```
!S1ModDef.f95                          Stereo-3D Simulation Environment Vsn:1.00
!2025.05.24.1840cdt- Variable Modules of the visual simulation environment.

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!         IP Status- Free source code (e.g.: post copyright)
!
!          Computer- "T3"/Dell Precision T3500/Intel i5 E5520/Win10Pro-21H2
!                     ^name ^Mfgr.Id           ^chipset       ^OS
!                    /Absoft Pro Fortran 21.0.2/GeForce GTX 1050/f90gl~Glut3.7
!                     ^compiler ~Fortran 95     ^graphics card   ^graphics

!    f90gl bindings- public domain; see "https://math.nist.gov/f90gl/"

!Disclaimer:
! ****************************************************************
! **********   Individual cognition is always flawed,  **********
! **********         including yours and mine.         **********
! **********                  - So: -                  **********
! **********       Use this code at your own risk.     **********
! ****************************************************************

!Table of Contents: ...use to search...
! Module OpenGLRec          !Ref: OpenGL GL/GLU/GLUT Documentation
! Module TaskDef            !Project/Context
! Module ioDef              !Files,Units,TimeStamp,Selfies,Flags
! Module ScreenDef          !screen & colors
! Module KeyboardDef        !Keyboard
! Module ModuleDef          !Mo Module
! Module ViewDef            !View bounds->[0.,+1.]->[extent]Destination
! Module ModelDef           !Modelview Matrix Generation
! Module SimDef             !Simulation F9-F12
! Module HelpDef            !Help (a text block)
! Module AppsDef            !User Apps F1-F8
! Module F3dvDef            !File .3dv data
! Module BreakPtDef         !BreakPoint & Scrolling
! Module UseAllBbDef        !Contents

!-------------------------------------------------------------------------------7 9
Module OpenGLRec
!use OpenGLRec          !Ref: OpenGL GL/GLU/GLUT docs            JMS 2020.06.30
 use opengl_gl
 use opengl_glu
 use opengl_glut
!Contains
End Module OpenGLRec
!-------------------------------------------------------------------------------7 9
Module TaskDef
!use TaskDef   ,only: & !Project/Context                         JMS 2020.06.30
 !--Environment ID:
  character::EnvBanner*22   ='Sn3D-Environment'
  character::EnvVersion*22  ='2025.05.24 vsn 1.0'
 !--Executable  ID  (Re)Define in Main &/or .nml to agree with project options:
  character::ExeBanner*58   ="Sn3D__-"   !(left side,1st line)
  character::ExeName*22     ='Sn3D.exe'
  character::ExeVersion*22  ='2025.05.24 vsn 1.0'
 !--Analyst info             Set in "Sn3D.nml":
  character::Analyst(     0:8)*35!="  Jeff Setterholm"    !Your info. here
  character::Phone(       0:8)*35!="   "(___) ___-____"
  character::Street(      0:8)*35!=" 8095 230th St. E."
  character::CityStateZip(0:8)*35!="Lakeville, MN 55044"
  character::IPSummary(   0:8)*35!="   IP: ________"      !of your app

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```
!----For Screen/Keyboard traceability in S_*.f95\Subroutine SK():
!        "When OpenGL goes South... it helps to know where."
!     Application-specific groups (e.g. files) of subroutines:       2022.04.15
  integer(4)   ::jGroups =   18     !# of groups
  character(16)::jGroupName(0:19) & !Group name(s)
                              = (/ '                ' &   !un-#'d
                                  ,'S1ModDef.f95    ' &   ! 1
                                  ,'S2ModCallbacks.f' &   ! 2
                                  ,'S3Main.f95      ' &   ! 3
                                  ,'S4Callbacks.f95 ' &   ! 4
                                  ,'S5Screen.f95    ' &   ! 5
                                  ,'S6View8.f95     ' &   ! 6
                                  ,'S7Motion7.f95   ' &   ! 7
                                  ,'S8Help.f95      ' &   ! 8
                                  ,'S9Font.f95      ' &   ! 9
                                  ,'-unspecified-   ' &   !10
                                  ,'S-11AppF1.f95   ' &   !11
                                  ,'S-12AppF2.f95   ' &   !12
                                  ,'S-13AppF3.f95   ' &   !13
                                  ,'S-14AppF4.f95   ' &   !14
                                  ,'S-15AppF5.f95   ' &   !15
                                  ,'S-16AppF6.f95   ' &   !16
                                  ,'S-17AppF7.f95   ' &   !17
                                  ,'S-19AppF8.f95   ' &   !18
                                  ,'-unlisted.f95   '  /)
!                                      ^= #jGroups+1
  integer(4)::jNoWrite != 1 :can`t write files,e.g.running from a CD 2022.04.18
!                      = 0 :can   write files

!Contains
End Module TaskDef
!-------------------------------------------------------------------------------7 9
Module ioDef
!use ioDef              !Files,Units,TimeStamp,Selfies,Flags     JMS 2023.09.02
 !--Filenames,nml&refresh:
  character::ExeFileOut*35 !='RubikVis-out.txt'  !.exe- output file  (If any)
  character::ExeFileIn*35  !='RubikVis-init.txt' !    - input  file
  character::EnvNml*79    !="Sn.nml"            !Environ- .nml file
  character::EnvIni*79    !="Sn.ini"            !       - .ini file
 !Each app can have its own .nml & .ini files. The namelist datae
 !  are all imported at the beginning of execution after reading Sn.nml
 !  & before transitioning to OpenGL control.
  character::UserNml(8)*79 =char(0) !"RubikVis.nml"!    - .nml
  character::UserIni(8)*79 =char(0) !"RubikVis.ini"!User- .ini file
  integer(4)::Uupdate   !U-key flag to re-read updated .nml files.
