Release of the Alpha Test DSK Prototype Toolkit 01-JUL-2010

Dear SPICE Users,

Special SPICE Toolkits augmented with code and documentation for the ``alpha-test''prototype Digital Shape Kernel (DSK) subsystem are now available. The DSK subsystem provides a mechanism for storing and performing geometric computations with topography data. A "tutorial" outlining this extension to the SPICE shape modeling capability is available from the NAIF website at
http://naif.jpl.nasa.gov/naif/tutorials.html
with name 45_shape_model_preview.

As alpha-test software, some of the provided module interfaces will change or will not be supported when the DSK subsystem becomes part of the official SPICE Toolkit. See the document dsk.req (included below) for details.

```
**************************************************************
The DSK file format supported by this software is NOT
compatible with that used by previous versions of the
DSK prototype subsystem.
**************************************************************
```

However the DSK file format supported by this software is now stable and will be supported by NAIF from now on: when the DSK subsystem is included in official SPICE Toolkits, those Toolkits will support this format. Future file format changes will take the form of support for additional data representations (analogous to new SPK or CK data types).

The Alpha DSK Toolkit packages are on the NAIF server

```
naif.jpl.nasa.gov
```

in the path

```
pub/naif/misc/alpha_dsk
```

These Toolkits may be picked up via anonymous ftp.

Fortran and C versions

Fortran and C versions of the software are available for all platforms on which Fortran or C SPICE Toolkits are supported.

The C version of the software contains certain high-level geometry APIs that are not provided in the Fortran version: these APIs have name of the form

```
*pl02.c
```

IDL version

The IDL version of the software is available only for the platforms

```
MacIntel_OSX_AppleC_32bit
MacIntel_OSX_AppleC_64bit
PC_Linux_GCC_32bit
```

This software was written recently and has not undergone the multi-platform regression testing that has been applied to the C and Fortran versions of the Alpha DSK subsystem. However the underlying C-language "dsklib_c" code has been regression-tested on all platforms NAIF supports.

MATLAB version

NAIF tentatively plans to develop a MATLAB version of this prototype, but this work has not yet started.

Documentation

A ``Required Reading'' technical reference document for the current DSK subsystem is included in the ``doc'' path of the Alpha DSK packages and is included at the end of this message.

The two DSK-specific utility programs MKDSK and DSKBRIEF have user's guides; these are included in the packages.

API routines in the Fortran and C packages have normal SPICE headers that include example code.

Primary documentation for the IDL APIs is provided by the example programs in the path

```
alpha_dsk_idl/src/dskcook_idl
```

of these IDL packages. The IDL API routines correspond to routines in the C-language "dsklib_c" library; the headers of the corresponding C routines should be consulted for details. There currently is no IDL-specific header documentation for these APIs.

Data

Example DSK files that may be used for testing are located on the NAIF server under the path

```
pub/naif/misc/alpha_dsk/data
```

All of the files provided there are IEEE little-endian, suitable for use on PC/Windows, PC/Linux and modern (INTEL) Mac platforms.

****
Unlike SPK files, non-native DSK files cannot be read by SPICE
software.
****

See dsk.req for information on moving these files to big-endian platforms
(Sun and old PowerPC Mac platforms).

"Required Reading" Technical Reference for Alpha Test DSK Subsystem --- C Version

Last revised on 2010 JUN 09 by N. J. Bachman

Abstract

The Alpha Test DSK (``Digital Shape Kernel'') subsystem is a prototype
software set that supports storage of and geometric computations using
topography data.

Introduction

The SPICE DSK subsystem enables SPICE-based application software to
easily ingest and perform geometric computations with topography data, or
more generally, data representing surfaces of objects. The DSK subsystem
also supports exchange and archival of such data.

As with the existing SPICE kernel subsystems, the DSK subsystem comprises

- A file format
- Software
- Documentation

This prototype SPICE DSK software set provides a subset of the
capabilities that will be provided by the SPICE Toolkit version of the
software. In particular, the current software set supports representation
of surfaces only by collections of triangular plates; this representation
is called ``type 2.''

