Open Network Video Interface Forum
PTZ Coordinate Spaces

White Paper

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Introduction

The goal and purpose of this document is to extend the range of the existing coordinate spaces that are specified in the ONVIF Core Specification [ONVIF Core Spec], WSDL [ONVIF PTZ WSDL] and schema [ONVIF Schema]. This is necessary to ease the interpretation of pan, tilt and zoom move operations by the client for a specific PTZ NVT, where the additional spaces give a more detailed description of the underlying physical PTZ model. This document specifies a number of coordinate systems that can be used for pan, tilt and zoom movements of absolute, relative and continuous type.

1 References

[ONVIF Core Spec]	ONVIF Core Specification, ver 1.0, 2008. URL:http://www.onvif.org/onvif/ver10/tc/onvif_core_ver10.pdf
[ONVIF PTZ WSDL]	ONVIF PTZ Service WSDL, ver 1.0, 2008. URL:http://www.onvif.org/tc/wsdl/ptz1_0.wsdl
[ONVIF Schema]	ONVIF Schema, ver 1.0, 2008. URL:http://www.onvif.org/tc/wsdl/onvif1_0.xsd

2 Terms and Definitions

2.1 Abbreviations

PTZ	Pan Tilt Zoom
FOV	Field of view
NVC	Network Video Client
NVT	Network Video Transmitter

2.2 Terminology

2.2.1 Field of view

In this document, Field of View (FOV) is the part of the world that is visible through the camera at a particular position and orientation in space. The Field of View is usually expressed in degrees and it changes when adjusting the zoom level for the camera. Different lenses have different FOV. For example, a fisheye wide-angle lens has much larger FOV than a telephoto lens.

2.2.2 Digital PTZ

Digital PTZ is a term used to describe the ability to pan, tilt and zoom without moving mechanical parts. A camera that supports Digital PTZ is often based on a large megapixel sensor, where a moveable cropped area can be panned (horizontal movement) or tilted (vertical movement).

2.2.3 Nadir

In this document, nadir is defined as the direction below a dome camera that is mounted in the ceiling and looking downwards. If the camera is differently mounted, nadir remains undefined.

2.2.4 E-flip

E-flip is the term used to describe the behaviour when a PTZ Dome rotates the image and control directions when passing nadir direction during a tilt movement. This functionality is useful when controlling domes using human joystick control, where a client can track an object that passes nadir and doesn’t have to bother about inverted controls.

Notice that the ONVIF Core Specification doesn’t currently cover the specification of the configuration parameter that is necessary to turn the e-flip functionality on or off. This is expected in the next release of the core specification. In order to support non-human and human control to interact without conflict, it is suggested that the vendors put the e-flip extension parameter as attribute in the PTZConfiguration.

3 PTZ Coordinate Spaces

Spaces are used to specify absolute, relative and continuous movements. Whereas absolute movements require an absolute position, relative movements are specified by a position change, and continuous movements require the specification of a velocity (relative movement over time). For these three cases, different coordinate systems, also called spaces, are used describing the desired movement. In addition to the generic space defined in the ONVIF Core Specification, this document specifies further spaces that map to the underlying physical dome model. Each space in this document has a unique identifier that should be referenced in the move operations specified in the ONVIF Core Specification. By setting a coordinate space as default space in the PTZConfiguration it is possible to spare the client of sending the reference in each move request. When a PTZNode presents a space in its property list, it shall specify the coordinate range available on this PTZ node.

For all of the following spaces, a requested position, translation, velocity or speed will be clamped to the closest value in the allowed range, if it is outside the available range.

3.1 Absolute Position Spaces

The Absolute Position Spaces are used when the NVC wants to move the camera to a certain position. The absolute movement from current position A to an arbitrarily chosen position B doesn't have to follow a specific path. Instead, the PTZ NVT may choose the shortest path in order to reach the target destination.

3.1.1 Spherical Pan/Tilt Position Space in Degrees

Figure 1 shows a camera with pan and tilt mechanics and the corresponding spherical coordinate system. The space description assumes that the dome is mounted on the ceiling. The definition of a Pan movement is the rotation of the camera module around the pan axis. Thereby, the tilt axis is also rotated in the same direction in the plane orthogonal to the pan axis, so that it is still orthogonal to the camera lens axis. Tilt movement is the rotation of the camera module around the tilt axis. With the tilt axis the camera direction can be changed from looking downward to looking at the horizon. Some devices may support a camera which can look above the horizon.