 !--Unit#'s & timestamp
  integer(4)::Ur =11    !Unit#- to read various input files.
  integer(4)::Us = 6    !     - write to- screen    - on
  integer(4)::Ut!=13    !     = 13 all writes to ASCII file ExeFileOut, however
                        !  ...= Us        - when ExeFileOut open fails
  integer(4)::Uread=12  !     - 12- for user use in apps
  integer(4)::Uwrite=14 !    = 14- (set =13 when not in use.)
  integer(4)::Uselfie=10     !For exporting selfies to .bmp files
  character::DaTimeLabel*18  !Runtime clock

  character ::DaTimeLabel22*22  !Runtime clock

 !Timer(s):
  integer(4)::JulianDay
  real(8)   ::DaySecond

 type ::  TimeRec;sequence                                              !2023.07.16
  integer(4)   ::nClock  !Clock# (0:30)
```

```
125   integer(4)    ::nClock  !Clock# (0:30)
126   integer(4)    ::V(8)  !Output of: date_and_Time(values=V)
127                  !V( ) = 1:iYear, 2:iMonth, 3:iDay, 4:Utc time offset(if any)
128                  !      ,5:iHour, 6:iMin  , 7:iSec, 8:imSec
129                  !
130   character(22)::cDaT22   !Character string:                24->22   2023.08.22
131   integer(4)    ::JDay     !Julian Day
132   real(8)       ::Sec      !Day second... millisecond resolution
133  end type TimeRec
134  type(TimeRec)::DaT       !Current Date & Time- computed by: Jdate20(DaTime)
135  type(TimeRec)::DaTo(0:30)!30 separate clocks -   nRunSec(nClock,RunSecs,iW)
136
137  !--variables of Pi16Eval(), the Pi value generator:                 2025.04.30
138   real(16)  ::Pi16   !Pi- returned value
139   integer(4)::ModePi !Compautation mode:
140                      !<=0 :returns Pi16
141                      != 1 :use Wikipedia's series (2025)
142                      != 2 :use Spiegel's series   (1968)
143   integer(8)::IterPi !Number of iterations of the series  [1 -to- 10 trillion]
144
145  !--Export now:
146   integer(4)::Up      !!Unit#=  0 - usually off. usage: if(Up>0) write(Up,...)
147                       !      = Us- for one iteration-  <- press key:"p"
148                       !      = Ut-                  -  <-          :"P"
149   integer(4)::UpVerb=0!      = 0: Up- doesn't expound on internal ops.
150                       !      =+1:   - verbose about DoF's in play
151   integer(4)::NowView=1!Toggles the screen-viewing of details- via'vV'
152   integer(4)::NowPrint!=0 usually; during one iteration...
153                       !=1 by pressing key: 'p' :fp=fpt    ->.txt
154                       !=2                : 'P' :fp=stdout ->screen
155   integer(4)::DepthSelfie !Toggle the "`" key to display a screen depth map.
156  !--File access flags:
157   logical  ::LExists  !File existence flag
158   integer(4)::iAlloc  !Array allocation flag =0:success
159  !--Teapot:
160   integer(4)::iTeapot=4 !Use: Tt: -draws the GLUT Teapot eight ways.
161
162 !Namelist interface to TweakRec - for runtime reconfiguration of the .exe:
163
164 !NAMELIST / SnNml /  ExeFileIn, ExeFileOut          &
165 !                   ,UserIni  , UserNml            &
166 !                   ,ExeBanner, ExeName, ExeVersion  &
167 !                   ,Ut
168 !Contains
169 End Module ioDef
170 !-------------------------------------------------------------------------------7 9
171 Module ScreenDef
172 !use ScreenDef          !screen & colors                          JMS 2021.03.08
173  !--Screen dimensions:
174   integer(4)::xWindowFull,yWindowFull !Screen- Pixels hor. & ver.
175   integer(4)::xWindowMM  ,yWindowMM   !      - mm     hor. & ver.
176  !--Size,ratio,OrthoVecs:
177   real(8)   ::PixelsPerCM=0.d0        !      - Pixels per cm     = 37.50 for T-2
178   real(8)   ::MagFactor     !Screen mag= yWindowFull/(PixelsPerCM*5.08)
179   real(8)   ::xyWindowRatio != xWindowFull / yWindowFull           typically >1.
180   real(8)   ::vScrnHVD(2,3) !...defined in ProjOrtho      built on xyWindowRatio
181  !--Fullscreen,color,ID:
182   integer(4)::iFullScreen
183   integer(4)::iScrnColor
184   integer(4)::WinId
185  !--Palette -Colors3D:   incoming color override (e.g. for Red/Cyan 3D):
186   integer(4)::ForceRGBA   ! >0: use Colors3D(ForceRGBA)
```

```
187                          ! =0: use Colors3D(   nCol  )
188                          ! <0: force ColorRGBA=Env.ColorRGBA[4]
189   real(4)   ::ColorRGBA(4)!Forced color components, each in: [0.,1.]
190                          !e.g. "Red" is {1.,0.,0.,1.}, "Cyan"is {0.,1.,1.,1.}
191                          !  ... sets the (Red,Breen,Blue,Alpha) components
192  !--Screen text placement & raw location:
193   integer(4)::lCharX     ,lCharY      !<- Values set in GlutHandoff
194   integer(4)::nCharOffset=0           !Split screens need a character offset
195   integer(4)::nCharMaxX  ,nCharMaxY
196   integer(4)::nCharCenX  ,nCharCenY   !For aligning text on arbitrary screens
197   real(8)   ::cWidth     ,cHeight
198   real(8)   ::xPrint, yPrint, zPrint
199
200  !--ScreenSide:
201   integer(4)::SideInit           !=0:uninitialized; =1:initialized.
