8 Spatial reference frames

8.1 Introduction

A spatial coordinate system is a means of associating a unique coordinate with a point in object-space. It is defined by binding an abstract CS to a normal embedding (see 8.2). A spatial reference frame is a specification of a spatial coordinate system for a region of object-space (see 8.3). It is formed by the binding of an abstract coordinate system to the normal embedding specified by an ORM for that object. A full specification specifies the CS and the ORM and includes values for CS parameters, if any, and a specification of the region of object-space. Some or all CS parameters may be bound by ORM parameters. In particular, a CS based on an oblate ellipsoid (or sphere) must match the parameters of the oblate ellipsoid (or sphere) RD of the ORM.

A spatial reference frame template is an abstraction of a collection of spatial reference frames that share the same abstract coordinate system, coordinate system parameter binding rules, and similar ORMs that model the same spatial object type (see 8.5). Spatial reference frames may be organized into specified sets so as to form an atlas for a large region of space. This International Standard specifies a collection of spatial reference frame templates, realizations of those templates, and sets of those realizations.

8.2 Spatial coordinate systems

If a normal embedding of position-space into object-space is defined, any abstract CS for a region of that position-space can be used to specify a *spatial CS* that associates coordinates in coordinate-space to points in object-space. This association is a *binding of a CS* via *a normal embedding*. The association is defined as:

$$\boldsymbol{p} = \boldsymbol{E}\left(\boldsymbol{G}\left(\boldsymbol{c}\right)\right)$$

iTeh Standards
(https://standards.iteh.ai)
Document Preview

where:

$\boldsymbol{c}$ is a coordinate in the CS domain,

$\boldsymbol{G}$ is the CS generating function,

$\boldsymbol{E}$ is the normal embedding function, and

$\boldsymbol{p}$ is the point in object-space associated with $\boldsymbol{c}$.

https://standards.iteh.ai/catalog/standards/iso/bddbeeea-ba53-43e2-b92a-05032bec66f1/iso-iec-18026-2009

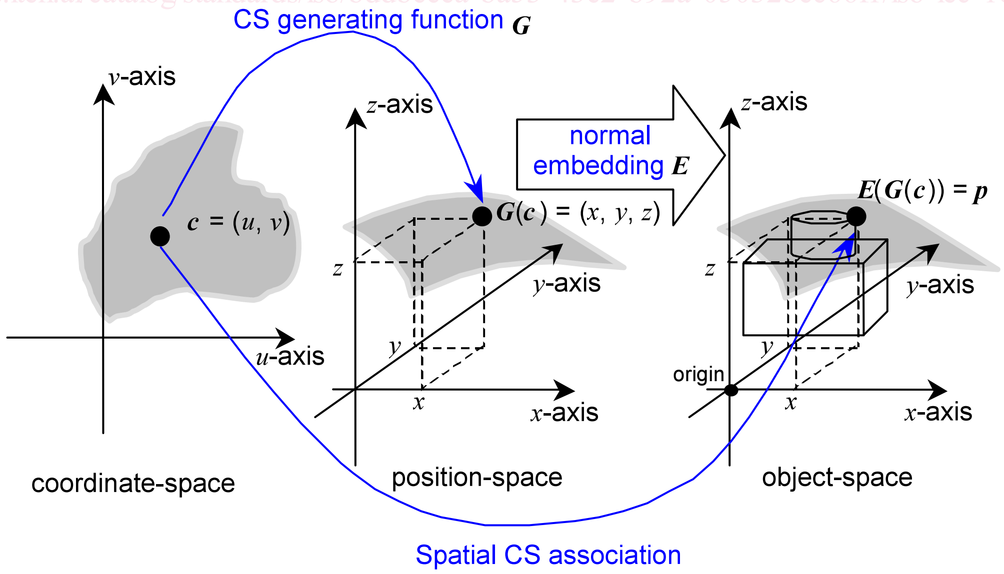


Figure 8.1 — A spatial embedding of a surface CS

© ISO/IEC 2009 – All rights reserved

EXAMPLE Figure 8.1 illustrates a spatial surface CS bound with a normal embedding of 3D position-space to the 3D object-space. In this illustration, a surface coordinate (u, v) in coordinate-space is associated to a position (x, y, z) in the abstract position-space. That position is then identified with a position in the space of an object via the normal embedding of position-space. In this example, the normal embedding is determined by the selection of an origin and three unit points.