Capabilities absent from this prototype, but that will be provided by the
official version of the DSK subsystem include:

- Support for DTMs (Digital Terrain Models)
- Support for multiple-segment DSK files
- Support for geometric computations involving data from

multiple loaded files

-- Support for high-level geometry computations.

-- Support for all DSK features in Fortran, C, IDL, and MATLAB.

-- Full documentation of all DSK capabilities

Supported Languages

This prototype software is available in the C language.

A limited subset of the software is available in Fortran.

Some APIs will be made available in IDL as time permits (contact NAIF for details).

Future compatibility and support

This prototype SPICE DSK software set is an update of that provided to the DAWN and Rosetta missions in the 2006-2009 time frame.

The file format supported by this version of the DSK subsystem is now ``official'': the SPICE system will continue to support this format in a backward-compatible fashion. Future changes to the format will consist only of addition of new data types (``data types'' are mechanisms for representing topography data).

The software portion of this prototype subsystem is NOT official, and some of it will not be included in the SPICE Toolkit. The prospects for continued support of the software are expected to be as follows:

1. DLA subsystem routines: almost certainly will become official with no interface changes

2. DSK ``type 2'' routines: most will become official with no interface changes

3. ``Plate 02'' routines (having names of the form *pl02.c''): these will NOT become part of the SPICE Toolkit

4. Lower-level, supporting routines: may be revised.

5. The DSK creation utility MKDSK will continue to be supported and will later be enhanced to accept a wider variety of input files and create a wider variety of output files.

6. The DSKBRIEF utility will continue to be supported but likely have its display contents revised.

DSK files

DSK file characteristics

DSK format

The DSK file format is designed to efficiently handle large volumes of data. To make this possible, DSK files are in binary format and support direct access.

The drawback of binary format is that DSK contents are not directly readable by (most) humans. DSK contents can be accessed only via subroutine interfaces and utility programs.

Comments in DSK files

DSK files can hold an unlimited amount of documentation in a data structure called the ``comment area.'' This feature is analogous to that comment area capability provided by the SPK, CK, and binary PCK file formats. A DSK file's comment area can be accessed by the SPICE utility COMMNT. It also can be accessed using the SPICE DAS subsystem's comment area routines.

Porting DSK files

DSK files can be moved between computer systems having incompatible binary file formats, but only with the help of SPICE porting tools. The easiest way to convert a DSK file between big- and little- endian binary file formats is to use the SPICE utility program BINGO. This program is not part of the SPICE Toolkit; is is available from the NAIF web site:

http://naif.jpl.nasa.gov/naif

DSK files also can be ported in ``transfer format''; the SPICE utilities TOXFR and TOBIN are used for this. See the Convert User's Guide in the doc path or the Porting Kernels tutorial on the NAIF web site for details.

Design

The DSK format is designed to be extensible: as needed, new mathematical representations for topography data can be accommodated. These types of representations are called ``data types.''

The DSK file format is based on two lower-level formats: the DSK format is a special case of the DLA (``DAS linked array'') format, and the DLA format is a special case of the DAS (``Direct Access, Segregated'') format. Because of this hierarchical relationship, some DSK functionality

is provided by routines belonging to the DLA or DAS subsystems. This can be seen in the code examples provided with this sofware set.

DSK Software

Overview

The DSK software set contains

- -- DSK utility programs
- -- DSK example programs
- -- DSK routines

Documentation of the routines is provided by SPICE-style ``headers'' in the source code.

The utility programs have user's guides; these are located in the ``doc'' path.

Utility programs

MKDSK

The program MKDSK converts a triangular plate model data file to a DSK containing a single type 2 segment. MKDSK can accept as input a variety of files containing triangular plate data. See the MKDSK User's Guide for details.

DSKBRIEF

The program DSKBRIEF displays a segment-by-segment summary of the coverage of a DSK file. See the DSKBRIEF User's Guide for details.