202   integer(4)::Side               !-1:Left, 0:full screen, +1:Right
203   integer(4)::nCharOffsetS(-1:1)
204   integer(4)::nCharMaxXS(-1:1)
205   integer(4)::nCharCenXS(-1:1)
206
207  !--^K:Keys redirector:
208   integer(4)::ctlKbd=0 !Ctl-K(#11) =0:normal        Toggled in cbKeyboard
209                        !           =1:keyboard reader, except ctl-Q quits
210  !--SubWindow
211   integer(4)::SubWinId
212   integer(4)::WId
213
214 !Contains
215 End Module ScreenDef
216 !-------------------------------------------------------------------------------7 9
217 Module KeyboardDef
218 !use KeyboardDef        !Keyboard                                    JMS 2020.06.30
219  !--Keyboard primitives:
220   character::KbdKeyChar*1  !was: unsigned char KbdKey !<- K's are upper case
221   integer(4)::KbdKeyIn      !not zeroed out  if  used- & displayed
222   integer(4)::KbdKey        !    zeroed out once used-
223   integer(4)::ArrowKeyIn    !not zeroed out  if  used
224   integer(4)::ArrowKey      !    zeroed out once used-
225   integer(4)::nKpress=0     !number of Keypresses
226   integer(4)::KeyHist(3,3)  !Key press(1:key#,type[1:kbd,2:Arrow],3:modifier|
227   integer(4)::NumLockOn=1   !An attempt to detect NumLock-off
228   real(8)   ::DtoR !Degrees-to-Radians conversion constant.
229   integer(4)::iKeyMods
230 !Contains
231 End Module KeyboardDef
232 !-------------------------------------------------------------------------------7 9
233 Module MouseDef
234 !use MouseDef           !Mouse                                       JMS 2020.06.30
235  use OpenGLRec,only:glcint  !The OpenGL GL,GLU,GLUT interface
236 !use MouseDef   ,only: &  !Mouse
237 !     MouseScreenh,iMouse7DoF                              &
238 !    ,Mouse2DRec,mbID,PresPrevRec,PpX,PpY,ManChanRec       &
239 !    ,MouseInit,iMouseButton,MouseDirect,MouseDirectPrev   &
240 !    ,nMpress,mdHist,MXY,MXYdel                            &
241 !    ,mdTot,Mouse,MouseU,Mouse0,MChan,MChanX,MChanY,MChan0
242 !-------------------------------------
243  !--Mouse control of 7DoF:
244   integer(4):: iMouse7DoF=0  !Toggle: =0:control- PoI    'm' key
245                              !        =1:       - FS7
246  !--Mouse 3D screen coordinates:
247   real(4)   ::MouseScreenh(4)
248
249 !--Raw mouse 2D positional output:
```

```
249 !--Raw mouse 2D positional output:
250  type ::  Mouse2DRec
251   integer(kind=glcint):: iX ,iY                                    ![0:ScreenPix]
252   integer(4)           ::md        !Record's MouseDirect index
253   integer(4)           ::mcx ,mcy  !X:MChan(#) & Y:MChan(#)
254   character*6         ::ID        !Button's identifier
255  end type Mouse2DRec
256  !--Mouse Button ID's:
257   character*6::mbID(12)=(/ "LMB-up","LMB-dn" & !iMouse7DoF=1: mouse 7DoF
258                           ,"MMB-up","MMB-dn" &
259                           ,"RMB-up","RMB-dn" &
260                           ,"L-up  ","L-down" & !iMouse7DoF=0: user discretion
261                           ,"M-up  ","M-down" &
262                           ,"R-up  ","R-down"  /)
263 !--Track Present & Previous 1D channel activity:
264  type ::  PresPrevRec
265   integer(4)::iPix   !current 1D screen pixel value
266   integer(4)::nChar  !Screen character y:column# or x:row# of .iPix
267   integer(4)::iUsed  !usage status
268                      !=-2 key/button remains N/A
269                      !=-1 key/button just N/A
270                      !=+1 key/button just applicable
271                      !=+2 key/button remains applicable
272                      !=+3 iPix value has changed
273   integer(4)::Iter   !counter- iteration
274   real(8)   ::RunSecs!       - seconds- millisecond resolution.
275  end type PresPrevRec
276  type(PresPrevRec)::PpX(2),PpY(2)
277
278 !--Mouse 1D Channel rescale & direct:
279 !--1D Manual Channel Record:
280  type ::  ManChanRec
281   integer(4)::mc          !Record's MChan index
282   integer(4)::iDeltaPix   !Delta iPix in the most recent activation.
283   real(8)   ::r01    !                                              [ 0.:   1.    ]
284   real(8)   ::rm11   !                                              [-1.:   1.    ]
285   integer(4)::i7DoF       !Target 7DoF variable XyzRpyS(i7Dof), or =0 for none.
286   integer(4)::ie          !=1: interior
287                          !=2: exterior
288   real(8)   ::V           !Numerical value
289   integer(4)::Locked      !0:unLocked, 1:Locked (w.r.t. Mouse changes?)
290   integer(4)::iX1Y2       !Applicable axis: =1:X|column, =2:Y|row
291   integer(4)::iPixMax     !Range of Pp().iPix value  [1:iPixMax]
292   integer(4)::mdParent    !part of ____, e.g. a mouse button pair.
293  type(PresPrevRec)::Pp(2)
294   real(8)   ::Sensitivity !DoF value change for iDeltaPix = +1
295   character::ID*8        !channel use identifier.
296  end type ManChanRec
297
298  !--Mouse button states:
299   integer(4)::MouseInit =0    !=1: when Mouse callbacks have been initialized.
300   integer(4)::iMouseButton    !0:Left  1:Middle  2:Right
301                                    !( =1 x - unavailable on my computer. )
302   integer(4)::iMouseState     !0:down    1:up
303
304  !--The button and state yield 6 possibilities:
305   integer(4)::MouseDirect     !=2*iMouseButton-iMouseState+2 [1, 2,x,x, 5,  6]
306                              !  odds "up", evens "down"      Left      Right
307   integer(4)::MouseDirectPrev !Previous iteration's value of MouseDirect
308   integer(4)::nMpress=0       !number of mouse button changes
309   integer(4)::mdHist(3)       !MouseDirect value History
310                              !1:most recent ->2:prev->3:prev
```

```
311   integer(4)::MXY( 4,3)       !Mouse (X|Y|md|IterTotal,history 1:3)
312   integer(4)::MXYdel(4)       !Mouse (X|Y|md|IterTotal)
313
314   integer(4)       ::mdTot=12 !Total number of mouse button states.
315   type(mouse2DRec)::Mouse(12)!2D positions on the screen.
