

HEAVENSAT

(NOTE : For Version 1.98)

Updated 16 Dec 2006

1. Introduction

HEAVENSAT is a program written by Alexander Lapsin for the visual tracking of artificial earth satellites.

The program has no documentation and I volunteered to write a manual as such an outstanding program deserved a manual and rather than have him spending his time writing a manual instead of programming improvements I would do the manual.

PLEASE NOTE : Any errors introduced are probably due to me and if a better way of doing a particular task is obvious to you then by all means let me know so that this manual can be updated.

2. Features

HEAVENSAT was developed for the visual satellite observer. I happened to come upon it on the Internet and immediately knew that this was THE program I had been looking for in my video tracking of satellites.

Some features of the software :

- 1 Show a view of the sky for any date, time and location.
- 1 The program can show in real time a view of the sky that will contain any satellites in the database in use that are in the field of view at that moment.
- Can handle any sized database a database containing more than 10000 satellites has been tested with no problems.
- 1 One can watch a particular area of the sky and watch satellites cross the field of view
- 1 One can lock on a satellite selected and follow it across the sky and see which other satellites are in the field of view of the main target.

There are many other features which I have yet to explore!

3. Installing the program

Download the following files:

(1) OpenGL version of HEAVENSAT1.97 (previous version), file size 4.7 Mbytes

(2)HEAVENSAT198glPatch.zip file size 473 Kbytes.

(3) Microsoft VC80.CRT 0.6 Mbytes

(4) Sky2000 Master Catalog V4 11.1 Mbytes.

With your unzipper (WINZIP/WINRAR whatever)- click on HEAVENSAT197gl.ZIP and extract to C:\Heavensat

It should do this and you will have a directory structure C:\Heavensat\Heavensat197gl\ and all the files and created subdirectories will be in the sub directory "Heavensat197gl".

Now a bit of fiddling - copy all the files in this directory (ie the one marked "Heavensat197gl" into C:\Heavensat . Having done this then delete the subdirectory Heavensat197gl.

Unpack Heavensat198glPatch.zip to the Heavensat directory and make sure all the new files unpack into their respective directories. Now click on Microsoft VC80CRT.zip and extract to C:\Heavensat\ Click on Sky2000.zip and extract to C:\Heavensat.

It should now all be okay but if not this is the directory structure I have on my PC:

ile Folder	2006/10/07 01:22 PM		
ile Folder	2006/10/07 01:24 PM		
ile Folder	2006/10/21 11:26 AM		
ile Folder	2006/10/21 11:30 AM		
ile Folder	2006/10/07 01:25 PI		
ile Folder	2006/10/07 01:25 PM		
ile Folder	2006/10/07 01:27 PM		
	file Folder file Folder file Folder file Folder file Folder file Folder		

In the root directory its called HEAVENSAT which has subdirectories and files as shown :







The subdirectories contain :

BITMAPS:

🗳 Dackward.DMD	starbei.png
K binocular.bmp	k stop.bmp
Chart.bmp	K sun.ong
Clock.bmp	Sun flare.nng
	text.bmp
	K track bmp
	K telider bmp
	Control Comp
grass.png	
guiaing.omp	
C horgrid.bmp	
List.bmp	
Les lock.bmp	
🖺 moon.jpg	
🖺 mount.bmp	
🖄 parameters.bmp	
ڬ play.bmp	
ڬ sat2.bmp	
ڬ sat2.png	
ڬ sat3.bmp	
ڬ sat.bmp	
ڬ sat.png	
ڬ satp.png	
ڬ satsel.bmp	

satsel.png sky.bmp splash.jpg star1.png star2.png star3.png star.bmp star.bmp

INI:

HEAVENSAT V1.98



1 KB







Chart.ini



msvcp80.dll

8.0.50727.42

Microsoft® C++ Runtime Library

LANGUAGES:





Microsoft.VC80.CRT:





Star Catalogs:





TLE:



msvcm80.dll

8.0.50727.42

Microsoft® C Runtime Library

NOTE : TLE - has a sample TXT file. Suggest you delete this and put in your own elements database. Extension TXT or TLE okay. I put in the large SPACETRACK ~8500 version plus CLASSFD.TLE.