8.3 Spatial reference frame

8.3.1 Specification

A *spatial reference frame* (SRF) is a specification of a spatial coordinate system that is constructed from an ORM and a compatible abstract CS, such that coordinates uniquely specify positions with respect to the spatial object of the ORM. A specification of an SRF includes:

a) an ORM,

b) a CS compatible with the ORM,

c) a binding of all parameters of the spatial CS,

d) (optionally) k^{th} coordinate-component names,

e) (optionally) additional restrictions on the domain of valid coordinates in that spatial CS, and

f) (optionally) if the CS is of CS type 3D, a vertical coordinate-component identification (see 8.4).

iTeh Standards

An SRF implicitly specifies a spatial CS defined by the binding of the CS via the normal embedding associated with the ORM.

(https://standards.iteh.ai)

Spatial CS compatibility and the other elements of the specification of an SRF are defined in the following clauses.

Document Preview

8.3.2 SRF specification elements

ISO/IEC 18026:2009
https://standards.iteh.ai/catalog/standards/iso/bddbeeea-ba53-43e2-b92a-05032bec66f1/iso-iec-18026-2009

8.3.2.1 ORM and CS compatibility

The compatible CS type of the CS element of an SRF depends on the dimension of the ORM. The *dimension of an ORM* is defined as the dimension of the RD components of the specification of the ORM. The compatible CS types by ORM dimension are specified in Table 8.1.

Table 8.1 — Compatible CS types

ORM dimension	Compatible CS types
1D	1D CS
2D	Curve CS 2D CS
3D	Curve CS Surface CS 3D CS

The use of surface CSs or 3D CSs that are based on an oblate ellipsoid (or sphere) are restricted to ORMs that are based on an oblate ellipsoid (or respectively, sphere) RD.

The surface CSs that are based on an oblate ellipsoid (or sphere) are:

 © ISO/IEC 2009 – All rights reserved

a) surface geodetic,

b) surface planetodetic, and

c) all map projections.

The 3D CSs that are based on an oblate ellipsoid (or sphere) are:

a) geodetic 3D,

b) planetodetic 3D, and

c) all augmented map projections.

As a further restriction, some CSs are based on spheres only. CS OBLIQUE_MERCATOR_SPHERICAL has this restriction.

An SRF may be described in terms of the properties and other characteristics of the CS that is specified by the SRF. In particular, an SRF is said to be a *3D SRF*, *surface SRF*, or *2D SRF* if the CS of the SRF is of the corresponding CS type. Similarly, the CS properties of linearity, orthogonality, and handedness may be used as descriptors of an SRF corresponding to the properties of the CS that is specified by the SRF. Thus, an SRF is said to be a *linear SRF* or a *curvilinear SRF* if the CS of the SRF has the respective linearity property. Every 3D SRF in this International Standard is a right-handed SRF in consequence to the CS handedness restriction imposed in 5.6.4.

iTeh Standards
(https://standards.iteh.ai)
Document Preview

8.3.2.2 CS parameter binding

All CS parameter values must be specified. In the case of a combination of a CS and an ORM based on an oblate ellipsoid (or sphere), the major semi-axis and minor semi-axis (or equivalently, the inverse flattening) (or respectively, sphere radius) of the ORM and CS shall match.

8.3.2.3 Coordinate-component names

ISO/IEC 18026:2009

A CS specification (see 5.9) includes the coordinate-component symbols with common names (if any). A specification of an SRF may optionally assign SRF-specific names to the k^{th} coordinate-components. The name assignment shall reflect the common use in the intended application domain.

EXAMPLE For an equatorial spherical CS, the assignment of SRF-specific names to the k^{th} coordinate-components of “right ascension” for λ, “declination” for θ, and “radius” for ρ.

8.3.2.4 Coordinate valid-region

A CS specification (see 5.9) includes the specification of the CS domain and CS range where the generating function (or mapping equations) and its inverse(s) are defined. An SRF specification may further restrict the CS domain. A *valid-region* is a restriction of the CS domain of the generating function (or mapping equations) for a CS as used in an SRF. An *extended valid-region* is a second valid-region that contains the first valid-region as a subset. The specification of these restrictions is important for several (SRF specific) reasons:

a) If the ORM is local, the restrictions are used to model, in coordinate-space, the local region of the space of the object.

b) If the CS is a map projection or an augmented map projection, the restrictions are used to bound or otherwise limit distortions (see 5.8.3.1).

© ISO/IEC 2009 – All rights reserved

c) The SRF may be used in conjunction with other SRFs to form an atlas for a large region (see 8.7 SRF sets). In this case, the restrictions are used to control the pair-wise overlap of the spatial coverage of members of the SRF collection.

d) If the CS generating function (or map projection mapping equations) or the inverse function(s) have been implemented with a numerical approximation, the restrictions are used to control error bounds.

The extended valid-region is used primarily for overlapping regions in forming an atlas as in (c) above. Not all properties of the SRF that are true in the valid-region will necessarily be true in the extended valid-region. In particular, a distortion error bound that holds in the valid-region may not hold in the extended valid-region.