316   type(Mouse2DRec)::MouseU    !=Mouse(MouseDirect)- read only
317   type(Mouse2DRec)::Mouse0    !Mouse()- undefined.
318
319  !--Channel information processing:
320  type(ManChanRec)::MChan(24) !(LuX,LuY,LdX,LdY,x,x,x,x,RuX,RuY,RdX,RdY
321                              !                 ,TBDuX,TBDuY,TBDdX,TBDdY)
322  type(ManChanRec)::MChanX    !MouseU's Mchan- X- read only
323  type(ManChanRec)::MChanY    !               - Y-
324  type(ManChanRec)::MChan0    !MChan() undefined
325
326 !Contains
327 End Module MouseDef
328 !-------------------------------------------------------------------------------7 9
329
330 Module ViewDef
331 !use ViewDef       !View bounds->[0.,+1.]->[extent]Destination   JMS 2020.06.30
332 !use ViewDef,only: ThreePhase,Key,V,jVG,VisGeom
333  implicit none
334
335 !--View seq. each call:  *** Apps manage themselves in three phases: ***
336   integer(4)::ThreePhase      !=1 Initialization & background number crunching.
337                               !=2 Update variables & display 2D information
338                               !=3 Redraw the 3D graphics part of the app.
339   integer(4)::ThreePhaseEnder !>0 terminates the present callback from OpenGL
340 !--
341 !-- Runtime initial values:
342   real(8)   ::UnitCube0(0:8) & !Z0,D ,E ,N ,F ,L ,R ,T ,B  !Unit Cube
343              =(/ 1.0d0,24.0d0,1.2d0,-10.0d0,10.0d0,-10.4d0,10.4d0,-6.5d0,6.5d0/)
344   real(8)   ::Dv0(1:6)          !         N2,F2,L2,R2,T2,B2 !Destination rescale
345
346  !--Frustum parameters in GlutHandoff:
347   real(8)   ::FrustNom( 0:8) & != Z,D,E,N,F,L,R,T,B  <-Nominal values
348              =(/ 1.0d0,24.0d0,1.2d0,-10.0d0,10.0d0,-10.4d0,10.4d0,-6.5d0,6.5d0/)
349 !            =(/-1.0d0,24.0d0,1.2d0,-10.0d0,10.0d0,-12.4d0, 8.4d0,-8.5d0,4.5d0/)
350 !               ^ "zoom" <0. disables L,R,T,B autofit by OpenGL         20200419
351 !                 Note: Only Frustnom has a (0) coefficient for Z.
352
353 !\\\\\\\\
354  type ::  VisGeomKeyRec !Vision Geometry Keys & Flags: "Key._"
355 !--Viewing gear target:
356   integer(4):: &
357         SplitScreen!=-1: Right|Left split- screen    + crossed-eyes
358                    != 0: Full-screen view- screen    + red|cyan glasses
359                    !=+1: Left|Right split- cellphone + head-mounted viewer
360 !--Viewing Mode:
361   integer(4)::VuMode!=-1: OpenGL ~raw screen coordinates
362                     != 0: Orthographic
363                     !=+1: Perspective
364                     !=+2: Stereo 3D
365 !--Eye's view being drawn:
366   integer(4)::iEye  !=-1: Left
367                     != 0: Monocular
368                     !=+1: Right
369 !--Unit cube bounds:
370   integer(4)::Cube  != 0: Default screen volume
371                     !=+1: User pre-defined UnitCube0(0:8)
372                     !=+2: Pixel-driven volume
373                     !=+3: Other user defined volume (TBD)
```

```
373                     !=+3: Other user defined volume (TBD)
374 !--Unit cube's input scale:
375   integer(4)::Scaler!= 0: L,R,T,& B are redefined by screen's- centimeters
376                     !                                 & Key.cScaler="cm."
377                     !=+1: L,R,T,& B are redefined by screen's- inches
378                     !                                 & Key.cScaler="in."
379                     !=+2: Users D,E,N,F,L,R,T, & B passthrough
380                     !                              &eg Key.cScaler="Furlongs" a12 max
381                     !     Setting E=D/20. provides comfortable 3D viewing.
382   character:: &
383           cScalar*12 ="Not defined."
384
385 !--Destination (screen|pixels|printout|etc.) bounds:
386   integer(4)::Dest  != 0: Default screen output
387                     !=+1: User pre-defined RvO(1:6)
388                     !=+2: Default Pixel output
389                     !=+3: User defined output (TBD)
390 !--Transforms no-morph:
391   integer(4)::SFSOut!= 0: FS(+X,+Y,+Z,W) -> OpenGL(+Z,+X,-Y,W),
392                     !       a left-handed coordinate system which uses
393                     !       destination values:(/ -1.,+1.,-1.,+1.,-1.,+1./)
394                     !=+1: Retain "Standard Flight Simulation Coordinates".
395 !--Full-screen 3D color control:
396   integer(4):: &
397           SplitColor!= 0: Passthrough- full color (here: 8bit RGB)
398                     !=+1: Left:Red , Right:Cyan (3D background- black)
399                     !=+2:     :Cyan,      :Red  (              - white)
400                     !   & negate for grayscale-before-color-splitting.
401  end type VisGeomKeyRec
402   type(VisGeomKeyRec)::Key,KeyReset
403 !////////
404
405   integer(4)::jVG !Vision geometry 2nd index for: Uv(,_),Rv(,_),Fh(,_) & Fo(,,_)
406                   != -2: Divide L,R,T,B by Z0. Implicitly Z0=1.
407                   !      both the baseline & the clipping planes values.
408                   !  -1: Left Eye's view
409                   !   0. Monocular view
410                   !  +1: Right eye's view
411
412 !\\\\\\\\
413  type ::  VisionGeometryRec !Vision Geometry variables: "V._"
414  !--Internalized keys & Flags
415   type(VisGeomKeyRec)::Key
416
417  !-----The unit cube normalizes the volume that you want to visualize:
418   real(8)   :: Mult0 !Initial multiplier of unit cube values; ==1. is a no-op.