The angles describing the rotation around pan and tilt axis are referred to as pan and tilt angles, where pan is represented by the X coordinate of the Position vector and tilt is represented by the Y coordinate of the Position vector. Both angles are specified in degrees. The initial position of this coordinate system is when the direction of the camera lens is parallel to the ceiling. The pan and tilt angles in this initial direction are zero (0,0).

When starting from the initial direction and increasing the pan angle, objects that have previously been in the centre of the image will move towards the left of the image. When starting from the initial direction and increasing the tilt angle, objects which have been previously in the middle of the image move towards the bottom of the image.

The maximum range for pan and tilt angles are between -180 and +180 degrees[1]. The NVT can restrict the tilt range arbitrarily. The tilt angle of a camera can change its direction in the space of

[1] -180 and +180 is the same pan position in the space and the camera can choose to represent the pan position using any of them.

a hemisphere like a dome camera is typically bounded from 0 to -90 degrees. If a device cannot pan the full range, it may limit the pan range to an appropriate interval.

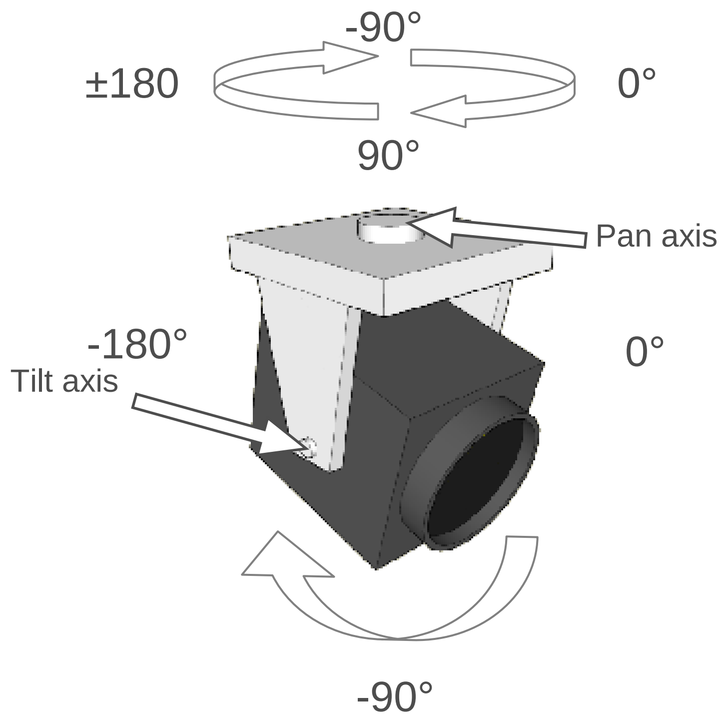

Figure 1: Spherical Pan/Tilt Position Space in Degrees for a camera mounted on the ceiling.

A camera that doesn’t support e-flip (or has disabled it) and allows an absolute tilt range between 0 and -180 degrees, shall not rotate the image and directions when requesting a tilt movement with less than -90 degrees.

If a camera supports e-flip and a client requests a tilt movement that passes nadir, the following behaviour is to be expected:

- There could be a hysteresis ($\pm\alpha^\circ$) room around nadir position, such that the image and direction rotation doesn’t occur exactly at nadir that could generate irritating oscillations.
- When the camera rotates the image and move directions (after passing nadir $\pm\alpha^\circ$), also the following changes to the coordinate system will occur:
  - The new pan angle will be $P_{new} = P_{old} + 180^\circ$
  - The new tilt angle will be $T_{new} = -180^\circ - T_{old}$, $-180 \le T_{old} \le -90$
  - If ignoring the hysteresis area, there is a one-to-one mapping between viewing directions and pan/tilt coordinates, even though there are two mechanical positions of the camera matching the same viewing direction but with rotated image. For example, the two mechanical directions $P_1 : 35, T_1 : -20$ and

$P_2: -145, T_2: -160$, would be represented by the coordinate $P: 35, T: -20$ since a tilt of $< -90 - \alpha$ would update the coordinates as described above.

The spherical pan/tilt position space is defined as follows:[2]

```
<tt:AbsolutePanTiltPositionSpace>
  <tt:SpaceURI>
    http://www.onvif.org/ver10/tptz/PanTiltSpaces/SphericalPositionSpace
Degrees
  </tt:SpaceURI>
  <tt:XRange>
    <tt:Min>-INF</tt:Min>
    <tt:Max>INF</tt:Max>
  </tt:XRange>
  <tt:YRange>
    <tt:Min>-180.0</tt:Min>
    <tt:Max>180.0</tt:Max>
  </tt:YRange>
</tt:AbsolutePanTiltPositionSpace>
```

The Min and Max elements of the XRange are set to plus and minus infinity to indicate that the range is not bounded to either side.

