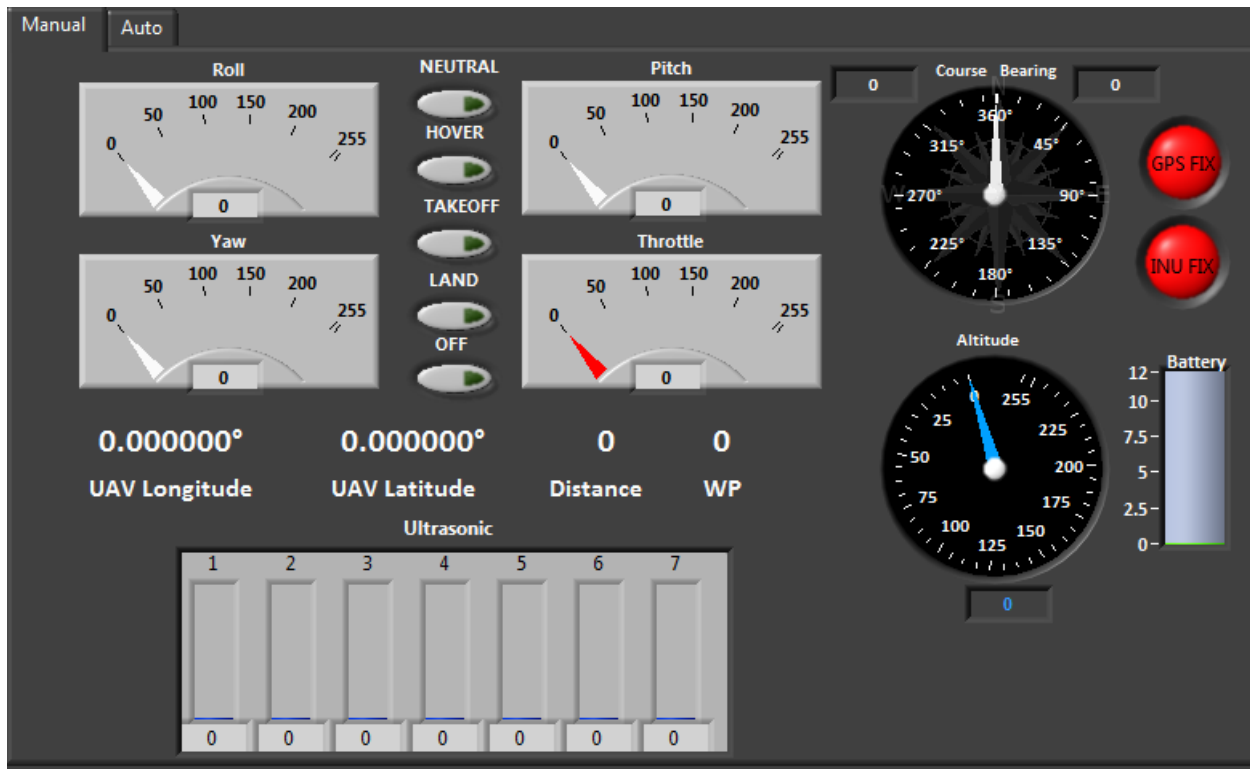


Figure 7: Manual Tab

The Manual Tab displays Sensor readings and other data reported from the Vehicle

Controls/Indicators

1. Course/Bearing Gauge
 - a. Bearing: The compass angle of the Vehicle with respect to its next waypoint.
 - b. Heading: The compass angle of the Vehicle with respect to Magnetic North.
2. Altitude:
 - a. Altitude over Datum: Altitude reported by GPS Device
 - b. Altitude over Ground: Altitude reported by other Sensors, such as barometric or distance sensors.
3. Ultrasonic: Each Ultrasonic sensor reports how far away it sees an obstacle, in inches.
4. Battery: Battery Voltage, maximum is 12V.
5. GPS FIX: Indicates receiving GPS Position Data.
6. INU FIX: Indicates receiving INU Orientation Data.
7. Pitch/Roll/Yaw: Indicates INU Orientation Data for each Axis.
8. Throttle: Controls Vehicle Throttle.
9. UAV Latitude/Longitude: GPS Position Data.
10. WP: Current Waypoint Objective.
11. WP Distance: Distance to Next Waypoint, in feet.

