Satellite Simulation Workshop

Recovery

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How are you getting on ?

How is your research on SOHO case study going ?

Any useful insights to help us recover our satellite ?

Perhaps a specific questions to focus discussion...


1
See my list items by category
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5
Mark an item as "done"
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A few concepts to explain first...

Gyroscopes

Gyroscopes (Gyros) detect rotational movement (roll, pitch, yaw)

Gyros often have a "gain" setting (sensitivity) High/Low - depending on how they are being used

SOHO has a number of Gyroscopes on board:

- Gyro A is used to sense movement during navigation
- Gyro B constantly checks for problems and anomalies

Gyros are part mechanical, so have limited lifespan Sometimes deactivated to make them last longer

Flywheels

Spacecrafts use flywheels for navigation adjustment
Heavy weights that are kept spinning at high speed
Tilting them allows fine control of craft orientation

video-demo

Wheels require "management":

- Increase spin speed
- Decrease spin speed
- Zero direction calibration

Emergency Sun Reacquisition

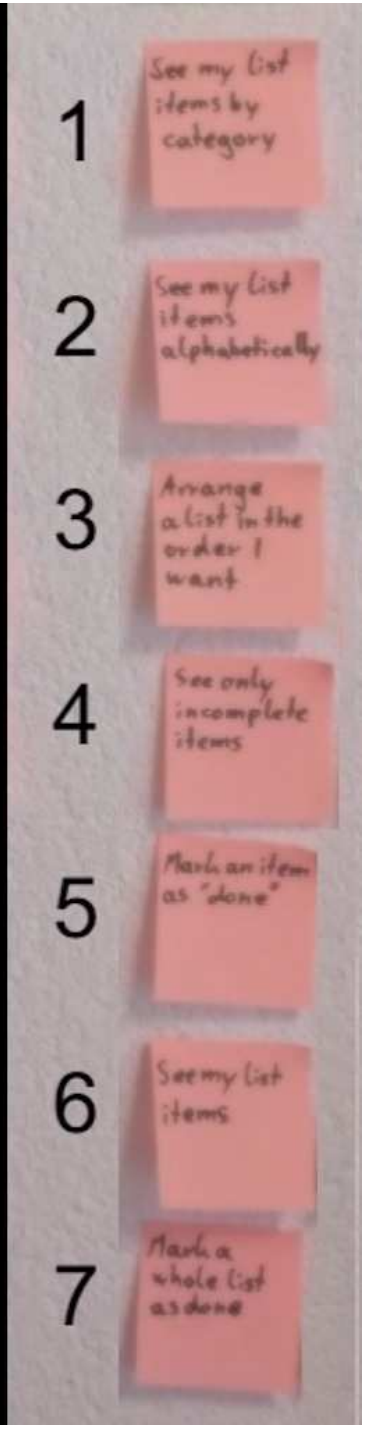
We encountered ESR in the previous session
An "auto pilot" feature to realign satellite with Sun
Uses Gyros, Flywheel and Thrusters to navigate

As we saw yesterday, this can be invoked manually
However, ERS can ALSO be triggered automatically
This is part of the fail-safe operation of the satellite
If "bad things" happen, realign satellite with SUN

As we are already well aware...
ESR needs valid Gyro readings to work correctly !

Summary of what I see as key events...

Gyro A is deactivated to preserve lifespan
Gyro B gain set to "high" for flywheel management
Flywheel management ends, but Gyro B left "high"
High gain causes non-existent roll to be detected
ESR-5 trigged to correct the non-existent roll
Missing reading from Gyro A causes an actual roll
Gyro B detects actual roll and initiates ESR-6
Readings from Gyroscopes A & B differ (A is off !)
Ground control assume Gyro B faulty so disables it
Satellite now has no operational gyros at all !
Satellite is slowly becoming misaligned with Sun
ESR-7 is triggered (with no working Gyroscopes !)
Total loss of power, telemetry and thermal control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Recovery Steps

1. Confirm orbit position via Deep Space Network
2. Make radio contact via Deep Space Network
3. Receive Spacecraft Telemetry
4. Thaw Hydrazine Fuel Tank
5. Thaw Hydrazine Fuel Pipes
6. Switch on gyroscopes (with correct gain) !
7. Perform Emergency Sun Reacquisition
8. Recommission science instruments

Recovery "milestones" taken from:
https://soho.nascom.nasa.gov/about/Recovery/docs/

What do WE need to do ?

The experiences of SOHO offer us valuable insights
A very similar situation to the loss of our satellite
We may well be able to recover in a similar way !

From our previous analysis of SOHO recovery,
we need additional behaviours from the simulator

Luckily there are some extra features available...