3.1.2 Digital Pan/Tilt Position Space

The Digital Pan/Tilt Position Space is suitable for Digital PTZ cameras, where the pan and tilt coordinates represent the centre point of a window positioned on a sensor, also known as absolute Digital PTZ. This space requires a Media Profile that includes a VideoEncoderConfiguration and a VideoSourceConfiguration [ONVIF Core Spec].

The pan movement is a horizontal movement in the X direction on the sensor plane and the tilt movement is a vertical movement in the Y direction on the sensor plane. The coordinate system originates from the lower left of the sensor. Figure 2 exemplifies a window located at the left upper most coordinate (0.1,0.9) with a window size of (0.2*plane width, 0.2* plane height).

[2] The particular NVT should reference the propopsed name space but the actual ranges are device specific. The ranges indicated in the definition shall be interpreted as the maximum and minimum range limits for the space.

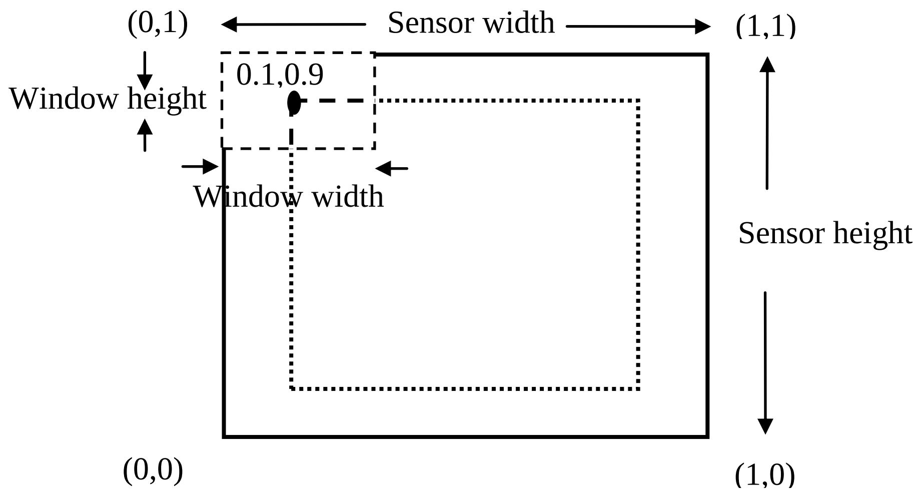

Figure 2: Digital Pan/Tilt Position Space.

The Digital Pan/Tilt Position space is defined as follows:

```
<tt:AbsolutePanTiltPositionSpace>
  <tt:SpaceURI>
    http://www.onvif.org/ver10/tptz/PanTiltSpaces/DigitalPositionSpace
  </tt:SpaceURI>
  <tt:XRange>
    <tt:Min>0</tt:Min>
    <tt:Max>1</tt:Max>
  </tt:XRange>
  <tt:YRange>
    <tt:Min>0</tt:Min>
    <tt:Max>1</tt:Max>
  </tt:YRange>
</tt:AbsolutePanTiltPositionSpace>
```

3.1.2.1 Example: Positions of a window on sensor

A window with VGA resolution (640x480) that is natively mapped to the same number of pixels of a cropped area on a 3MP (2048x1536) sensor, would have the pan and tilt range of:

$$X_{\min} = \frac{\left(\frac{W_w}{2}\right)}{S_w} \Rightarrow \frac{\left(\frac{640}{2}\right)}{2048} = 0.15625 \;, \; X_{\max} = 1 - \frac{\left(\frac{W_w}{2}\right)}{S_w} \Rightarrow 1 - \frac{\left(\frac{640}{2}\right)}{2048} = 0.84375 \;.$$

$$Y_{\min} = \frac{\left(\frac{W_w}{2}\right)}{S_w} \Rightarrow \frac{\left(\frac{480}{2}\right)}{1536} = 0.15625 \;, \; Y_{\max} = 1 - \frac{\left(\frac{W_w}{2}\right)}{S_w} \Rightarrow 1 - \frac{\left(\frac{480}{2}\right)}{1536} = 0.84375$$

As long as the aspect ratio of the window and the sensor are identical, the same ranges for pan and tilt are expected. The device will automatically adjust the ranges based on the amount of source pixels represented in the window of interest (its width and height configured in the VideoSourceConfiguration of the requested profile).