Future Expansion

Autonomous Tab

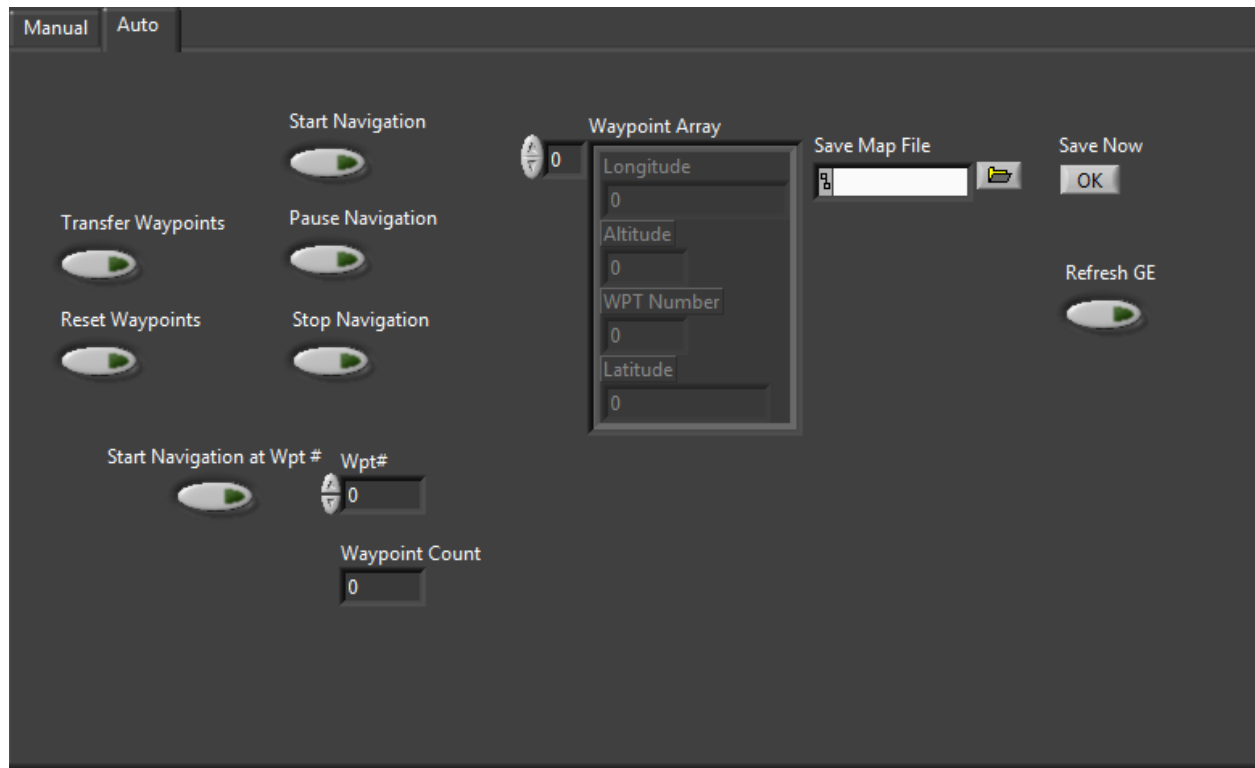


Figure 8: Autonomous Tab

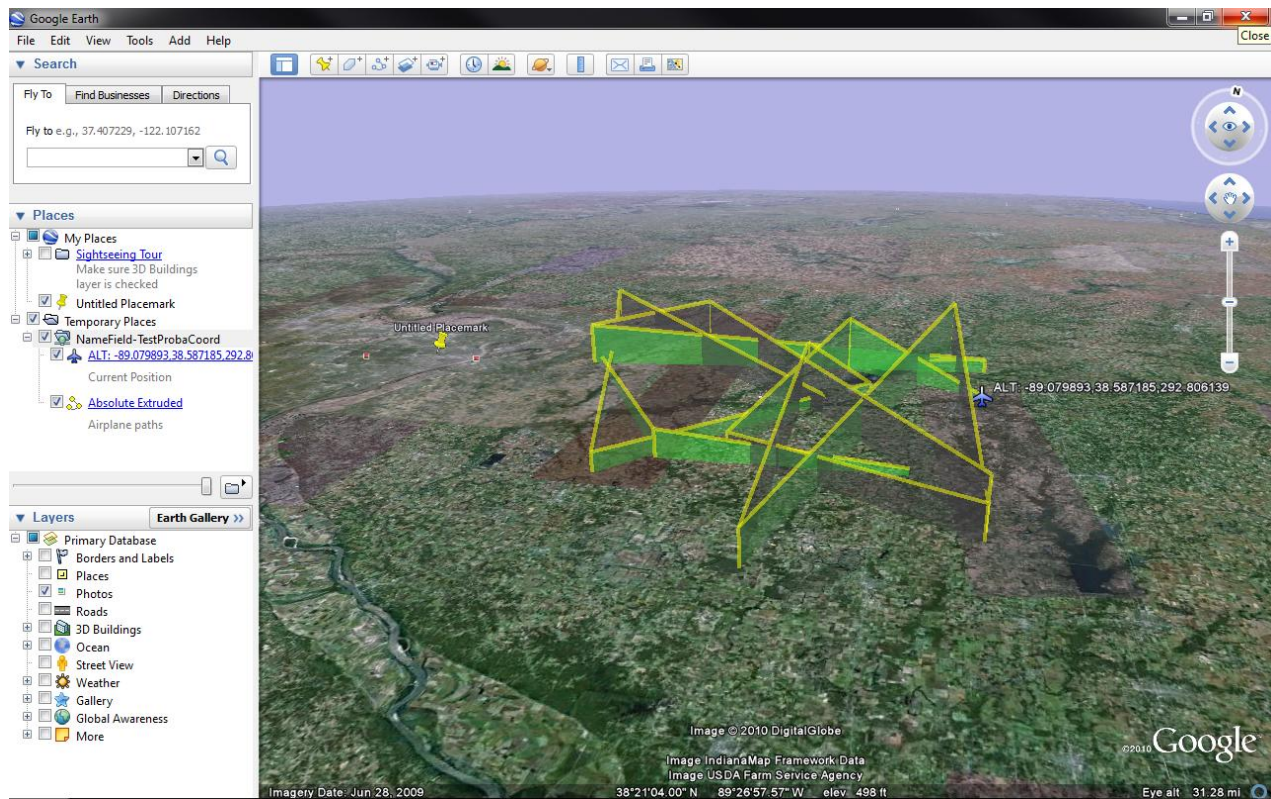


Figure 9: Google Earth Interface

The Google Earth Interface is used to create Waypoints and to mark the current and past position of the Vehicle(s). To Create a Waypoint, Right-click anywhere on the map.
To zoom in on the Vehicle, click on the Vehicle Icon in the Places Toolbar on the Left.

Controls/Indicators

1. Transfer Waypoints: Transfer Waypoints to Vehicle.
2. Reset Waypoints: Reset Waypoints on Vehicle and Google Earth Interface.
3. Start Navigation: Command Vehicle to start autonomous navigation from Waypoint 0.
4. Pause Navigation: Command Vehicle to Pause current autonomous navigation.
5. Stop Navigation: Command Vehicle to Stop autonomous navigation.
6. Start Navigation at Wpt#, Wpt#: Command Vehicle to start autonomous navigation from selected Waypoint Number.
7. Waypoint Count: Total number of Waypoints.
8. Waypoint Array: Displays all Waypoints.
9. Save Map File: File Path to save Map.
10. Save Now: Save current Map to File. This File is a KML file that can be used by Google Earth, without having to use the GCSI Software.

