Boeing 727 Test Equipment Data Package

Principal Investigator:

Mike Bennett
Cypress Woods High School
16825 Spring Cypress Road
Cypress, Texas 77429
Donald.bennett@cfisd.net
281-213-1899
281-213-1909

NASA Mentors:

George Kessler
George.j.kessler@nasa.gov
281- 244-5041

Florence Gold
Florence.v.gold@nasa.gov
406-690-2661

ROV Camera Platform

Introduction:

The experiment is being flown as part of the HUNCH Program, High School Students United with NASA to Create Hardware. The HUNCH students of Cy-Woods were introduced to this project in September 2010 with an explanation of the need for this system, and operational challenges in zero gravity.
It was designed by the students in the Advanced Engineering Design and Presentation class as well as the Problems and Solutions classes at Cypress-Woods High School in Cypress, TX with the guidance of our NASA mentors.

Abstract:

The end purpose of the ROV is to be a free flying camera system, remotely operated by ground crew to maneuver inside the ISS transmitting audio and color video to the ground crew. The video would be used as a live feed or recorded for later review.
This would allow ground controllers to inspect items such as experiment racks, experiment power connections, experiment readouts and interface cables. This inspection would be controlled by the ground without the need to interfere with the scheduled tasks of the ISS crew members.
The ROV is to be internally powered; without a power tether, with the ability to return to its dock and recharge as needed. The wireless camera system is a color mini camera also capable of transmitting audio with the video stream.

For this phase of development the decision was made to focus more on the camera, video / audio transmission distance in an enclosed area, ROV body design, and battery systems. The design concept was to create two halves for the body of the platform that could be taken apart as needed without the need for tools.
This was accomplished through the use of rare earth magnetics around the perimeter of the shell as well as in the motor covers.
The control system was changed to a traditional RC remote control system. This allowed the testing of drive (ducted fan) propulsion and platform stability in zero gravity during testing on the Reduced Gravity aircraft.

Background:

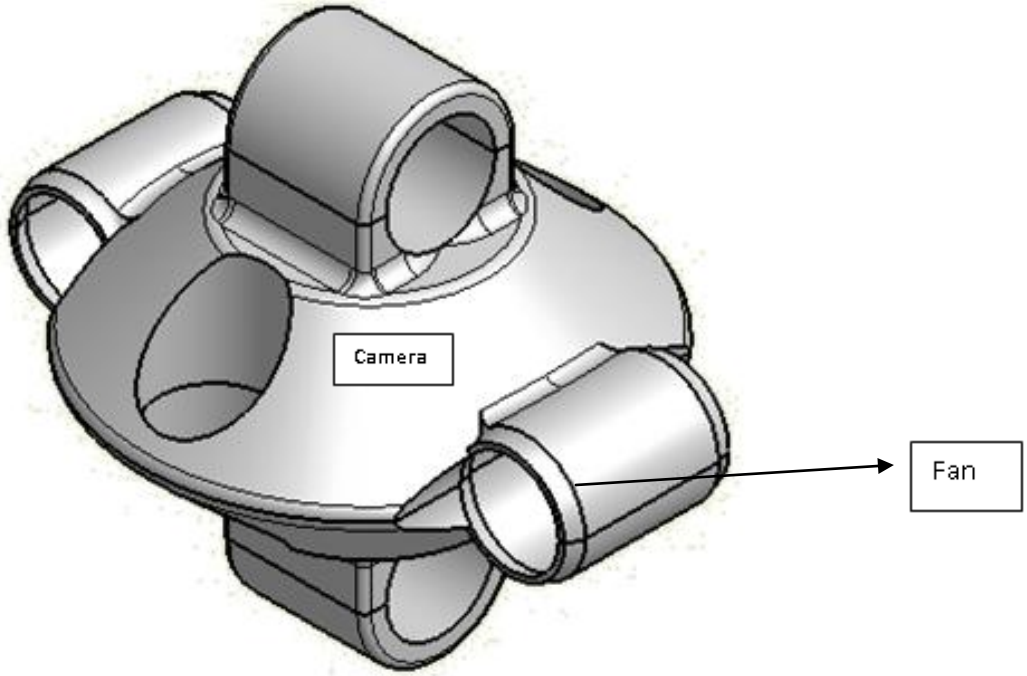
The experiment was based on the situation that on the International Space Station, an internal rack and experiments had been placed in an improper configuration. This has led to hardware damage and loss of science. The ROV (Remotely Operated Vehicle) will allow NASA engineers to ascertain the configuration of the interior of the International Space Station to mitigate future occurrences of these issues.