419
420  !--Unit Cube's 8DoF values:                                    & Note#1 below
421   real(8)   :: D! 1 X: Depth >0.    + is forward
422   real(8)   :: E! 2 Eye +Y (right) offset  (3D:>0., 2D:=0.) >= 0. initially
423   real(8)   :: N! 3    Near  <0.,>-D   limited by [E,(R-L)] >=-D
424   real(8)   :: F! 4    Far   >0.       limited by [E,(R-L)] >  N
425   real(8)   :: L! 5 Y: Left         + is  right    =Lnom/Z0
426   real(8)   :: R! 6    Right >Left                 =Rnom/Z0
427   real(8)   :: T! 7 Z: Top          + is   down    =Tnom/Z0
428   real(8)   :: B! 8    Bottom >Top                 =Bnom/Z0
429  !--Intermediate values: homogeneous/orthographic  ~Algebra 1+   & Note#1 below
430  !                       homogeneous/projective/3D - genuinely clever
431   real(8)   ::Mx! 9 f(N,F)-slope       +X:into
432   real(8)   ::Bx!10       -intercept  ~  Mx*X+Bx -> X - [0.,1.] in view
433   real(8)   ::My!11 f(L,R)-slope       +Y:right
434   real(8)   ::By!12       -intercept  ~  My*Y+By -> Y -
```

```
435   real(8)   ::Mz!13 f(T,B)-slope       +Z:down
436   real(8)   ::Bz!14       -intercept  ~  Mz*Z+Bz -> Z -
437  !--Corresponding Cube vector:
438   real(8)   ::Cv(14,-2:1) !=(/D,E,N,F,L,R,T,B,Mx,Bx,My,By,Mz,Bz/)
439                           !   1 2 3 4 5 6 7 8  9 10 11 12 13 14
440                           !  | ~user defined |----computed-----|
441 !--Unit Cube names (for printouts):
442   character::UcId(-2:1)*40
443
444 !--Clipping planes, in Flight Simulation coordinates:
445   real(8)   ::Clip(4,8)   !Defined using Uv(1:8,-2)
446
447  !--Destination- display 6DoF rescale values:
448   real(8)   ::N2! 1 depth/into- Near                                  & Note#1 below
449   real(8)   ::F2! 2           - Far
450   real(8)   ::L2! 3 lateral   - Left
451   real(8)   ::R2! 4           - Right
452   real(8)   ::T2! 5 vertical  - Top
453   real(8)   ::B2! 6           - Bottom
454  !--Intermediate values:       [0.,1.]-> y=m*x+b -> [ whatever]  & Note#1 below
455   real(8)   ::Mi! 7 f(N2,F2)-slope       depth/into
456   real(8)   ::Bi! 8          -intercept -> Mi*X+Bi -> [iwhatever]
457   real(8)   ::Mh! 9 f(L2,R2)-slope       lateral
458   real(8)   ::Bh!10          -intercept -> Mh*Y+Bh -> [hwhatever]
459   real(8)   ::Mv!11 f(T2,B2)-slope       vertical
460   real(8)   ::Bv!12          -intercept -> Mv*Z+Bv -> [vwhatever]
461  !--Corresponding Destination vector:
462   real(8)   ::Dv(12,-2:1) !=(/N2,F2,L2,R2,T2,B2,Mi,Bi,Mh,Bh,Mv,Bv/)
463                           !   1  2  3  4  5  6  7  8  9  10 11 12
464                           !  |  ~user defined  |----computed-----|
465
466 !--Homogeneous frustums:
467   real(8)   :: Fh(4,4,-1:1)!'The Frustum matrices in FS coordinates.'.
468              ! Fh(_,_, -1 ) view- left  eye- with or /wo splitting.
469              ! Fh(_,_, +1 )     - right eye-
470              ! Fh(_,_,  0 ) no screen splitting,& no eye offset (E=0.)
471   integer(4)::iFh(    -1:1)!Flags Fh(_,_,*) use =+1:computed.
472                           !                     = 0:undefined.
473   real(8)   :: Fo(4,4,-1:1)!'The output frustums in the requested coordinates.
474                           !  E.g.: the OpenGL version.
475
476  !--Metrology variables:
477   integer(4)::iSystemMFP    !=1:Meters; =2:Feet; +3:Pixels E.g.: = 1
478   real(8)   ::MfpScaleFactor!Scale factor of iSystemMFP       &  = 1.d-2
479   character::MFPUnitName    !                                   then  = 'Centimeters'
480   integer(4)::iPixelsPerUnit!in the same unit as L,R,T,B & D
481   real(8)   ::UlcPixelXyz(3)!exact 3D coordinates of the center of the UL pixel
482  end type VisionGeometryRec
483   type(VisionGeometryRec)::V,Vreset
484 ! Note#1: The individual values in the record are not accessed or used (by me);
485 !           the V. record provides a convenient central place to define them.
486 !         The variable names are locally defined & the vector(_,jVG) values
487 !           are unpacked within the subroutine(s) that operate on those values.
