Physical Unit Specification for Virtual Reality

December 16, 2008

Web3D Korea Meeting, Seoul, Korea

The U. Of Suwon

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Measurement Units for VR

- Specification of SI Units for X3D
  - Length, mass, electric current, thermodynamic temperature, volume, time, sound pressure, luminous intensity, amount of substance
  - Based on International System of Units (SI Units)

- Definition of a Physical Unit Component
  - Definition of a Physical node
  - Definition of a Length node
  - Definition of other physical properties

Applications

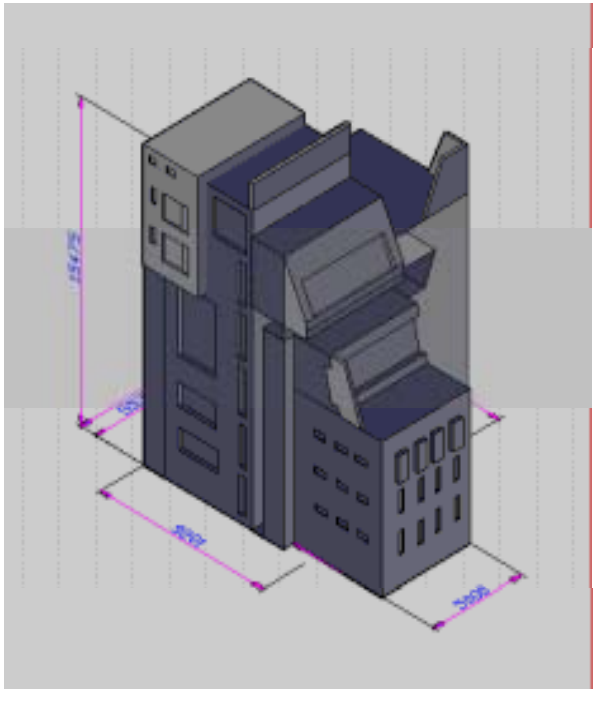
- CAD units
- Medical units
- GIS units
- Anthropometric units
- Microorganism units
- Astronomical units

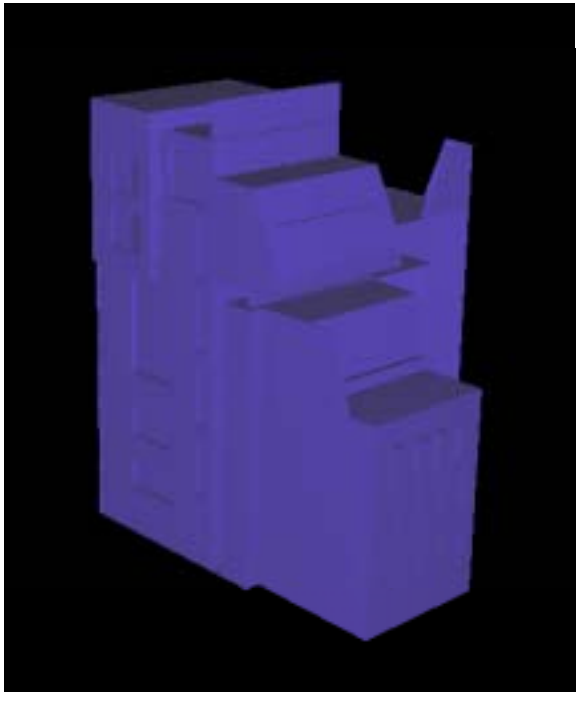
Unit X3D and Metadata

- Unit X3D
  - Allows comparison of objects' physical properties visually in the scene
  - Easy to insert the unit component into an X3D file
  - Does not interfere with X3D grammars nor X3D scene hierarchy
- Metadata
  - Not easy for users to match objects with their metadata
  - No visual effect on 3D objects
  - Appropriate for use by XML specialists
  - Inappropriate for 3D application developers or general Web users
  - Exists separately from the 3D scene