3.1.3 Zoom Position Space In Millimeter

The Zoom Position Space In Millimeter expresses the absolute focal length of a zoom camera. The maximum and minimum focal length is camera specific. The Zoom Position Space In Millimeter is defined as follows:[3]

```
<tt:AbsoluteZoomPositionSpace>
  <tt:SpaceURI>
    http://www.onvif.org/ver10/tptz/ZoomSpaces/PositionSpaceMillimeter
  </tt:SpaceURI>
  <tt:XRange>
    <tt:Min>0.0</tt:Min>
    <tt:Max>INF</tt:Max>
  </tt:XRange>
</tt:AbsoluteZoomPositionSpace>
```

The current Zoom Magnification (M) for a camera can be calculated from the focal length as follows:

$$M = \frac{f_c}{f_0},$$

where f_0 is the minimum focal length and f_c is the current focal length

The current angle of view can be calculated with the following formula:

$$\alpha = 2\arctan\frac{d}{2f_c},$$

where d represents the size of the sensor in the direction of interest and f_c is the current focal length.

3.1.4 Normalized Digital Zoom Position Space

The Normalized Digital Zoom Position Space represents the mapping between the width of the window used for a video stream and the width of the video source (sensor). This space requires a Media Profile that includes a VideoEncoderConfiguration and a VideoSourceConfiguration.

[3] The particular NVT should reference the propopsed name space but the actual range is device specific. The range indicated in the definition shall be interpreted as the maximum and minimum range limits for the space.

The Normalized Digital Zoom factor is calculated as $Z = \frac{1}{\left(\frac{w_w}{s_w}\right)}$.

The maximum zoom level that can be represented by this space is limited by the smallest size of the window allowed by the camera.

The Normalized Digital Position Zoom Space is defined as follows:[4]

```
<tt:AbsoluteZoomPositionSpace>
  <tt:SpaceURI>
    http://www.onvif.org/ver10/tptz/ZoomSpaces/NormalizedDigitalPosition
Space
  </tt:SpaceURI>
  <tt:XRange>
    <tt:Min>1.0</tt:Min>
    <tt:Max>INF</tt:Max>
  </tt:XRange>
</tt:AbsoluteZoomPositionSpace>
```

It’s important to notice that a zoom operation using this space doesn’t affect the current resolution of the video stream being configured in the VideoEncoderConfiguration of the Media Profile. Instead it changes the width and height of the window configured in the VideoSourceConfiguration.

3.1.4.1 Example: Zoom level for cropped area

For example, a Digital PTZ unit with a natively cropped VGA (640x480) window on a 3MP sensor (2048x1536) would have the zoom level, $Z = \frac{1}{\left(\frac{640}{2048}\right)} = 3.2$.

3.2 Relative Translation Spaces

The Relative Pan/Tilt Translation Spaces is suitable when a NVC wants to move the camera in a certain direction without knowing the camera‘s current Pan/Tilt position.

A Relative Pan/Tilt Translation can be derived from a corresponding (digital/spherical) Absolute Pan/Tilt Position Space by taking the difference of two absolute Pan/Tilt positions. However, there are also relative Pan/Tilt translations where no corresponding absolute Pan/Tilt space can be defined. An example is the Relative Translation Space In FOV described in section 3.2.2.

If the camera supports e-flip, the following additional behaviour should be expected by the space defined in Section 3.2.1 and Section 3.2.2:

- If the tilt translation is passing nadir position (including the room for a hysteresis $\pm\alpha°$), the camera should rotate the image at nadir $\pm\alpha°$ as described in section 3.1.1 (only for

[4] The particular NVT should reference the propopsed name space but the actual range is device specific. The range indicated in the definition shall be interpreted as the maximum range limit for the space.

cameras supporting absolute pan/tilt positioning). When a rotation occurs, the camera will continue the current movements according to the directions given when the command was issued. If the command is interrupted with a new request (after the flip), that request will be handled according to the new (flipped) direction and coordinates. A camera that doesn't support e-flip or has it disabled will not rotate the image and directions during a tilt movement passing nadir.

3.2.1 Spherical Pan/Tilt Translation Space in Degrees

The Spherical Pan/Tilt Translation Space In Degrees derives from the Absolute Spherical Pan/Tilt Position Space In Degrees (see section 3.1.1). Instead of an absolute Position space where the reference position is fixed, the relative spherical space specifies the reference position as the cameras current position at all times. Thereby, the Pan/Tilt Translation is expressed as the coordinate difference from the current position to the target position. If a NVC wants to pan the camera by 5 degrees, it can use this relative spherical space and set the X coordinate of the direction to 5 and the Y coordinate to 0.