Channel of Communication

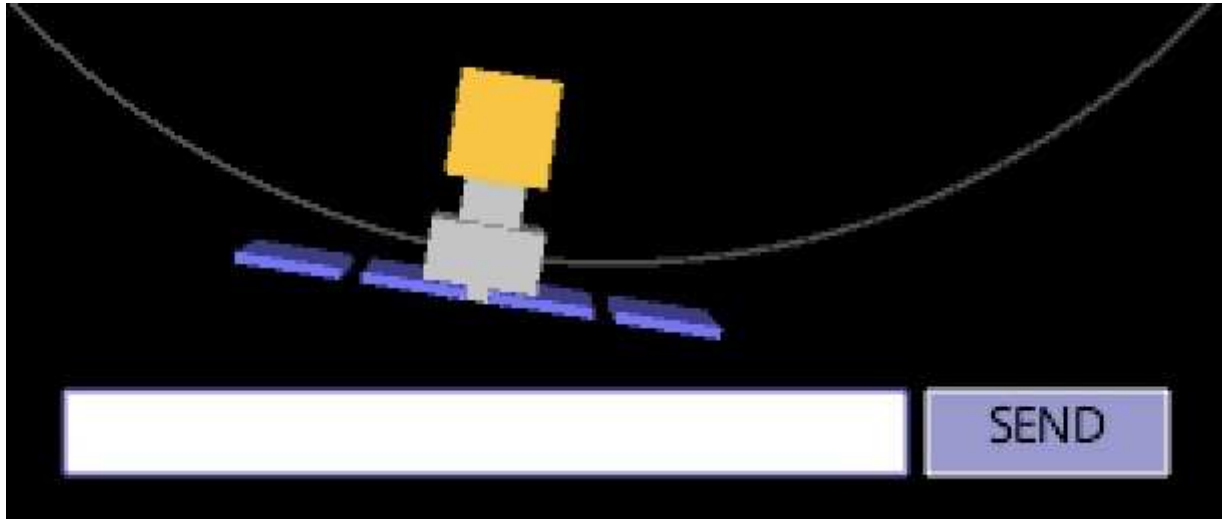
The radio antenna on the satellite is misaligned

As a result, the command prompt is disabled

We need an alternative channel of communication

Recovery of SOHO used the "deep space network"

Let us use a similar mechanism...



Command Line

We will need to make use of the command line "terminal" on OSX/Linux or "CMD" on Windows (don't use powershell - it can cause problems !)

Ensure you are in same the folder as the simulator
Echo commands and direct them to "deepspace"

```
echo GYR1 > deepspace
```

open-folder

All previously introduced commands will still work

A set of additional NEW commands also provided...

Deep Space Radar Scan

It would be good to know if satellite is still there !

We can request a deep space radar scan using RAD

```
echo RAD > deepspace
```

Radar scan appears in a file called "radarscan.png"

Satellite Status

To get current fuel tank and pipe temperatures:

```
echo TMP > deepspace
```

Data will appear in a file called "temperatures.txt"

To get the current battery level:

```
echo BAT > deepspace
```

Battery level will appear in a file called "battery.txt"

To get the current fuel tank level:

```
echo FTL > deepspace
```

Fuel tank level will appear in a file called "fuel.txt"

Temperature Control

To thaw fuel system we need to control heating

To turn on and off the fuel TANK heaters:

```
echo FTH1 > deepspace
echo FTH0 > deepspace
```

To turn on and off the fuel PIPE heaters:

```
echo FPH1 > deepspace
echo FPH0 > deepspace
```

Note that using heaters will deplete battery level !

Current Satellite Orientation

Satellite is currently not well aligned to the Sun
However, solar panels are collecting *some* power (although not very much !)

Make sure you turn off all unnecessary equipment
You'll have to wait some time to charge the battery
Once battery has charged, you can use the heaters

Full battery is not enough to thaw both pipes & tank
So you may need multiple phases of charge / heat

Over to you !

Have a go - see if you can recover the satellite

- SCI Switches the science experiments on and off
- RAD Produces deep space network radar scan

- BAT Outputs the current battery power level
- FTL Outputs the current fuel tank level

- FTH Switches the fuel tank heater on and off
- FPH Switches the fuel pipe heater on and off
- TMP Outputs the fuel tank and pipe temperatures

- GYR Switches the gyroscope on and off
- ESR Initiates Emergency Sun Reacquisition

Any Luck ? Want me to try ?

My Recovery Plan

In order to recover soho, we are going to need:
SCI0 to switch off the science experiments
FTH1 and FTH0 to switch on and off fuel tank heater
FPH1 and FPH0 to switch on and off fuel pipe heater
TMP to keep an eye of fuel tank & pipe temperatures

GYR1 to switch on gyroscope, then quickly...
ESR to perform an Emergency Sun Reacquisition
SCI1 to switch science experiments back on again
(to complete the recovery of the satellite)