A valid-region may be described and/or specified. A *valid-region description* is a descriptive statement of the region such as the spatial boundary of a named political entity.

EXAMPLE 1 "The German state of Baden-Wurttemberg" and "The Baltic Sea" are valid-region descriptions.

In this International Standard, a *valid-region specification* is a finite (or empty) list of coordinate-component constraints of the form:

k^{th} coordinate-component belongs to a non-empty interval of real numbers I_k.

An *extended valid-region specification* is a finite (or empty) list of coordinate-component constraints of the form:

k^{th} coordinate-component belongs to an interval of real numbers J_k, where I_k has been specified and $J_k \supseteq I_k$.

iTeh Standards
(https://standards.iteh.ai)
Document Preview

Angular coordinate-component intervals shall be evaluated modulo 2π to represent an interval of the unit circle. Thus, $[4\pi/3, 2\pi/3]$ representes the angular interval $[4\pi/3, 2\pi) \cup [0, 2\pi/3]$.

In the case of an SRF with an oblate ellipsoid (or sphere) based ORM, celestiodetic coordinates may be similarly constrained. In particular, valid-region specifications for a map projection based SRF may specify coordinate-component constraints for easting, northing, latitude, and/or longitude. Celestiodetic longitude intervals shall be evaluated modulo 2π. In particular, if the interval limits satisfy $\lambda_1 > \lambda_2$, then:

ISO/IEC 18026:2009

$$[\lambda_1, \lambda_2] = [\lambda_1, \pi] \cup (-\pi, \lambda_2],$$
$$(\lambda_1, \lambda_2] = (\lambda_1, \pi] \cup (-\pi, \lambda_2],$$
$$[\lambda_1, \lambda_2) = [\lambda_1, \pi] \cup (-\pi, \lambda_2), \text{ and}$$
$$(\lambda_1, \lambda_2) = (\lambda_1, \pi] \cup (-\pi, \lambda_2).$$

EXAMPLE 2 The SRF is based on a transverse Mercator map projection (see SRFT TRANSVERSE_MERCATOR).
Valid-region specification: $167\ 000 \le u \le 833\ 000$, $0 \le v \le 9\ 500\ 000$
Extended valid-region specification: $0 < u$, $-100 < v$
In this example, $I_{\text{Easting}} = [167\ 000, 833\ 000]$ and $I_{\text{Northing}} = [0, 9\ 500\ 000]$ are closed bounded intervals, and $J_{\text{Easting}} = (0, +\infty)$ and $J_{\text{Northing}} = (-100, +\infty)$ are open semi-bounded intervals that are further constrained by the CS domain.

EXAMPLE 3 The SRF is based on a transverse Mercator map projection (see SRFT TRANSVERSE_MERCATOR).
Valid-region specification: $-78^\circ \le \lambda < -72^\circ$, $0^\circ \le \varphi < 84^\circ$
Extended valid-region specification: $-78{,}5^\circ \le \lambda < -71{,}5^\circ$
In this example, $I_{\text{Longitude}} = [-78 \cdot (\pi/180), -72 \cdot (\pi/180))$ and $I_{\text{Latitude}} = [0, 84 \cdot (\pi/180))$ are left-closed, right-open bounded intervals, as is $J_{\text{Longitude}} = [-78{,}5 \cdot (\pi/180), -71{,}5 \cdot (\pi/180))$. J_{Latitude} is not specified. This indicates that there are no constraints for latitude (except for the CS domain definition) in the extended valid-region specification.

 © ISO/IEC 2009 – All rights reserved

8.4 SRF induced surface spatial reference frame

In the case of an SRF specified with the combination of a 3D ORM and a 3D CS, the 3D CS induces a surface CS on each coordinate-component surface (see 5.5.2). An SRF specification may optionally identify the 3rd coordinate-component as the *vertical coordinate-component* for the SRF. In that case, the surface CS induced on the zero-value vertical coordinate-component surface is the induced surface SRF for the specification. The vertical coordinate-component is optionally specified in the coordinate-component name specification element of the SRF.

The CS GEODETIC and the CS PLANETODETIC 3rd coordinate-components (h: ellipsoidal height), and the 3rd coordinate-component of any augmented map projection CS (h: ellipsoidal height) are identified in this International Standard as the vertical coordinate-component. When an SRF is specified with any of these 3D CSs, the h = 0 coordinate-component surface coincides with the surface of the oblate ellipsoid (or sphere) RD of the ORM. Any SRF based on these CSs intrinsically specifies the corresponding surface CS on the oblate ellipsoid (or sphere) RD surface.

In an SRF realized from the SRF template LOCAL_TANGENT_SPACE_EUCLIDEAN specification (see 8.5.6) or the SRF template LOCAL_TANGENT_SPACE_CYLINDRICAL specification (see 8.5.8), the 3rd coordinate-component, height, is specified as the vertical coordinate-component. In these cases, the zero-value vertical coordinate-component surface is a plane parallel to the tangent plane at the SRF tangent point. SRF templates are defined in 8.5.