The spherical pan/tilt translation space is defined as follows:[5]

```
<tt:RelativePanTiltTranslationSpace>
  <tt:SpaceURI>
    http://www.onvif.org/ver10/tptz/PanTiltSpaces/SphericalTranslation
Space Degrees
  </tt:SpaceURI>
  <tt:XRange>
    <tt:Min>-360</tt:Min>
    <tt:Max>+360</tt:Max>
  </tt:XRange>
  <tt:YRange>
    <tt:Min>-INF</tt:Min>
    <tt:Max>+INF</tt:Max>
  </tt:YRange>
</tt:RelativePanTiltTranslationSpace>
```

3.2.2 Pan/Tilt Translation Space in FOV

The Relative Pan/Tilt Translation Space In FOV is introduced to simplify the navigation with dome cameras in graphical user interfaces. When the user wants to centre the camera on a certain position in the current camera view, the user requests a movement with respect to the current FOV. Due to the mechanics of a dome, the image content may rotate (see Figure 1). Figure 3 shows a rectangle representing the image content. The relative Pan/Tilt Translation Space in FOV has its origin in the centre of the image. The upper right corner corresponds to the normalized coordinate (1,1). This Space shall not be available in profiles without a VideoSourceConfiguration. The Space does not assume a certain dome model and can therefore be implemented on e.g. ditigal and mechanical domes.

---

5 The particular NVT should reference the propopsed name space but the actual ranges are device specific. The ranges indicated in the definition shall be interpreted as the maximum and minimum range limits for the space.

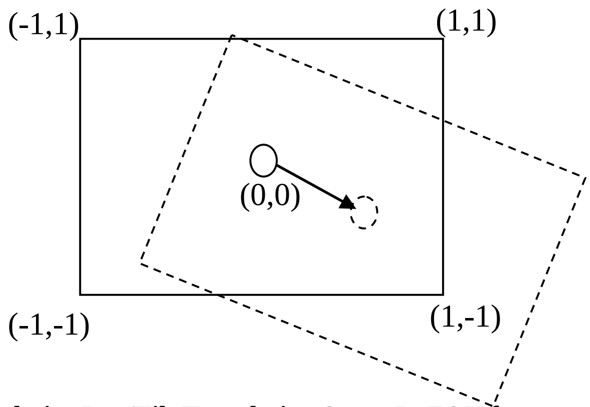

Figure 3: Relative Pan/Tilt Translation Space In FOV for a mechanical dome.

The proposed minimum range for this relative direction space ranges from minus infinity to plus infinity. However, an NVT may provide a different range. The relative direction space is defined as follows:[6]

```
<tt:RelativePanTiltTranslationSpace>
  <tt:SpaceURI>
    http://www.onvif.org/ver10/tptz/PanTiltSpaces/TranslationSpaceFov
  </tt:SpaceURI>
  <tt:XRange>
    <tt:Min>-INF</tt:Min>
    <tt:Max>+INF</tt:Max>
  </tt:XRange>
  <tt:YRange>
    <tt:Min>-INF</tt:Min>
    <tt:Max>+INF</tt:Max>
  </tt:YRange>
</tt:RelativePanTiltTranslationSpace>
```

3.2.3 Digital Pan/Tilt Translation Space

The Digital Pan/Tilt Translation Space is derived from the Absolute Digital Pan/Tilt Position Space (see section 3.1.2). Instead of an absolute position space where the reference position is fixed, the relative space specifies the reference position as the cameras current position at all times. Thereby, the pan/tilt translation is expressed as the coordinate difference from the current position to the target position. If a NVC wants to move the window area of the Video Source Configuration by a tenth of the sensor width horizontally, it can use this relative spherical space and set the X coordinate of the direction to 0.1 and the Y coordinate to 0. This Space shall not be available in profiles without a VideoSourceConfiguration.

The following figure shows the space description of this Digital Pan/Tilt Translation coordinate system. The outer box represents the image sensor, the dotted inner box the cropped area, and the arrow demonstrates a translation request of the cropped area with a pan/tilt vector of (0.1,-0.2).

6 The particular NVT should reference the propopsed name space but the actual ranges are device specific. The ranges indicated in the definition shall be interpreted as the maximum and minimum range limits for the space.