488 !////////
489
490 !--- Other variables:
491 ! real(8)  ::Cu( 14),Du( 12),Fu( 4,4),Fou( 4,4) !Compacts source code
492
493   character::cVuModeName(0:2)*17=(/ 'e=0: Orthographic'  &        !Centered *17
494                                    ,'e=1:  Perspective'   &
495                                    ,'e=2:    Stereo 3D'      /)
496
497   character::cEyeName(-1:1)  *21=(/ '  Left  Eye's  View  '&             !C *21
```

```
497    character::cEyeName(-1:1)*21=(/    'Left  Eye`s  View   &              !C *21
498                                  ,'Left:Red | Right:Cyan'&
499                                  ,'  Right Eye`s  View  ' /)
500
501    character::cSplitName(-1:1)*32=(/ 'E=-1: Right|Left-> Crossed-Eye  '&  !C *32
502                                     ,'        E= 0: Full-Screen       '&
503                                     ,'E=+1: Left|Right-> CellPhone HMD' /)
504
505    character::cFrustumUnits*12 ='     Inches'   !11 char. right justified
506                                !='Centimeters'
507                                !='   Whatever'
508    character::ClipLabel(1:16)*7 =  &
509                    (/ '1Near  ','2Far   ','3Left  ','4Right ' &
510                      ,'5Upper ','6Lower ','7undef ','8undef ' &
511                      ,'1Near  ','2Far   ','3LfarL ','4RnearL' &
512                      ,'5RfarR ','6LnearR','7Upper ','8Lower '  /)
513    character::ClipSymbolicLabel(16)*64 = (/ &
514   !Orthographic
515    '-1.                  0.                  0.                  -N  '& !1 Near
516  ,'+1.                   0.                  0.                  +F  '& !2 Far
517  ,' 0.                  -1.                  0.                  -L  '& !3 Left
518  ,' 0.                  +1.                  0.                  +R  '& !4 Right
519  ,' 0.                   0.                 +1.                  -T  '& !5 Upper
520  ,' 0.                   0.                 -1.                  +B  '& !6 Lower
521  ,' 0.                   0.                  0.                   0. '& !7 undef
522  ,' 0.                   0.                  0.                   0. '& !8 undef
523   !Projective
524  ,'-1.                   0.                  0.                  -N  '& !1 Near
525  ,'+1.                   0.                  0.                  +F  '& !2 Far
526  ,'-L-E                 +D                   0.                  -D*L'& !3 LfarL
527  ,'-L+E                 +D                   0.                  -D*L'& !4 RnearL
528  ,'+R-E                 -D                   0.                  +D*R'& !5 RfarR
529  ,'+R+E                 -D                   0.                  +D*R'& !6 LnearR
530  ,'-T                    0.                 +D                   -D*T'& !7 Upper
531  ,'+B                    0.                 -D                   +D*B'/)!8 Lower
532  !contains
533  End Module ViewDef
534  !-------------------------------------------------------------------------7 9
535
536  Module ModelDef
537  !use ModelDef      !--On screen control of PoI DoF's:           JMS 2020.06.30
538  !-------------------------------------
539  !--Motion 7DoF control record:
540   type ::  Motion7Rec ;Sequence
541    real(8)    ::DoF(7)         !(/ X,Y,Z,Roll,Pitch,Yaw,Mag /)
542    real(8)    ::H(4,4)         !Homogeneous motion transform of Dof(1:7)
543    real(8)    ::DoFreset(7)    !Nominal Value of each DoF
544    real(8)    ::Sens(7)        !Screen sensitivity of each DoF
545  !                             =(/.05d0,.05d0,.05d0,1.0d0,1.0d0,1.0d0,.01d0/)
546    integer(4)::n               !Record index- M7(n)
547    character::ID*20           !Name
548    !--Control of the above: e.g. via keyboard & Mouse:
549    integer(4)::iType           !=0:control as- Point-of-Interest
550                               !=1:           - Flight Simulation object
551    integer(4)::Locked(0:7)     !=0: DoF()- can be changed
552                               !=1:      - value is locked
553    integer(4)::ie              !=1: Control- interior
554                               !=2:        - exterior
555    integer(4)::ioe(0:2)        !(0)- =1: Primary control- vertical- X,Z,Pitch,Mag
556                               !     =2:                 - lateral - Y,Roll,Yaw
557                               !(1)    :Controlled DoF- vertical
558                               !(2)    :              - lateral
```

```
559   integer(4)::DoFsInUse(0:7)!=0 not under control
560                              !=1 primary   #1 -onscreen
561                              !=2 secondary #2 -
562   integer(4)::M7Init          !=0: Initialized: no
563                              !=1:            : yes
564  end type Motion7Rec
565   type(Motion7Rec)::M7(0:10),M7u,M7zero
566 !         Nominally M7(0) is the Point-of-Interest controller,
567 !           & the rest are per user discretion.
568   common /Motion7Com/ M7com
569
570   real(8)    ::DoFL(7)         !(/ X,Y,Z,Roll,Pitch,Yaw,Mag /)
571   real(8)    ::H(4,4)         !Homogeneous motion transform of Dof(1:7)
572   real(8)    ::DoFreset(7)    !Nominal Value of each DoF
573   real(8)    ::Sens(7)        !Screen sensitivity of each DoF
574   integer(4)::nM7L            !Record index- M7(n)
575   character::ID*20           !Name
576   integer(4)::iType           !=0:control as- Point-of-Interest
577                              !=1:          - Flight Simulation object
578   integer(4)::Locked(0:7)     !=0: DoF()- can be changed
579                              !=1:       - value is locked
580   integer(4)::iec             !=1: Control- interior
581                              !=2:         - exterior
582   integer(4)::ioe(0:2)        !(0)- =1: Primary control- vertical- X,Z,Pitch,Mag
583                              !     =2:                 - lateral - Y,Roll,Yaw
584                              !(1)    :Controlled DoF- vertical
585                              !(2)    :              - lateral
586   integer(4)::DoFsInUse(0:7)!=0 not under control
587                              !=1 primary   #1 -onscreen
588                              !=2 secondary #2 -
589   integer(4)::M7Init          !=0: Initialized: no
590                              !=1:            : yes
591 !use ModelDef, only: &
592 !       DoFL,H,DoFreset,Sens,nM7L,ID,iType,Locked,ie,ioe,DoFsInUse,Init
593
594   real(8)    ::X,Y,Z,Roll,Pitch,Yaw,Mag
595   real(8)    ::hPoIRotate(4,4)!            - rotation only transform
596   integer(4)::Flags(5,2)=0  !(1m|2a|3m|4a|5k , 1:I|2:e) 7DoF control array
597
598  !--Flight Sim 7DoF body control:
599 ! "Seven DoF Point-of-View Control:" &  !  1 Gray
600   character*32::c7DoFID(15) = (/ &
601   "Seven DoF Control:              " &  !  1 Gray
602  ,"                  . Lock    > ^  " &  !  2 DkGray
603  ,"                    1 X      #  |" &  !  3 Gray
604  ,"                    2 Y    #    -" &  !  4 Gray
605  ,"                    3 Z      #  |" &  !  5 Gray
606  ,"                    4 Roll #    -" &  !  6 Gray
607  ,"                    5 Pitch  #  |" &  !  7 Gray
608  ,"                    6 Yaw  #    -" &  !  8 Gray
609  ,"                    7 Mag    #  |" &  !  9 Gray
610 !  ^1             18^ ^20   28^ ^30
611  ,"   Arrowkeys & LMB+motion: ^ ^  " &  ! 10 DkGray
612  ,"enable NumLock INTERIOR control " &  ! 11 White