All this is quicker to do than try and explain :-))

4. Starting the program.

All should now run okay when you click on HEAVENSAT.EXE.





The following screen should appear :

🚢 Heavensat	1.98				
Common Sky/c	hart Time Help				Concerned and
Calculations	🔛 Sky 🍪 Chart				
Loaded 18	5 satellites				
Using all	satellites from base	2°30/46 6#			
Observer	time zone:UTC+2.0				
			Find	Save	Clear
Start date	2006 12 15 10 14 04 Actual time	Illumination required			
Duration	4 hours 💌	Skip if magnitude unknown			
Distance	0.01				
Star mag.	2				
Satellite mag.	9				
Sat elevation	10				
Begin					
Search near sta	rs Passes prediction Sun/Moon transit				

5. Setting up the various OPTIONS under COMMON.

As with any program running for the first time it is necessary to set up certain values. Click on **COMMON**, found top right corner and a new subscreen will appear called **OPTIONS**

Options						×
Observer	Common	Satellites	Stars	Sky	Chart	
Observer Latitude Longitud Height, I Time z UTC+	Common , deg [- le, deg [1 m 2 one 2	Satellites	Stars © to	Sky	Chart	
			Ok		pply	Cancel

The first data applies to the observer so fill in the required details and then click **APPLY**

Now click on **Common** and see if there is anything you want to change.

DD.MM.YYYY English 1 ider cursor Horizontal		 Cridit	
DD.MM.YYYY English 1 Inder cursor Horizontal			
English 1 I I Mer cursor I Horizontal			
1 Inder cursor]		
ider cursor ④ Horizontal			
 Horizontal 			
	A.		



When satisfied press APPLY

Now click on **SATELLITES** and you will get a screen similar to that shown

 $file://C:\heavensat_manual\htm$

Options		×
Observer Common	Satellites Stars Sky Chart	
Active satellites	Selected Select	
SGP4/SDP4 model	Revised SpaceTrack Report No. 3, #2 💉	
	Ok Apply Cancel	

You may wish to have your elements file in another directory. For example in directory c:trackv60. Click on **Select** - on right hand side of this screen, then click on **CHANGE DIR** at foot of screen. A new screen appears

					0	
Change dir	Check all	Uncheck all			l	Clear

Move the vertical slider bar to search for the directory you want and find your TLE file and click on it

Satellites bases								
C:\TRACK\v60	All satellites				Selected s	atellites		
CONTROL.INI	Name	Number	Element	file 🔨	Name	Number	Element	file
CON_INI.INC	NOSS 0 (A)	5678	0	DEC1				
DRAG_BST.OUT	NOSS 0 r	5679	ñ	DEC1				
ELEMENTS.INC	NOSS 0 (C)	5680	0	DEC1				
FORMAT.TXT	NOSS 0 (D)	5681	0	DEC1				
INDATES.INC	NOSS 0 (E)	5682	0	DEC1				
MOON.INC	DMSP 7	7816	0	DEC1				
TESTING.DAT	NOSS 1 (A)	8818	0	DEC1				
PB.EXE	NOSS 1 (C)	8835	0	DEC1				
PBCONFIG.PB	NOSS 1 (D)	8836	0	DEC1				
PBD.EXE	NOSS 1 (J)	8884	0	DEC1				
PBHELP.PBH	AMS 1(DMSP F1)	9415	0	DEC1				
PBINST.EXE	AMS 2(DMSP F2)	10033	0	DEC1				
	NOSS 2 (A)	10502	0	DEC1				
PASSI OG EXE	NOSS 2 (D)	10529	0	DEC1				
SEECOSALDAT	NOSS 2 (E)	10544	U	DEC1				
SDP4 CPP	NUSS Z (F)	10594	0	DECI				
SEECOSAT BAS	NOSS 2 (A)	11309	0	DECI				
SEECOSALEXE	NOSS 3 (C)	11720	0	DEC1				
	NOSS 3 (D)	11732	ñ	DEC1				
SGP4NEW INC	NOS5 3 (G)	11745	Õ	DEC1				
	KH 9-16 Elint	11852	Ō	DEC1				
	KH 9-17 Elint	13172	0	DEC1				
search He	NOSS 4 (A)	13791	0	DEC1				
	NOSS 4 (E) ot	13844	0	DEC1				
	NOSS 4 (F) ld	13845	0	DEC1				
	NOSS 4 (H) tr	13874	0	DEC1				
	NOSS 5 (A)	14112	0	DEC1				
	KH 9-18 Elint	14139	0	DEC1				
✓ DECIS.TLE	KH 9-18 late	14139	0	DEC1 🞽				
	<)	>				
Change dir Check all Uncheck all								Clear
					-	01		
						Ok		Cancel