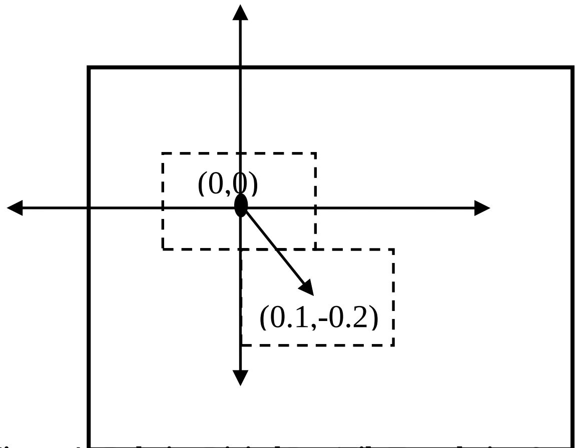

Figure 4: Relative Digital Pan/Tilt Translation Space.

The maximum translation in positive direction for pan and tilt in this coordinate system would be represented by (1,1) the same way as the maximum negative translation would map to the coordinate (-1,-1). For example, a translation of a cropped area on a megapixel sensor from its lower left corner to its upper right corner corresponds to a relative movement using the translation vector (1,1) assuming that the cropped area has zero size. The Digital Pan/Tilt Translation Space is defined as follows:

```
<tt:RelativePanTiltTranslationSpace>
  <tt:SpaceURI>
    http://www.onvif.org/ver10/tptz/PanTiltSpaces/DigitalTranslationSpace
  </tt:SpaceURI>
  <tt:XRange>
    <tt:Min>-1</tt:Min>
    <tt:Max>+1</tt:Max>
  </tt:XRange>
  <tt:YRange>
    <tt:Min>-1</tt:Min>
    <tt:Max>+1</tt:Max>
  </tt:YRange>
</tt:RelativePanTiltTranslationSpace>
```

3.2.4 Zoom Translation Space In Millimeter

The Zoom Translation Space In Millimeter derives from the Absolute Zoom Position Space In Millimeter specified in section 3.1.3 and specifies the translation of the focal length in the camera optics. If the NVT supports absolute zoom movements using the Absolute Zoom Position Space In Millimeter, the maximum negative and positive translation is given by the difference of the maximum and minimum position in Millimeter.

The Zoom Translation Space In Millimeter is defined as follows:[7]

```
<tt:RelativeZoomTranslationSpace>
  <tt:SpaceURI>
```

[7] The particular NVT should reference the propopsed name space but the actual range is device specific. The range indicated in the definition shall be interpreted as the maximum and minimum range limits for the space.

```
    http://www.onvif.org/ver10/tptz/ZoomSpaces/TranslationSpaceMillimeter
  </tt:SpaceURI>
  <tt:XRange>
    <tt:Min>-INF</tt:Min>
    <tt:Max>INF</tt:Max>
  </tt:XRange>
</tt:RelativeZoomTranslationSpace>
```

3.2.5 Normalized Digital Zoom Translation Space

The Normalized Digital Zoom Translation Space derives from the Absolute Normalized Digital Zoom Position Space specified in section 3.1.4 and specifies the translation of the mapping between the width of a window on a sensor and the width of the full sensor. A translation change in positive direction would make the window smaller in percentage of the sensor and thereby decreasing the field of view and increasing the zoom factor. This space requires a MediaProfile that's including a VideoEncoderConfiguration and a VideoSourceConfiguration.

Notice that a translation operation that uses this space will affect the width and height of the crop window that is configured in the VideoSourceConfiguration of the requested profile.

The Normalized Digital Zoom Translation Space is defined as follows:[8]

```
<tt:RelativeZoomTranslationSpace>
  <tt:SpaceURI>
    http://www.onvif.org/ver10/tptz/ZoomSpaces/NormalizedDigital
TranslationSpace
  </tt:SpaceURI>
  <tt:XRange>
    <tt:Min>-INF</tt:Min>
    <tt:Max>INF</tt:Max>
  </tt:XRange>
</tt:RelativeZoomTranslationSpace>
```

3.3 Continuous Velocity Spaces

The Continuous Velocity Spaces are used when the NVC wants to move the dome continuously in a certain direction with a defined speed.