613  ,"       7:Mag  8:reset 9:INT|EXT " &  ! 12 DkGray
614  ,"       4:Roll 5:Pitch 6:Yaw     " &  ! 13 DkGray
615  ,"   ^   1:X    2:Y     3:Z       " &  ! 14 DkGray
616  ," < v > 0:zero#1       .:Lock#1   "  /)! 15 DkGray
617   integer(4)::iColors(15) & !color (state+3)
618                         =(/ 1, 3, 2, 2, 2, 2, 2, 2, 2, 3,1, 3, 3, 3, 3/)
619 !                        =(/11,12,11,11,11,11,11,11,11,12,1,12,12,12,12/)
620                        !            X  Y  Z  r p y  M   (DoF+3)
```

```
621
622 !--7DoF variable identifiers:
623   character*6::cDoFID(0:7) = (/ "undef0" &
624                                ,"    X1" &
625                                ,"    Y2" &
626                                ,"    Z3" &
627                                ," Roll4" &
628                                ,"Pitch5" &
629                                ,"  Yaw6" &
630                                ,"  Mag7"  /)
631
632 !--Model nutation... enables monocular depth perception:
633   integer(4)::Nnutate      !=0:off, =1:on
634   real(8)   ::NutateAng    !Angle
635   real(8)   ::Nutate7(7)   !(X,Y,Z,Roll,Pitch,Yaw,Mag)
636   real(8)   ::Nutateh(4,4) !H matrix
637
638  !--VuDef has same name variables:
639   integer(4)::nRowOffset = 33   !Screen text offset - vertical      ...Seeh44d()
640   integer(4)::nRowIn
641   integer(4)::nColOffset =  1   !                    - lateral
642   integer(4)::nColIn
643 !Contains
644 End Module ModelDef
645 !-------------------------------------------------------------------------------7 9
646 Module SimDef
647 !use SimDef            !Simulation control,F9-F12
648  !--F9-F12 control,timers:
649   integer(4)::SimMode   !=-1:ReStartup  'Delete' key          Sets Init=0
650   integer(4)::SimModeNew!= 0:Startup nAppInUseChanged>0
651                         != 1:Reset    F 9 <-Function keys  RunTimer=        0.00
652                         != 2:Hold     F10
653                         != 3:Run      F11                  RunTimer=RunTimer+.01
654                         != 4:Stop     F12
655                         != 5:Quit     'Q'or'q'... pressed twice
656   real(8)   ::dT=.01d0  !Simulation time increment
657   real(8)   ::RunTimer  !A clock that increments during "Run" +dT for each iter.
658   real(8)   ::UserTimer !
659   integer(4)::Fnew      != Function keypress
660  !--Iteration counters:
661   integer(4)::IterTotal !Iteration counter- total since launching 3DEnv.exe
662                         !                    e.g.: used to close opening messages.
663   integer(4)::IterRun;  !                 - total in the current 'Run' (F11->Run)
664  !--Millisec counter:
665   real(8)   ::RunSecs   !Elapsed seconds since program launch, msec resolution.
666                         !
667 !Contains
668 End Module SimDef
669 !-------------------------------------------------------------------------------7 9
670 Module HelpDef
671 !use HelpDef            !Help (a text block)                    JMS 2024.03.18
672  integer(4)::HhHelpView      !Use: Hh: -displays the Help
673  integer(4):: nHelpLines=46
674  character:: BufferHhHelpView(46)*73=(/                                        &
675  '      The `H`/`h` (=Help) key toggles this screen information.             ' &
676  ,'                                                                          ' &
677  ,'These algorithms support split screen left|right & right|left, and also  ' &
678  ,'  a full screen display mode, with orthographic, perspective, & stereo   ' &
679  ,'  viewing options in each display mode. [The gem of code underlying this ' &
680  ,'  functionality is subroutine ViewGeom in file S6View8.f95.] Apps are    ' &
681  ,'  called from within this live double-buffered environment.              ' &
682  ,'                                                                          ' &
```

```
683 ,'Pressing `P` hardcopies the homogeneous projection(s) to Sn3D-Out.txt,   ' &
684 ,'  while  `p` prints them on the DOS screen, which can be viewed          ' &
685 ,'  by toggling the `Escape` key. Writes to unit#`Up` are reported during  ' &
686 ,'  that iteration, simplifying at-will focused quantitative snapshots of  ' &
687 ,'  your algorithms in action.                                             ' &
688 ,'                                                                         ' &
689 ,'Nutation is toggled by `Nn`, yielding monocularly-perceivable depth.     ' &
690 ,'                                                                         ' &
691 ,'In simulations, rigid bodies often have 6 Degree-of-Freedom ("=6DoF")    ' &
692 ,'  motion (X,Y,Z,Roll,Pitch, & Yaw); herein Standard Flight Simulation    ' &
693 ,'  Coordinates are used (+X:forward, +Y:right, +Z:down, etc.). In viewing ' &
694 ,'  your particular point-of-interest ("PoI"), magnification is added      ' &
695 ,'  as the 7th DoF. Exterior control of PoI is also implemented (`9`).     ' &
696 ,'                                                                         ' &
697 ,'The numeric keypad and mouse (LMB-down) provide interactive control of  ' &
698 ,'  the 6DoF and 7Dof states. E.g.: Left-click a DoF name to select it.    ' &
699 ,'Keyboard keys:           Apps Access:            Simulation Ctls:        ' &
700 ,'  Cc:Screen Color          F1:Application Stub    F 9:Reset               ' &
701 ,'  E : display mode          F2:Dodecahedron Vis.   F10:Hold                ' &
702 ,'    =0:  full    screen     F3:                    F11:Run                ' &
703 ,'    =1:Left|right split     F4:                    F12:Stop               ' &
704 ,'    =2:right|left split     F5:                    ...runs RunTimer       ' &
705 ,'   e: projection            F6:                     & sets SimMode        ' &
706 ,'    =0:orthographic         F7:                    for your convenience.  ' &
707 ,'    =1:perspective          F8:PixelDraw                                  ' &
708 ,'    -2:stereovision               Turn NumLock on!                        ' &
709 ,'  Hh:help screen          Numeric keypad 6DoF & 7DoF control:            ' &
710 ,'  M :8 free Mchan[0.,1.]`s  1:X                 Left Mouse Button=LMB    ' &
711 ,'   m:7Dof/6Dof toggle       2:Y                 and arrow keys           ' &
712 ,'  Nn:2 model Nutation modes 3:Z                 can also be used.        ' &
713 ,'  P :Print to-.txt file     4:Roll                                        ' &
714 ,'   p:        -DOS screen    5:Pitch             See onscreen summary.    ' &
715 ,'  Qq:Quit                  6:Yaw                                         ' &
716 ,'  Tt:7 Teapot views        7:Mag                The teapot is an         ' &
717 ,'  Vv:2 Viewing info modes   8:Reset 1:7         example 7DoF object.     ' &
718 ,'                           9:Interior/Exterior PoI control              ' &
719 ,'                           0:Resets most recently selected DoF #1       ' &
720 ,'Sn3D.exe  V1.0  2025.05.24                              In S1ModDef @L665+' /)
721 !Contains
722 End Module HelpDef
723 !-------------------------------------------------------------------------------7 9
724 Module AppsDef
725 !use AppsDef           !User Apps F1-F8                          JMS 2020.06.19
726 !*** Application Selection:
727   integer(4)::AppNumber      !# of app. you are viewing.