the elements should appear in the central column. Click on APPLY and then Ok

One is offered the chance to change the colour of the satellite- I like mine yellow as I can then see they are "sunlit". The satellite will change colour to blue when in earths shadow. The **MARKER** option allows one to identify a selected satellite with a symbol. Choice #1 is the smallest and #10 the largest. Around #5 is best but I prefer the **MARKER** off. The final choice is the **POINT SCALE**. This controls the size of the satellite on the screen with #1 being smallest and #8 being the largest. Around #4 is about the best.

One is allowed to choose the prediction algorithm used - the first choice is the original SPACETRACK #3 report which contained some errors. The second one is the updated reported released in August 2006 and the third one is the implementation by Bill Gray of PROJECT PLUTO of the August 2006 report. Choices #2 and #3 will probably give the same answers but the code by Bill - ie #3 - runs a lot faster than #2. One can switch "on the fly" from one algorithm to the others and therefore see what effect it has. Finally one can choose the geophysical model used - I don't know much about this but don't think it will make any material difference as to which is used.

Now click on STARS. Select the star catalog you want to use- you should have the option of two. Choose the one you like.

Options	×
Observer Common Satellites Stars Sky Chart	
Observer Common Satellites Stars Sky Chart	
Ok Apply Cancel	

Click on APPLY

Next click on SKY. For the moment accept the default values shown- you can always change them later and see what effects the have.

Exploring the options offered:

Stars Image Style. #1 gives most realistic appearance, #2 gives big diameter stars and #3 gives the smallest. I prefer option #1.
 Stars Scale. #1 is least diffuse image whilst #20 most diffuse. Around about #10 is okay.

Stars Colour. Select Spectrum as this will then match the spectrum of the star which gives an indication of the star colour.

Click on APPLY

Finally click on **CHART**. For the moment accept the default values shown - you can always change them later and see what effects then have.

Options			225				×
Observer	Common	Satellites	Stars	Sky	Char	't	
Stars im Stars im Stars i Stars i Star	age style color Select scale orial grid Select scale torial grid Select scale scale scale	2 2 Statemetes 2 Statemetes	v spectr now	um			
			Ok		Apply		Cancel

The options offered here apply to the CHART view and have the same meaning as for SKY so again its a matter of personal choice.

Click on **APPLY** and then **OK** and you will be returned to the main screen again.

6.Ready to go

Things now get pretty hectic as so many things can be done so for the moment instructions to get started will be given and you can then explore further.

Assuming all set up correctly, when you load the program the screen will display the number of satellites loaded, your coordinates and the time system.

🚟 Heavensat 1.98	
Common Sky/chart Time Help	
🕮 Calculations 🔛 Sky 👶 Chart	
Loaded 185 satellites	
Using all satellites from base	
Observer coordinates lat: -33°56'26.1",	lon:18°30'46.6"
Observer time zone:UTC+2.0	

Now go to the lower half of the screen where you will see you can select three options, namely

Search near stars.

- 1 Passes prediction.
- I Sun/moon transit.

These are self explanatory so it will be left to you to explore but for the moment let us choose the second option, namely **Passes prediction**.

Start date	2006	12	15	20	15	00	Actua	al time	Illumination required
Duration	4		hou	Jrs	~				Skip if magnitude unknown
Sun elevation	90		7						
Sat elevation	10								
Satellite mag.	15								
Begin	(

Enter the start date and time and make sure **Illumination required** is checked. Also enter the **Time duration** and the **Minimum satellite elevation**, typically 10 or 15 degrees. Finally enter the **magnitude of the faintest satellite** you hope to track.

Press **BEGIN** and the passes will be shown on the screen.