The zero-value 3rd coordinate-component surface of an SRF realized from the 3D CS SRF template LOCAL_TANGENT_SPACE_AZIMUTHAL_SPHERICAL specification (see 8.5.7) induces a lococentric surface azimuthal CS on the tangent plane of the SRF. For the purpose of specifying an induced surface reference frame, the 3rd coordinate-component θ, depression/elevation angle, is specified as a vertical coordinate. The zero-value vertical coordinate-component surface is a plane parallel to the tangent plane at the SRF tangent point.

iTeh Standards
(https://standards.iteh.ai)
Document Preview

SRF templates that are based on surface CSs that can be induced by a zero-value vertical coordinate-component surface of an SRF based on a 3D CS are not separately specified. The induced surface CS is noted in the corresponding 3D CS based SRF template specification.

ISO/IEC 18026:2009

NOTE Starting with a 3D SRF, this International Standard identifies surface SRFs on coordinate-component surfaces. The relationship between a surface CS and the 3D CS which induces it is functionally similar to, but conceptually different from, the ISO 19111 concept of compound coordinate reference frame. A compound coordinate reference frame synthesizes a 3D reference frame from a surface and a vertical system. (See also 5.8.6.1 and Clause 9.)

8.5 SRF templates

8.5.1 Introduction

A *spatial reference frame template* (SRFT) is an abstraction of a collection of SRFs that share the same abstract CS, coordinate component names, CS parameter binding rules, and similar ORMs that model the same spatial object type. An SRF template allows for a consistent derivation of SRFs. It is not necessary that an appropriate SRFT be defined in order to define a new SRF; however in this International Standard all SRFs are derived from SRFTs. The specification elements for SRFTs are defined in Table 8.2.

Table 8.2 — SRFT specification elements

Element	Definition
SRFT label	The label of the SRF template (see 13.2.2).
SRFT code	The code of the SRF template (see 13.2.3). Code 0 (UNSPECIFIED) is reserved.

© ISO/IEC 2009 – All rights reserved

Element	Definition
Short name and description	A short name as published or as commonly known and an optional description.
Object or object type	One or more of: abstract, physical, Earth, planet, satellite, and Sun; and, optionally, additional restrictions.
ORM constraint	Criteria for allowable ORMs.
CS label	The label of a CS of compatible type.
CS coordinate-component names and/or symbols	SRF-specific names and/or symbols for the k^{th} coordinate-component names and/or symbols. If all coordinate-component names and symbols are the same as the CS, the phrase “Same as the CS.” shall be used. The vertical coordinate-component shall be designated in this specification element if applicable.
Template parameters	CS and RD parameters, if any, and/or SRF parameters that are not specified by a CS parameter binding rule.
CS parameter binding rules	A set of rules for binding for CS parameters and ORM component RD parameters, if any, and/or SRF parameters.
Coordinate valid-region	Optional restriction of the domain of the CS to a valid-region. If a valid-region is specified, optionally an extended valid-region. If both are unspecified, then there are no additional constraints on coordinate validity.
Notes	Optional, additional, non-normative information such as a description of the SRF structure, modelled region, intended use, and/or application domain.
References	The references (see 13.2.5).

Coordinates in a given SRF may be represented in a variety of formats or encodings if the coordinate-component values are sufficiently identified in the representation scheme. In particular, a representation scheme for coordinates of an SRF:

1. shall identify the coordinate-components by name and/or symbol, or
2. shall identify coordinate-components of an encoding scheme in terms of the coordinate-components specified in the SRF, or
3. shall define the ordering of a coordinate-component-tuple representation in terms of the coordinate-components specified in the SRF.

The API (see 11) provides coordinate value encoding schemes in the form of data records with field names that correspond to coordinate-component names. Where coordinate-component-tuples appear in the API, the ordering is the order specified in the corresponding CS specification table.

This International Standard specifies a collection of SRFTs as identified in Table 8.3. Additional SRFTs may be registered in accordance with Clause 13. Registered SRFs shall be derived only from standardized or registered SRFTs.