728   integer(4)::AppNumberNew   !Use: F_ =[1,...,8] ... the Function keys
729   character::AppName*80
730   integer(4)::AppInit(8) = 0 !      - initialization flag= 0:no
731                              !                           = 1:done
732   integer(4)::IterApp(  0:8) !Present-use iterations of app (_)
733   character::AppBanner(0:8)*58= char(0) !App- banner    (left side,2nd line)
734                               !           defined in each app
735   character::AppInFIle(0:8)*35= char(0) !   - Input data
736
737 !Contains
738 End Module AppsDef
739 !-------------------------------------------------------------------------------7 9
740 Module F3dvDef
741 !use F3dvDef           !File .3dv data                           JMS 2020.06.19
742 !*** .3dv 3D Data Access (App F5 - not included in v:c0,5):------------
743   integer(4)::Init3dv
744   character::File3dv*35   !3dv- filename. Default:"DrawingFS.3dv"
```

```
745   integer(4)::U3dv         !   - file unit number      (was:fp3dv)
746   integer(4)            ::nPoints       !Points  - number
747   real(8)   ,allocatable :: Points(:,:) !        - vectors (3,nPoints)
748   integer(4)            ::nConns        !connects- number
749   integer(4),allocatable::iConns( :,:)  !        - table   (2,nConns)
750
751 !Contains
752 End Module F3dvDef
753 !-------------------------------------------------------------------------------7 9
754 Module BreakPtDef
755 !use BreakPtDef         !BreakPoint and scrolling tracker        JMS 2020.06.29
756 !*** Break point control: "BrkVal=Brk(BrkRefNum,BrkN,BrkM)":-----------
757   integer(4)::BrkOn  !=0:off,=1:on. When on: +- keys move BrkLim
758   integer(4)::BrkLim !Progress- counting- Reference
759   integer(4)::BrkCur !                   - incremental count1<=P<=Pref
760                      !                    return when P=Pref
761   integer(4)::BrkVal
762   integer(4)::BrkLineNum
763   integer(4)::BrkN
764   integer(4)::BrkM
765   integer(4)::BrkDone              !        - completion flag when >0
766   character::BrkLab*80 ![80]       !        - label- incremental
767   character::BrkLabelOut*80 ![80] !                - Output when P=PRef
768
769 !Contains
770 End Module BreakPtDef
771 !-------------------------------------------------------------------------------7 9
772 !This module must list last, otherwise the compiler 'use' sequence is violated.
773 !  I.e.: Don't use modules before they're defined.
774 Module UseAllSnDef                                                 !JMS 2024.05.02
775 !use UseAllSnDef        !Contents                                    JMS 2020.06.19
776 !use OpenGLRec          !The OpenGL GL,GLU,GLUT interface            JMS 2020.06.19
777  use TaskDef            !Project/Context                             JMS 2020.06.19
778  use ioDef              !Files,Units,TimeStamp,Selfies,Flags         JMS 2020.06.19
779  use ScreenDef          !screen & colors                             JMS 2020.06.19
780  use KeyboardDef        !Keyboard                                    JMS 2020.06.19
781  use MouseDef           !Mouse                                       JMS 2020.06.19
782  use ViewDef            !View bounds->[0.,+1.]->[extent]Destination  2020.06.19
783  use ModelDef           !Modelview Matrix Generation                 JMS 2020.06.19
784  use SimDef             !Simulation F9-F12                           JMS 2020.06.19
785  use HelpDef            !Help text block                             JMS 2020.06.19
786  use AppsDef            !User Apps F1-F8                             JMS 2020.06.19
787  use F3dvDef            !File .3dv data                              JMS 2020.06.19
788  use BreakPtDef         !BreakPoint Tracker                          JMS 2020.06.19
789
790  !Contains
791 End Module UseAllSnDef
792 !-------------------------------------------------------------------------------7 9
793
794 !~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
795 !~~~~~~~~~~~~~ Template-begin:                          2020.06.19.1450cdt JMS-
796 !use _Def      ,only: & !Contents                                    2020.06.19
797 !
798 !Module __Def
799 !use _Def              !Contents                                     2020.06.19
800 !    ,~
801 !Contains
802 !End Module __Def
803 !-------------------------------------------------------------------------------7 9
804 !~~~~~~~~~~~~~ Template- end.
805 !~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
806
```

807