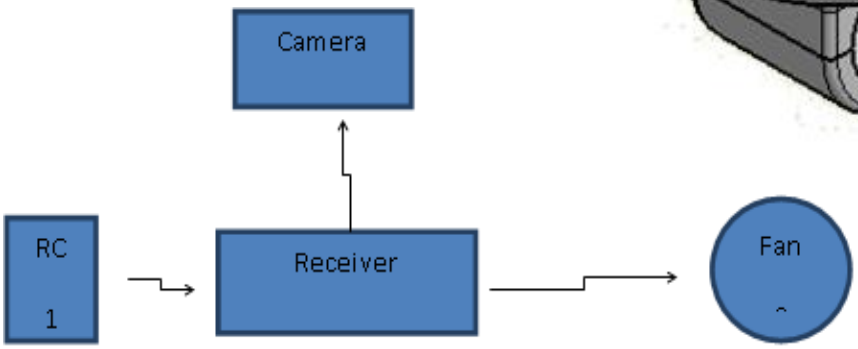
The ROV will be free floating. The experiment relies on one color camera, six ducted fans, internal batteries, motor speed controller, radio receiver and a hand held (RC) radio controller. The equipment is used to control the ROV and its main components.

- Futaba 10CG-- 10 channel, 2.4 GHZ RC transmitter: Used to send commands to a multi-channel receiver contained inside the ROV.
- Speed controllers: Controls the speed (RPM) as well as motor direction.
- Futaba receiver: Receives the transmitted signal and sends commands to attached speed controllers. Current configuration uses 6 channels.
- Speed Controllers: Allows the transmitter not only vary the RPM of the motors to but also its direction. Because each motor has its own speed controller, each unit could be operating a different RPM or rotation to aid in the controllability along the ROV axis.
- Ducted Fans: Final drive units for this design, chosen because of their size vs. CFM .
- Battery system: A pack of 8-AA 1.5 volt non-rechargeable batteries were chosen for the model. A non-rechargeable 9 volt battery was used to power the wireless camera.
- Wireless Camera: In the current configuration, the audio / video will be transmitted first to a laptop computer by Wi-Fi to be recorded onto the computer. In the final phase it would be transmitted on to ground controllers.

1. ROV
2. Fan
3. Camera

Location





Method:

We began the design phase by talking to our NASA mentors about the operational differences of an object in zero gravity and identifying the axis of Pitch, Yaw and Roll.

Our students were divided into the research areas of body design, battery research, camera research, and controller. Each area was responsible of communicating their findings back to the group on a regular basis.

This was especially important to the Body Design team. Our original goal was to construct a ROV that would fit into a 8x8x8 area.

Using the design software Autodesk Inventor we were able to create a 3D model of each body component, and then create a 3D assembly to study before moving to the manufacture stage.

The placement of the fan units were examined and modified as well as the methods of securing the motors during operation. The relocation was proposed to give better control of Pitch, Yaw and Roll.

Successes:

During the testing on the Reduced Gravity Aircraft the following was observed:

- The ROV could be somewhat controlled in zero gravity. The team was able to control the flight of the ROV, but concluded that a gyro stabilization system is needed for full control.
- The control system was able to fully control each ducted fan unit without difficulty in the test area.
- The live video feed from the wireless camera was able to be successfully transmitted back to the laptop computer. It was monitored in real time by observing the laptop screen as well as being recorded onto the computer hard drive for review at a later date.
- The software used with the capture adapter also has the ability to capture screen shots of the video.

Conclusion:

The following are considerations for the next phase of the vehicle design.

- The body shape seems to function well. The ability to quickly access the electronic components, batteries and motors without tools will remain a part of the design.
- Adding a LED light system for illuminating areas that might be in shadow. Given the small current draw of LED's it should not impact the battery life of the ROV.
- Adding a lower LUX camera in combination with the LED lights.
- Moving to a higher resolution camera with increased transmission range.
- While the traditional AA batteries were used, continue to research a new high capacity battery for the motors. We would not recommend the use of LiPo batteries because of observed problems during ground testing.
- Add a recharging system for the batteries in the ROV. An induction charging systems was explored this year.
- Higher thrust fan systems. Given the mass of the unit a larger amount of thrust is needed both in acceleration and braking.

- Adding a gyro stabilization system to the ROV. This would aid in the control of the ROV along each of the three axis.
- Designing a control system that would use a Wi-Fi signal instead the traditional RC controller.
- Incorporate the camera into the ROV body.
- Adding fan guards at each end of the fan openings.
- Enlarge the internal area of the ROV by either marginally increasing the overall size of the ROV or reducing the wall thickness of the top and bottom sections.

Acknowledgments:

The HUCH students and teachers of Cypress Woods High School would like to express our gratitude to our NASA mentors Mr. Hale, Mr. Phillion, Mr. Kessler and Mrs. Gold.
We would also like to thank the incredible staff of the Reduced Gravity Office for all the help we were given to ensure our experiment was successful. The ability to do a free float truly made a great difference in our observations.
The expertise and guidance given by these individuals in all phases of our project design and documentation was invaluable to the HUNCH students.
Not only has this experience impacted our students, two of the flight crew students were asked to share their experiences with Elementary school students in our District.