© ISO/IEC 2009 – All rights reserved

Table 8.3 — SRFT directory

CS type	Short name	SRFT label
3D	Celestiocentric	CELESTIOCENTRIC
	Local space rectangular 3D	LOCAL_SPACE_RECTANGULAR_3D
	Celestiodetic	CELESTIODETIC
	Planetodetic	PLANETODETIC
	Local tangent space Euclidean	LOCAL_TANGENT_SPACE_EUCLIDEAN
	Local tangent space azimuthal spherical	LOCAL_TANGENT_SPACE_AZIMUTHAL_SPHERICAL
	Local tangent space cylindrical	LOCAL_TANGENT_SPACE_CYLINDRICAL
	Lococentric Euclidean 3D	LOCOCENTRIC_EUCLIDEAN_3D
	Celestiomagnetic	CELESTIOMAGNETIC
	Equatorial inertial	EQUATORIAL_INERTIAL
	Solar ecliptic	SOLAR_ECLIPTIC
	Solar equatorial	SOLAR_EQUATORIAL
	Solar magnetic ecliptic	SOLAR_MAGNETIC_ECLIPTIC
	Solar magnetic	SOLAR_MAGNETIC_DIPOLE
	Heliospheric Aries ecliptic	HELIOSPHERIC_ARIES_ECLIPTIC
	Heliospheric Earth ecliptic	HELIOSPHERIC_EARTH_ECLIPTIC
	Heliospheric Earth equatorial	HELIOSPHERIC_EARTH_EQUATORIAL
Surface (map projection) and 3D (augmented map projection)	Mercator	MERCATOR
	Oblique Mercator spherical	OBLIQUE_MERCATOR_SPHERICAL
	Transverse Mercator	TRANSVERSE_MERCATOR
	Lambert conformal conic	LAMBERT_CONFORMAL_CONIC
	Polar stereographic	POLAR_STEREOGRAPHIC
	Equidistant cylindrical	EQUIDISTANT_CYLINDRICAL
Surface	Surface celestiodetic (*induced*)	CELESTIODETIC
	Surface planetodetic (*induced*)	PLANETODETIC
	Local tangent plane Euclidean (*induced*)	LOCAL_TANGENT_SPACE_EUCLIDEAN
	Local tangent plane azimuthal (*induced*)	LOCAL_TANGENT_SPACE_AZIMUTHAL_SPHERICAL
	Local tangent plane polar (*induced*)	LOCAL_TANGENT_SPACE_CYLINDRICAL
2D	Local space rectangular 2D	LOCAL_SPACE_RECTANGULAR_2D
	Local space azimuthal	LOCAL_SPACE_AZIMUTHAL_2D
	Local space polar	LOCAL_SPACE_POLAR_2D

iTeh Standards (https://standards.iteh.ai) Document Preview ISO/IEC 18026:2009

© ISO/IEC 2009 – All rights reserved

8.5.2 Celestiocentric SRFT

Celestiocentric SRFs shall be derived from the SRFT specified in Table 8.4.

Table 8.4 — Celestiocentric SRFT

Element	Specification
SRFT label	CELESTIOCENTRIC
SRFT code	1
Short name and description	celestiocentric SRFT The generalization of geocentric spatial reference frames to include non-Earth objects.
Object type	physical
ORM constraint	Shall be derived from any 3D ORM.
CS label	EUCLIDEAN_3D
CS coordinate-component names and/or symbols	The same as the CS.
Template parameters	none
CS parameter binding rules	None (no CS parameters).
Coordinate valid-region	No additional restrictions.
Notes	When the object is Earth, this SRFT is referred to as a *geocentric SRFT*.
References	[EDM]

iTeh Standards
(https://standards.iteh.ai)
Document Preview
ISO/IEC 18026:2009
https://standards.iteh.ai/catalog/standards/iso/bddbceea-ba55-45e2-b92a-05052bec66f1/iso-iec-18026-2009

8.5.3 Local space rectangular 3D SRFT

Local space rectangular SRFs shall be derived from the SRFT specified in Table 8.5.

Table 8.5 — Local space rectangular 3D SRFT

Element	Specification
SRFT label	LOCAL_SPACE_RECTANGULAR_3D
SRFT code	2
Short name and description	local space rectangular 3D SRFT A 3D Euclidean spatial reference frame for an abstract 3D space.
Object type	3D abstract object.
ORM constraint	Shall be an ORM for a 3D abstract object.
CS label	LOCOCENTRIC_EUCLIDEAN_3D
CS coordinate-component names and/or symbols	The same as the CS.
Template parameters	$\boldsymbol{r}$ = vector direction of forward (forward axis). $\boldsymbol{s}$ = vector direction of up (up axis).