🚟 Heavensat 1.98				
Common Sky/chart Time Help				
📕 Calculations 🔛 Sky 🚱 Charl	t			
Loaded 185 satellit	tes			
Using all satellite	es from base			
Observer coordinate	es lat:-33°56'26	.1", lon:18°30'46.6		
Observer time zone:	:UTC+2.0			
Begin passes predic	ction from 15.12	.2006 20:15:00 to 1	6.12.2006 00:15:00	
satellite	max el	maximum mag	rise	set
90060	79.69	7.02	15.12.2006 11:41:52	15.12.2006 21:13:02
90062	56.41	5.68	15.12.2006 14:09:28	15.12.2006 22:04:49
90057	62.82	7.69	15.12.2006 15:38:29	16.12.2006 00:55:36
90061	67.31	4.65	15.12.2006 16:02:28	15.12.2006 23:13:20
90045	28.72	6.10	15.12.2006 16:25:51	15.12.2006 20:55:24
90028	56.07	4.99	15.12.2006 18:41:15	15.12.2006 21:08:05
USA 179 Cn r	75.30	7.37	15.12.2006 19:16:24	15.12.2006 22:39:36
NOSS 4 (E) ot	32.10	9.15	15.12.2006 20:03:26	15.12.2006 20:26:20
90058	68.39	6.37	15.12.2006 20:07:33	15.12.2006 23:31:33
90058-2	68.37	6.37	15.12.2006 20:07:50	15.12.2006 23:31:44
TiPS	14.18	9.13	15.12.2006 20:08:33	15.12.2006 20:21:14
NOSS 4 (H) tr	28.57	9.30	15.12.2006 20:11:02	15.12.2006 20:33:44
<				>

NOTE Currently geostationary satellites are NOT shown on this screen at this stage.

As an aside, if you click on **CHART** at this time it will show the satellite situation at the time of the pc clock and **NOT** the start time selected. More later. The same applies if you select **SKY** at this point. Changing the time using the option in the Right hand column also does not affect these displays. These views are only changed once you have performed the next step.

Look through the list of satellite passes shown on the screen and select one of interest. Let this be **Lacrosse 5**. Click on it and a new screen will appear and show the trajectory of Lacrosse 5.



You can examine this pass in greater detail by clicking on the **Slider Bar** which is 7th item down in the icons on the RHS of screen. This slider has a coverage of 10 minutes and the start and end times can be changed by clicking on the double arrows at each end of the slider bar.



Experiment with sliding the slider in this bar. Note that you can also drag the sky around by left clicking the mouse in the screen and holding the mouse down whilst you drag the sky.

If you **right** click on the satellite you are shown several options, eg

ı object information.

Clicking on this will show a wealth of detail as shown in the picture below:

NOSS 3-2 r			×
NOSS 3-2 r #28096 File: C:\TRACK\v60\DE0 Element number:0 Time: 16.12.2006 20:11	C15.TLE L:11.987		
Elevation:38.755° Azimuth:292.565° Altitude:1148.942 km Range:1656.906 km Latitude:-29.682° Longitude:8.007° S-s-0 angle:114.3° Ra: 22h00m44.2s Dec: -05°48'39.8"	Data age:4.6 days Inclination:63.683° Eccentricity:0.007 Apogee:1157.935 km Perigee:1053.907 km Period:107.416 m	Mag:3.85 [v] Cylinder, Length:8.0 m Diameter:3.0 m Ang. size:01.0"	X:6507.505157 Y:689.915147 Z:-3708.750715 VX:2.636293 VY:4.001012 VZ:5.457657
1 28096U 03054B 0634 2 28096 63.6780 33.9	46.13962332 0.00000020 9909 0069500 95.0211	0 00000-0 35842- 264.9789 13.40577	-4 0 06 A 1732 02

ı center object.

This should not present a problem - it centers the object on the screen

Add to selected list.

I have still to examine this option and how to use it.

ı Add current event.

I have still to examine this option and how to use it.

ı ephemeris.