If a camera supports e-flip (specified in section 3.1.1), and it's enabled, the following behaviour should be expected by the pan/tilt spaces defined in Section 3.3.1 and 3.3.2:

- If the tilt translation is passing nadir position (including the room for a hysteresis $\pm\alpha°$), the camera should rotate the image at nadir $\pm\alpha°$ as described in section 3.1.1 (only for cameras supporting absolute pan/tilt positioning). When a rotation occurs, the camera will continue the current movements according to the directions given when the command was issued. If the command is interrupted with a new request (after the flip), that request will be handled according to the new (flipped) direction and coordinates. A camera that doesn't support e-flip or has it disabled will not rotate the image and directions during a tilt movement passing nadir.

8 The particular NVT should reference the propopsed name space but the actual range is device specific. The range indicated in the definition shall be interpreted as the maximum and minimum range limits for the space.

3.3.1 Pan/Tilt Velocity Space in Degrees per Second

The Pan/Tilt Velocity Space In Degrees Per Second describes a continuous rotation around the pan and tilt axis (specified in section 3.1.1) with a constant rotation speed. Thereby, the velocity describes the signed pan and tilt angle change in degrees per second. The pan velocity is expressed by the X coordinate of the direction vector and the tilt velocity by the Y coordinate and the space is defined as follows:[9]

```
<tt:ContinuousPanTiltVelocitySpace>
  <tt:SpaceURI>
    http://www.onvif.org/ver10/tptz/PanTiltSpaces/VelocitySpaceDegrees
  </tt:SpaceURI>
  <tt:XRange>
    <tt:Min>-INF</tt:Min>
    <tt:Max>INF</tt:Max>
  </tt:XRange>
  <tt:YRange>
    <tt:Min>-INF</tt:Min>
    <tt:Max>INF</tt:Max>
  </tt:YRange>
</tt:ContinuousPanTiltVelocitySpace>
```

3.3.2 FOV Scaled Pan/Tilt Velocity Space Per Second

The FOV Scaled Pan/Tilt Velocity Space Per Second is introduced to support keyboard and joystick control, where the requested velocities are internally scaled by the current zoom factor of the dome. A pan/tilt vector in this space describes the move with respect to the current centre of the image. The length of this vector specifies the desired translation per second. This Space shall not be available in profiles without a VideoSourceConfiguration. The Space does not assume a certain dome model and can therefore be implemented on e.g. digital and mechanical domes.

The FOV scaled pan/tilt velocity space is defined as follows:[9]

```
<tt:ContinuousPanTiltVelocitySpace>
  <tt:SpaceURI>
    http://www.onvif.org/ver10/tptz/PanTiltSpaces/VelocitySpaceFOV
  </tt:SpaceURI>
  <tt:XRange>
    <tt:Min>-INF</tt:Min>
    <tt:Max>INF</tt:Max>
  </tt:XRange>
  <tt:YRange>
    <tt:Min>-INF</tt:Min>
    <tt:Max>INF</tt:Max>
  </tt:YRange>
</tt:ContinuousPanTiltVelocitySpace>
```

[9] The particular NVT should reference the propopsed name space but the actual ranges are device specific. The ranges indicated in the definition shall be interpreted as the maximum and minumum range limits for the space.

3.3.3 Zoom Velocity Space In Millimeter Per Second

The Zoom Velocity Space In Millimeter Per Second derives from the Zoom Translation Space In Millimeter in section 3.2.4 and specifies the change per second of the focal length. The Zoom Velocity Space in Millimeter Per Second space is defined as follows:[10]

```
<tt:ContinuousZoomVelocitySpace>
  <tt:SpaceURI>
      http://www.onvif.org/ver10/tptz/ZoomSpaces/VelocitySpaceMillimeter
  </tt:SpaceURI>
  <tt:XRange>
      <tt:Min>-INF</tt:Min>
      <tt:Max>INF</tt:Max>
  </tt:XRange>
</tt:ContinuousZoomVelocitySpace>
```

3.3.4 Normalized Digital Zoom Velocity Space Per Second

The Normalized Digital Zoom Velocity Space Per Second derives from the Normalized Digital Zoom Translation Space in section 3.2.5 and specifies the signed change per second of the ratio between window width and sensor width. The Normalized Digital Zoom Velocity Space Per Second is defined as follows:[10]

```
<tt:ContinuousZoomVelocitySpace>
  <tt:SpaceURI>
      http://www.onvif.org/ver10/tptz/ZoomSpaces/NormalizedDigitalVelocity
Space
  </tt:SpaceURI>
  <tt:XRange>
      <tt:Min>-INF</tt:Min>
      <tt:Max>INF</tt:Max>
  </tt:XRange>
</tt:ContinuousZoomVelocitySpace>
```

3.4 Speed Spaces

The Speed Spaces are introduced to specify the speed when moving to an absolute or relative position. Thereby, the NVC specifies the combined speed for the two direction parameters.