© ISO/IEC 2009 – All rights reserved

Element	Specification
CS parameter binding rules	$\boldsymbol{q} = \boldsymbol{0}$, $\boldsymbol{r}$ and $\boldsymbol{s}$, select from: $+e_1$ positive primary axis, $+e_2$ positive secondary axis, $+e_3$ positive tertiary axis, $-e_1$ negative primary axis, $-e_2$ negative secondary axis, or $-e_3$ negative tertiary axis, subject to: $\boldsymbol{s} \neq \pm\boldsymbol{r}$, where: $e_1 = \begin{pmatrix}1\\0\\0\end{pmatrix}$, $e_2 = \begin{pmatrix}0\\1\\0\end{pmatrix}$, and $e_3 = \begin{pmatrix}0\\0\\1\end{pmatrix}$.
Coordinate valid-region	No additional restrictions.
Notes	CAD/CAM and other engineering applications.
References	[EDM]

iTeh Standards
(https://standards.iteh.ai)
Document Preview

8.5.4 Celestiodetic SRFT

Celestiodetic SRFs shall be derived from the SRFT specified in Table 8.6.

Table 8.6 — Celestiodetic SRFT

ISO/IEC 18026:2009
https://standards.iteh.ai/catalog/stand... -ba53-43e2-b92a-05032bec66f1/iso-iec-18026-2009

Element	Specification
SRFT label	CELESTIODETIC
SRFT code	3
Short name and description	celestiodetic SRFT The generalization of geodetic SRFs to include other planets and ellipsoidal bodies.
Object type	physical
ORM constraint	Shall be derived from: ORMT OBLATE_ELLIPSOID, OBLATE_ELLIPSOID_ORIGIN, SPHERE, or SPHERE_ORIGIN.
CS label	GEODETIC
CS coordinate-component names and/or symbols	The same as the CS. The vertical coordinate-component is ellipsoidal height (h).
Template parameters	none

© ISO/IEC 2009 – All rights reserved

Element	Specification
CS parameter binding rules	CS parameters match RD values. Oblate ellipsoid RD case with major semi-axis a and inverse flattening f^{-1}: $a = a$ $b = a(1-f)$ Sphere RD case with radius r : $a = b = r$.
Coordinate valid-region	No additional restrictions.
Notes	1) The SURFACE_GEODETIC CS is induced on the oblate ellipsoid (or sphere) RD surface. 2) When the object is Earth, this SRFT is referred to as a *geodetic SRFT*.
References	[HEIK]

8.5.5 Planetodetic SRFT

Planetodetic SRFs shall be derived from the SRFT specified in Table 8.7.

Table 8.7 — Planetodetic SRFT

Element	Specification
SRFT label	PLANETODETIC
SRFT code	4
Short name and description	planetodetic SRFT Similar to celestiodetic SRFT with reversed direction for longitude.
Object type	planet
ORM constraint	Shall be derived from: ORMT OBLATE_ELLIPSOID, OBLATE_ELLIPSOID_ORIGIN, SPHERE, or SPHERE_ORIGIN.
CS label	PLANETODETIC
CS coordinate names and/or symbols	The same as the CS. The vertical coordinate-component is ellipsoidal height (h).
Template parameters	none
CS parameter binding rules	CS parameters match RD values: Oblate ellipsoid RD case with major semi axis a and inverse flattening f^{-1}: $a = a$ $b = a(1-f)$ Sphere RD case with radius r : $a = b = r$.
Coordinate valid region	No additional restrictions
Notes	Planetary science applications
References	[RIIC]

iTeh Standards (https://standards.iteh.ai) Document Preview ISO/IEC 18026:2009 https://standards.iteh.ai/catalog/standards/iso/fdfbeeea-ba53-43e2-b92a-05032bec66f1/iso-iec-18026-2009

 © ISO/IEC 2009 – All rights reserved

8.5.6 Local tangent space Euclidean SRFT

Local tangent space Euclidean SRFs shall be derived from the SRFT specified in Table 8.8. The case with template parameters $\alpha = 0$ and $h_0 = 0$ is illustrated in Figure 8.2.

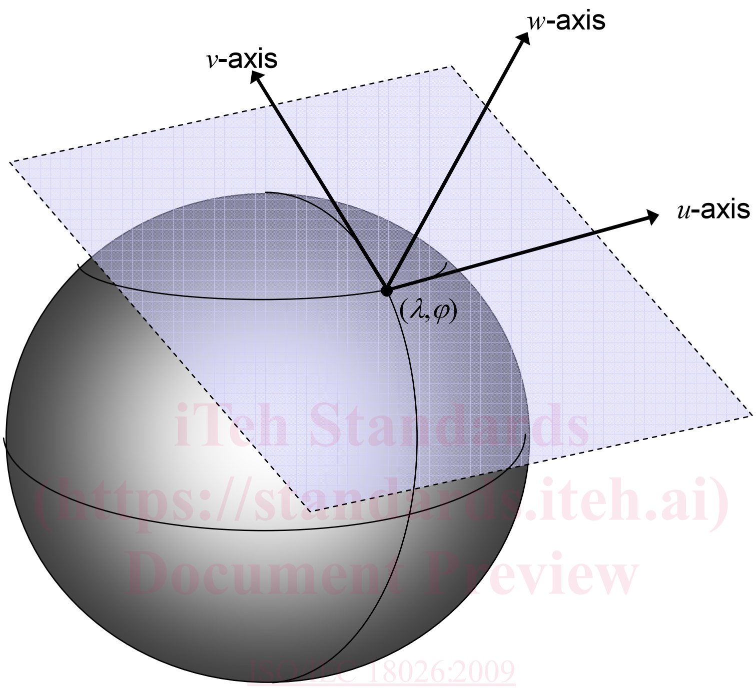
Table 8.8 — Local tangent space Euclidean SRFT