Future Expansion

Side Tab

Debugger Tab



Figure 10: Debugger Tab

Command/Control Monitoring Tab

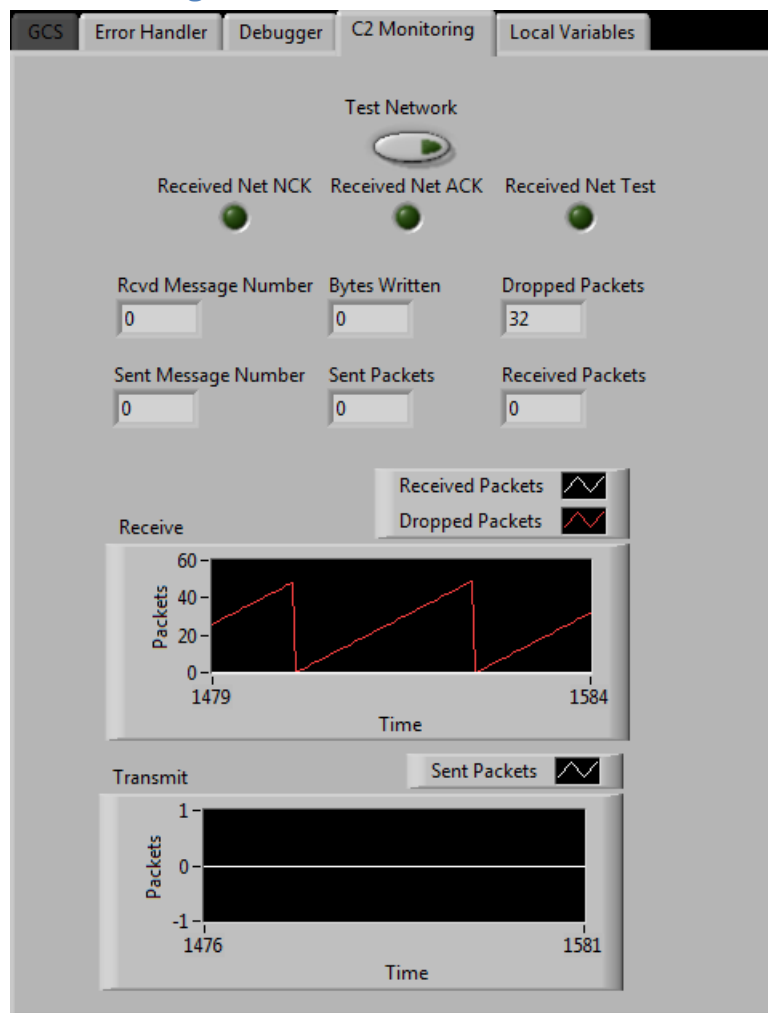


Figure 11: Command/Control Monitoring Tab

Bottom Tab

Vehicle Health System Tab

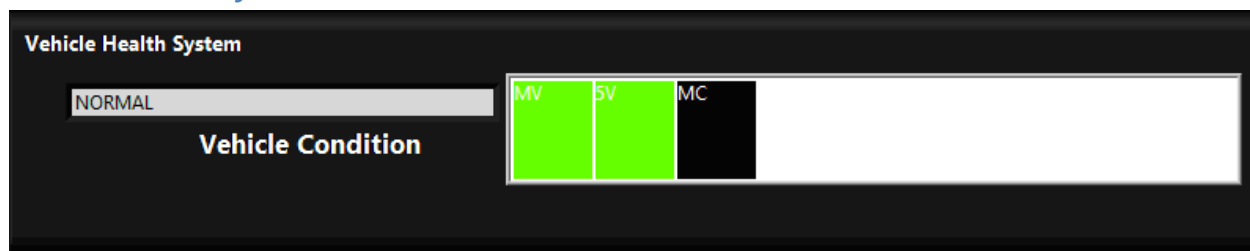


Figure 12: Vehicle Health System Tab

1. Vehicle Condition: Provides overall status of Vehicle. Conditions Include:
 - a. NORMAL:
 - i. Battery Voltage Nominal.
 - ii. No Error Codes.
 - iii. Main Current Nominal.
 - b. LAND SOON:

- i. Battery Voltage decreasing. Land soon before Batteries are too low to land Vehicle safely.
- c. NO COMMUNICATIONS:
 - i. No communication with Vehicle.
 - ii. Lost communication with Vehicle.
 - iii. A large number of are Packets being received but are not recoverable.
- d. EMERGENCY LANDING:
 - i. Vehicle was being flown but due to the following reasons, EMERGENCY LANDING Procedures have been implemented automatically.
 - 1. No Communications for X Seconds.
 - 2. Battery Voltage < X and Altitude over Ground > X.
 - 3. Pitch,Roll,Yaw,Throttle or Altitude over Ground uncontrollable.
 - 4. Loss of Critical Components: Primary Controller, GPS.
- e. EMERGENCY RECOVERY:
 - i. Vehicle was being flown but due to the following reasons, EMERGENCY RECOVERY Procedures have been implemented automatically.
 - 1. EMERGENCY LANDING Procedure not appropriate or not possible.
 - 2. No Communications for X Seconds.
 - 3. Battery Voltage < X and Altitude over Ground > X.
 - 4. Pitch,Roll,Yaw,Throttle or Altitude over Ground uncontrollable.
 - 5. Loss of Critical Components: Secondary Controller, Main ESC's.
- f.

Frequently Asked Questions

System Performance

Troubleshooting

Table 5: Troubleshooting Symptoms and Fixes

Symptom	Fix
When starting GCSI Software, it immediately stops running.	<ul style="list-style-type: none"> • The GCSI Software requires at least one Communications method specified. Configure a Communications method in the Connectivity Tab.

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Appendix

XX: [ICARUS Communications Protocol Guide](#)

XX: [ICARUS Communications Protocol Specifications](#)

XX: [Source Code](#)