Example programs

The programs listed here illustrate use of the higher-level geometry routines in this software set.

illum_pl02_ex1	Demonstrate computation of ``illumination angles'' (phase, solar incidence, and emission) at specified points on a surface represented by a type 2 DSK segment.

limb_pl02_ex1	Demonstrate computation of limb points on a surface represented by a type 2 DSK segment. Note that this limb computation is suitable only for objects whose shape is well approximated by a triaxial ellipsoid.
llgrid_pl02_ex1	Demonstrate computation of a grid of surface points at specified latitude/longitude coordinates on a surface represented by a type 2 DSK segment.
subpt_pl02_ex1	Demonstrate computation of a sub-observer point on a surface represented by a type 2 DSK segment.
subsol_pl02_ex1	Demonstrate computation of a sub-solar point on a surface represented by a type 2 DSK segment.
term_pl02_ex1	Demonstrate computation of terminator points on a surface represented by a type 2 DSK segment. Note that this limb computation is suitable only for objects whose shape is well approximated by a triaxial ellipsoid.

Subroutines

Top-level geometry routines

dskx02_c	Determine the plate ID and body-fixed coordinates of the intersection of a specified ray with the surface defined by a (Type 2) DSK plate model.
illum_pl02	Compute the illumination angles---phase, solar incidence, and emission---at a specified point on a target body at a particular epoch, optionally corrected for light time and stellar aberration. The target body's surface is represented by a triangular plate model contained in a (Type 2) DSK segment.
limb_pl02	Compute a set of points on the limb of a specified target body, where the target body's surface is represented by a triangular plate model contained in a (Type 2) DSK segment.
llgrid_pl02	Given the planetocentric longitude and latitude

values of a set of surface points on a specified target body, compute the corresponding rectangular coordinates of those points. The target body's surface is represented by a triangular plate model contained in a (Type 2) DSK segment.

subpt_pl02 — Compute the rectangular coordinates of the sub-observer point on a target body at a particular epoch, optionally corrected for light time and stellar aberration. The target body's surface is represented by a triangular plate model contained in a (Type 2) DSK segment. Return the sub-observer point's coordinates expressed in the body-fixed frame associated with the target body. Also, return the observer's altitude above the target body.

subsol_pl02 — Compute the rectangular coordinates of the sub-solar point on a target body at a particular epoch, optionally corrected for light time and stellar aberration. The target body's surface is represented by a triangular plate model contained in a (Type 2) DSK segment. Return the sub-solar point's coordinates expressed in the body-fixed frame associated with the target body. Also, return the observer's distance from the sub-solar point.

term_pl02 — Compute a set of points on the umbral or penumbral terminator of a specified target body, where the target body's surface is represented by a triangular plate model contained in a (Type 2) DSK segment.

Bulk readers

These routines allow an application to rapidly read all of the plate data from a DSK segment.

dskp02_c — Fetch plates from a type 2 DSK segment.

dskv02_c — Fetch vertices from a type 2 DSK segment.

Supporting APIs

dascls_c — Close a DSK file, or more generally any DAS file.

dasopr_c — Open a DSK file, or more generally any DAS file, for read access.

dlabfs_c — Begin a forward search for segments in a DSK file, or more generally, any DLA file.

dlafns_c	Find the next segment in a DSK file, or more generally, any DLA file.
dskb02_c	Look up model parameters and other bookkeeping data from a type 2 DSK segment.
dskd02_c	Look up double precision data from a type 2 DSK segment.
dski02_c	Look up integer data from a type 2 DSK segment.
dskn02_c	Compute the normal vector associated with a specified plate in a type 2 DSK segment.
dskw02_c	Write a type 2 DSK segment. User applications should not call this routine directly (it's permissible but quite difficult to do correctly); instead use MKDSK to create DSK files.
dskz02_c	Fetch vertex and plate counts from a type 2 DSK segment.

Converted Fortran routines

These routines have names lacking the ``_c'' or ``_pl02'' suffixes. They should not be called directly by user applications.

Header files

Declarations required by the DSK APIs are provided in the header files

```
dla_proto.h (new)
dsk_proto.h (new)
f2c_proto.h (new)
pl02.h      (new)
SpiceDLA.h  (new)
SpiceDSK.h  (new)
SpiceZpr.h  (updated CSPICE header)
SpiceZfc.h  (updated CSPICE header)
```

Of these, the files

```
SpiceDLA.h
SpiceDSK.h
```

will become part of CSPICE.

The files providing prototypes will be subsumed in other CSPICE header files, and so will not be provided in the official DSK subsystem.