Element	Specification
SRFT label	LOCAL_TANGENT_SPACE_EUCLIDEAN
SRFT code	5
Short name and description	local tangent space Euclidean SRFT Euclidean 3D spatial CS with 3rd coordinate-component surfaces that are parallel to a plane tangent to the oblate ellipsoid RD.
Object type	physical
ORM constraint	Shall be derived from: ORMT OBLATE_ELLIPSOID, OBLATE_ELLIPSOID_ORIGIN, SPHERE, or SPHERE_ORIGIN.
CS label	LOCOCENTRIC_EUCLIDEAN_3D
CS coordinate-component names and/or symbols	u: x (x) v: y (y) w: height (h) is the vertical coordinate-component.
Template parameters	$(\lambda, \varphi) =$ surface geodetic coordinate of the tangent point $\alpha =$ azimuth (v-axis azimuth from north) $x_F =$ false origin x $y_F =$ false origin y $h_0 =$ offset height
CS parameter binding rules	$\boldsymbol{r} = \boldsymbol{T}\begin{pmatrix}1\\0\\0\end{pmatrix}, \quad \boldsymbol{s} = \boldsymbol{T}\begin{pmatrix}0\\1\\0\end{pmatrix}$, and $\boldsymbol{q} = \boldsymbol{q}_0 - x_F\boldsymbol{r} - y_F\boldsymbol{s}$ where: $q_0 = \begin{pmatrix}\left(R_N(\varphi)+h_0\right)\cos(\varphi)\cos(\lambda)\\ \left(R_N(\varphi)+h_0\right)\cos(\varphi)\sin(\lambda)\\ \left(\frac{b^2}{a^2}R_N(\varphi)+h_0\right)\sin(\varphi)\end{pmatrix},$ a and b match the oblate ellipsoid (or sphere) RD values, and $\boldsymbol{T} = \begin{pmatrix}-\sin\lambda & -\cos\lambda\sin\varphi & \cos\lambda\cos\varphi\\ \cos\lambda & -\sin\lambda\sin\varphi & \sin\lambda\cos\varphi\\ 0 & \cos\varphi & \sin\varphi\end{pmatrix}\begin{pmatrix}\cos\alpha & \sin\alpha & 0\\ -\sin\alpha & \cos\alpha & 0\\ 0 & 0 & 1\end{pmatrix}.$
Coordinate valid-region	No additional restrictions.

iTeh Standards
(https://standards.iteh.ai)
Document Preview
ISO/IEC 18026:2009
https://standards.iteh.ai/catalog/standards/iso/fa0beeea-b153-43e2-b92a-05032bec66f1/iso-iec-18026-2009

© ISO/IEC 2009 – All rights reserved

Element	Specification
Notes	1) The LOCOCENTRIC_SURFACE_EUCLIDEAN CS is induced on the tangent plane surface. 2) The $w = -h_0$ coordinate-component plane[21] is tangent to the oblate ellipsoid RD at the point with surface celestiodetic coordinate (λ, φ). 3) α is the geodetic azimuth of the v-axis (see Figure 8.2). 4) h_0 is the ellipsoidal height of the CS origin.
References	[EDM]



iTeh Standards
(https://standards.iteh.ai)
Document Preview
ISO/IEC 18026:2009
https://standards.iteh.ai/catalog/standards/iso/bddbeeea-ba53-43e2-b92a-05032bec66f1/iso-iec-18026-2009

Figure 8.2 — Local tangent space Euclidean SRFT

8.5.7 Local tangent space azimuthal spherical SRFT

Local tangent space azimuthal spherical SRFs shall be derived from the SRFT specified in Table 8.9.

Table 8.9 — Local tangent space azimuthal spherical SRFT

Element	Specification
SRFT label	LOCAL_TANGENT_SPACE_AZIMUTHAL_SPHERICAL
SRFT code	6

[21] In ISO 19111 terminology, the tangent plane is an engineering datum.