If Relative Translation Space and Continuous Velocity Space are already defined, the corresponding Speed Space is derived as follows: Requesting a continuous movement with a velocity V for T seconds, is identical (up to acceleration and positional inaccuracies) to requesting a relative movement with Relative Position R and Speed S, where R equals V times T and S equals the length of vector V. Therefore, Speed values are always positive.

3.4.1 Pan/Tilt Speed Space In Degrees Per Second

The Pan/Tilt Speed Space In Degrees per Second derives from the Absolute Pan/Tilt Position Space In Degrees and it specifies the pan/tilt speed in degrees per second for absolute and relative movements. The Pan/Tilt Speed Space In Degrees per Second is defined as follows:[10]

---

10 The particular NVT should reference the propopsed name space but the actual range is device specific. The range indicated in the definition shall be interpreted as the maximum and minimum range limits for the space.

```
<tt:PanTiltSpeedSpace>
  <tt:SpaceURI>
http://www.onvif.org/ver10/tptz/PanTiltSpaces/SpeedSpaceDegrees
  </tt:SpaceURI>
  <tt:XRange>
    <tt:Min>0.0</tt:Min>
    <tt:Max>INF</tt:Max>
  </tt:XRange>
 </tt:PanTiltSpeedSpace>
```

3.4.2 Pan/Tilt Speed Space In FOV Per Second

The Pan/Tilt Speed Space in FOV Per Second derives from the Relative Pan/Tilt Translation Space in FOV. When the NVC requests a relative movement with a Pan/Tilt Speed of 0.5 FOV Per Second, the scene part which was first observed at the centre of the image will have been moved to the image border after one second. This Space shall not be available in profiles without a VideoSourceConfiguration. The Space does not assume a certain dome model and can therefore be implemented on e.g. digital and mechanical domes.

The ONVIF pan/tilt speed space in FOV per second is defined as follows:[11]

```
<tt:PanTiltSpeedSpace>
  <tt:SpaceURI>
    http://www.onvif.org/ver10/tptz/PanTiltSpaces/SpeedSpaceFOV
  </tt:SpaceURI>
  <tt:XRange>
    <tt:Min>0.0</tt:Min>
    <tt:Max>INF</tt:Max>
  </tt:XRange>
</tt:PanTiltSpeedSpace>
```

3.4.3 Zoom Speed Space In Millimeter Per Second

The Zoom Speed Space In Millimeter per Second derives from the Zoom Velocity Space In Millimeter Second of section 3.3.3 and specifies the absolute change per second of the focal length. If the NVT supports the Zoom Speed Space The Zoom Speed Space In Millimeter per Second is defined as follows:[11]

```
<tt:ZoomSpeedSpace>
  <tt:SpaceURI>
http://www.onvif.org/ver10/tptz/ZoomSpaces/SpeedSpaceMillimeter
  </tt:SpaceURI>
  <tt:XRange>
    <tt:Min>0.0</tt:Min>
    <tt:Max>INF</tt:Max>
  </tt:XRange>

</tt:ZoomSpeedSpace>
```

[11] The particular NVT should reference the propopsed name space but the actual range is device specific. The range indicated in the definition shall be interpreted as the maximum and minimum range limit for the space.

3.4.4 Normalized Digital Zoom Speed Space Per Second

The Normalized Digital Zoom Speed Space Per Second derives from the Normalized Digital Zoom Translation Space in section 3.2.5 and specifies the absolute change per second of the ratio between window width and sensor width. If the NVT supports absolute or relative zoom movements using the Normalized Digital Zoom Position Space or the Normalized Digital Zoom Position Space, the desired speed can be set using the Normalized Digital Zoom Speed Space Per Second. The Normalized Digital Zoom Speed Space Per Second is defined as follows:[12]

```
<tt:ZoomSpeedSpace>
  <tt:SpaceURI>
      http://www.onvif.org/ver10/tptz/ZoomSpaces/NormalizedDigitalSpeedSpa
ce
  </tt:SpaceURI>
  <tt:XRange>
      <tt:Min>0</tt:Min>
      <tt:Max>INF</tt:Max>
  </tt:XRange>
</tt:ZoomSpeedSpace>
```

[12] The particular NVT should reference the propopsed name space but the actual range is device specific. The range indicated in the definition shall be interpreted as the maximum and minimum range limits for the space.