Select **Ephemeris** and you will be shown rise and set times of the satellite. You are also asked what items you want shown as well as the **Time step** interval between successive predictions - use (say) 0.1 minutes

art: nd	2	2006 12	15 20 15 20	19 10 32 34						
me ster	o, min 1	I		II						
Calcul	late	Save								
Time	M A:	zimuth 🗹	Elevation	Time error		e ⊠ Ra	nge 🕑 Phase	angle 🗹	RA 🗹 Dec 💟 A	Age of element:
	Time	Azimuth	Elevation	Time error	Magnitude	Range	Phase angle	RA Dec	Age of elements	5



Press **Calculate** and ephemeris will be produced which you can save.

across	e 5									_ D 2
Start	20	006 12	15 20 1	9 10						
End	20	006 12	15 20 3	2 34						
Time st	ep, min 0.	1								
Calc	ulate	Save	1							
Calc		5440	J							
🗹 Tin	ne 🗹 Azi	muth 🗹 E	levation 🔽	Time error	Magnitude	🛃 Range	e 📝 Phase an	igle 🔽 RA	Dec	Age of elements
	Time	Azimuth	Elevation	Time error	Magnitude	Range	Phase angle	RA	Dec	Age of element
1	20 19 10	207.4909	000.0724	00.0	5.3	03154	150	240.6139	-47.4464	0005
2	20 19 16	207.0795	000.3706	00.0	5.3	03121	149	240.3849	-47.9249	0005
3	20 19 22	206.6597	000.6710	00.0	5.3	03088	149	240.1426	-48.4092	0005
4	20 19 28	206.2314	000.9734	00.0	5.3	03056	149	239.8863	-48.8995	0005
5	20 19 34	205.7942	001.2780	00.0	5.3	03023	148	239.6151	-49.3958	0005
6	20 19 40	205.3479	001.5849	00.0	5.2	02990	148	239.3281	-49.8982	0005 🧔
	10	st.	1	10	1.	1	1	10	10	
										2

If you now click on **CHART** you will see all satellites above your horizon at the instant you chose for Lacrosse 5.

NOTE all the things you do in the main window (SKY) can also be done in the CHART window.

On the right hand side of the screen you will see a column of icons. These are all necessary for full use of the program

The icons in descending order do the following

Zoom in - note how more stars become visible as field of view gets smaller

Zoom out - opposite to the zoom in function



Start time running - watch how the satellite/satellites move

Advance time - so you can set your time to match the real time . Note the time is shown at top left of screen as well as in the taskbar at right bottom corner.

- Retard time opposite effect of Advance time
- I Set time
- I Invoke the Time Slider Mode

1 Show satellites - several options are available here - for example you can elect to display all satellites above horizon in your database at that instant -

to show all- select Draw Satellite and then Click on All)

- Set field of view (binocular symbol)
- Lock on selected satellite (also unlock)
- Show trajectory (also don't show trajectory)
- Constellation lines (option of ON or OFF)
- Equatorial mount (instead of working in alt/az mode works in RA/Dec mode
- Flip vertical (or inverse)

- Flip horizontal (or inverse)
- 1 Show RA/Dec grid (or don't show)
- Show az/el grid (or don't show)
- Measure angular distances on screen
- Guiding --- don't know what this does yet :-)))
- Options menu select (hammer symbol)

7.DROP-DOWN menus

Looking at the opening screen you will see the following line:



Dealing with each in turn:

COMMON

Full Screen This enables you to set the full screen as your view window - the **DROP-DOWN** menu line will disappear. Either click on this option with the mouse or press F11. To **RETURN** to the original default view press F11 again.

Night Vision To preserve your night vision you can either click on this option with your mouse or press CTRL-N. To return back to default view click with your mouse on this option or press CTRL-N again

Set calculations window font This enables you to change fonts and colours used in your windows calculation section. Set up for what pleases you most.

unc.	Font style:	Size:	
Courier New	Regular	12	OK
Courier New Estrangelo Edessa Ficilex Girls Fixedsys Franklin Gothic Mediur Gautami Georgia	Regular Italic Bold Bold Italic	12 × 14 16 18 20 22 24 ×	Cancel
Effects	Sample	YyZz	
Color			
Color:	Script:		

1 Set Sky/chart fonts. This is similar to the previous option so select what pleases you most.

Options This was discussed earlier so will not be repeated. Note **Options** may also be selected from menu at right hand side screen (the **Hammer** icon.