 © ISO/IEC 2009 – All rights reserved

Element	Specification
Short name and description	local tangent space azimuthal spherical SRFT Azimuthal spherical spatial CS with the zero 3rd coordinate-component surface that is tangent to the oblate ellipsoid RD and with CS natural origin at the tangent point.
Object type	physical
ORM constraint	Shall be derived from: ORMT OBLATE_ELLIPSOID, OBLATE_ELLIPSOID_ORIGIN, SPHERE, or SPHERE_ORIGIN.
CS label	LOCOCENTRIC_AZIMUTHAL_SPHERICAL
CS coordinate-component names and/or symbols	The same as the CS. θ: depression/elevation angle, is the vertical coordinate-component.
Template parameters	$(\lambda, \varphi) =$ surface geodetic coordinate of the tangent point $\alpha =$ azimuth (v-axis azimuth from north) $h_0 =$ offset height
CS parameter binding rules	$\boldsymbol{q} = \begin{pmatrix} (R_N(\varphi)+h_0)\cos(\varphi)\cos(\lambda) \\ (R_N(\varphi)+h_0)\cos(\varphi)\sin(\lambda) \\ \left(\frac{b^2}{a^2}R_N(\varphi)+h_0\right)\sin(\varphi) \end{pmatrix}$ $\boldsymbol{r} = \boldsymbol{T}\begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$ $\boldsymbol{s} = \boldsymbol{T}\begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}$ where: a and b match the oblate ellipsoid (or sphere) RD values, and $\boldsymbol{T} = \begin{pmatrix} -\sin\lambda & -\cos\lambda\sin\varphi & \cos\lambda\cos\varphi \\ \cos\lambda & -\sin\lambda\sin\varphi & \sin\lambda\cos\varphi \\ 0 & \cos\varphi & \sin\varphi \end{pmatrix}\begin{pmatrix} \cos\alpha & \sin\alpha & 0 \\ -\sin\alpha & \cos\alpha & 0 \\ 0 & 0 & 1 \end{pmatrix}$
Coordinate valid-region	No additional restrictions.
Notes	1) Used in radar localization. 2) h_0 is the ellipsoidal height of the CS origin. 3) α is the geodetic azimuth of the v-axis (see Figure 8.2).
References	[EDM]

iTeh Standards (https://standards.iteh.ai) Document Preview
ISO/IEC 18026:2009
https://standards.iteh.ai/catalog/standards/iso/bddbeeea-ba53-43e2-b92a-05032bec66f1/iso-iec-18026-2009

8.5.8 Local tangent space cylindrical SRFT

Local tangent space cylindrical SRFs shall be derived from the SRFT specified in Table 8.10.

Table 8.10 — Local tangent space cylindrical SRFT

Element	Specification
SRFT label	LOCAL_TANGENT_SPACE_CYLINDRICAL
SRFT code	7
Short name and description	local tangent space cylindrical SRFT Cylindrical spatial CS with 3rd coordinate-component surfaces that are parallel to a plane tangent to the oblate ellipsoid RD.
Object type	physical
ORM constraint	Shall be derived from: ORMT OBLATE_ELLIPSOID, OBLATE_ELLIPSOID_ORIGIN, SPHERE, or SPHERE_ORIGIN.
CS label	LOCOCENTRIC_CYLINDRICAL
CS coordinate-component names and/or symbols	ρ: unchanged θ: unchanged ζ: height (h) is the vertical coordinate
Template parameters	(λ, φ) = surface geodetic coordinate of the tangent point α = azimuth (v-axis azimuth from north) h_0 = offset height
CS parameter binding rules	$\boldsymbol{q} = \begin{pmatrix} (R_N(\varphi) + h_0)\cos(\varphi)\cos(\lambda) \\ (R_N(\varphi) + h_0)\cos(\varphi)\sin(\lambda) \\ \left(\frac{b^2}{a^2} R_N(\varphi) + h_0\right)\sin(\varphi) \end{pmatrix}$ $\boldsymbol{r} = \boldsymbol{T}\begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$ $\boldsymbol{s} = \boldsymbol{T}\begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}$ where: a and b match the oblate ellipsoid (or sphere) RD values, and $\boldsymbol{T} = \begin{pmatrix} -\sin\lambda & -\cos\lambda\sin\varphi & \cos\lambda\cos\varphi \\ \cos\lambda & -\sin\lambda\sin\varphi & \sin\lambda\cos\varphi \\ 0 & \cos\varphi & \sin\varphi \end{pmatrix}\begin{pmatrix} \cos\alpha & \sin\alpha & 0 \\ -\sin\alpha & \cos\alpha & 0 \\ 0 & 0 & 1 \end{pmatrix}$
Coordinate valid-region	No additional restrictions.

iTeh Standards
(https://standards.iteh.ai)
Document Preview
ISO/IEC 18026:2009
https://standards.iteh.ai/catalog/standards/iso/bddbeeea-ba53-43e2-b92a-05032bec66f1/iso-iec-18026-2009

© ISO/IEC 2009 – All rights reserved