Unit X3D Examples - CAD

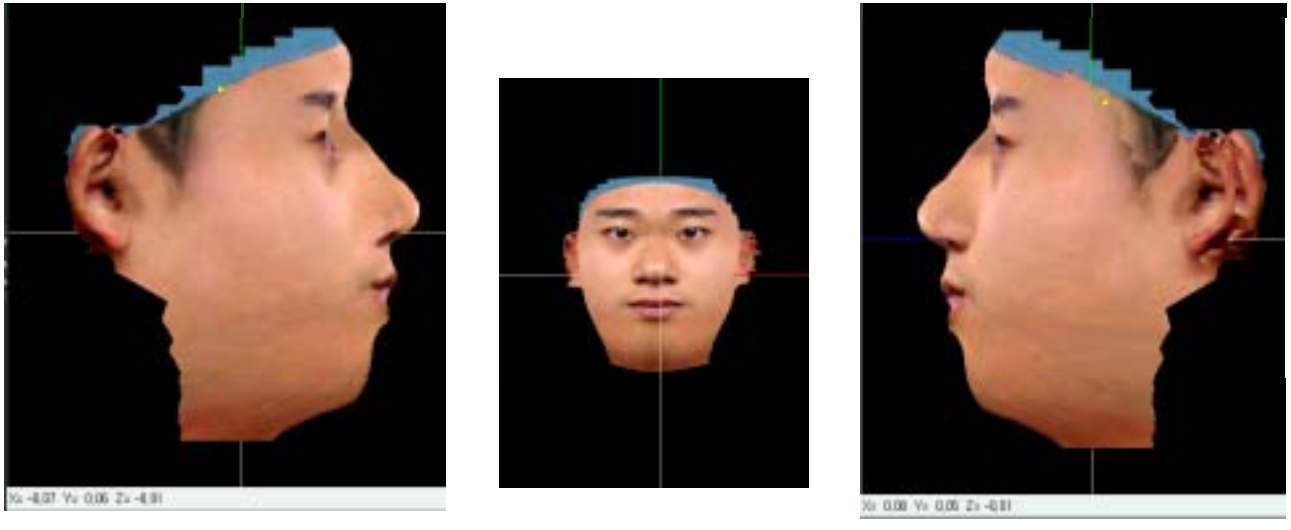
CAD applications





Unit X3D Examples – 3D Anthropometry

3D anthropometric applications



A facial model defined in millimeter unit

Definition of a Physical Node

- **Physical node**
  - Defines the physical units for an object

```
Physical : X3DPhysicalNode {
SFNode   [in,out]  Length          NULL [Length]
SFNode   [in,out]  Area            NULL [Area]
SFNode   [in,out]  Volume          NULL [Volume]
SFNode   [in,out]  Mass            NULL [Mass]
SFNode   [in,out]  Time            NULL [Time]
SFNode   [in,out]  Current         NULL [Current]
SFNode   [in,out]  Temperature     NULL [Temperature]
SFNode   [in,out]  Substance       NULL [Substance]
SFNode   [in,out]  Luminous        NULL [Luminous]
SFNode   [in,out]  SoundPressure   NULL [SoundPressure]
SFNode   [in,out]  metadata        NULL [X3DMetadataObject]
}
```

  - The field values can be NULL or contain an appropriate node type

Definition of a Length Node

- **Length node**

```
Length : X3DPhysicalNode {
 SFString  [in,out]    unit          “UNI”  [“YOTTA”|”ZETTA”|”EXA”|”PETA”|”TERA”|”GIGA”|
         ”MEGA”|”KILO”|”HECTO”|”DECA”|”UNI”|”DECI”|”CENTI”|”MILLI”|”MICRO”|”NANO”|
         ”PICO”|”FEMTO”|”ATTO”|”ZEPTO”|”YOCTO”|”INCH”|”LINK”|”FT”|”YD”|”RD”|
          ”CHAIN”|”FL”|”MILE”|”LG”|”MIL”|”AU”|”LY”|”PC”|”KPC”|”NMILE”|”ANG”|”USER”]

SFFloat   [in,out]   basis         “1”      [-∞ , ∞]
SFString  [in,out]   numeral       “DEC”  [“SCIEN” | “DEC” | “ENGIN” | “ARCH” | “FRAC”]
SFNode    [in,out]   metadata      NULL  [X3DMetadataObject]
}
```

  - The basic unit of a Length node is meter
  - The Unit field specifies a length unit
  - The Base field specifies the scale of measurement for the user-defined length unit, based on meter equal to 1
  - The Numeral field is for displaying the unit specification

Definition of Other Physical Properties

- **Area node**
  - Specifies an area unit for the area composing an object
  - The basic unit is square meter (m^2)
  - Located below the X3DPhysicalNode; derived from the X3DShapeNode
  - The Unit field specifies an area unit
  - The Value field specifies the value for an area

```
Area : X3DPhysicalNode {
SFString  [in,out]   unit                    “UNI2”
[”CENTI2”|”UNI2”|”FT2”|” YD2”|” HA”|”ACRE”|]
SFFloat   [in,out]   value          “1”      [-∞ , ∞]
SFNode    [in,out]   metadata       NULL     [X3DMetadataObject]
}
```

Definition of Other Physical Properties

- **Volume node**
  - The Volume node specifies the unit for an object's volume
  - The basic unit is cubic meter (m^3)
  - Located below the X3DPhysicalNode; derived from the X3DShapeNode
  - The Unit field specifies the unit of a volume
  - The Value field specifies the value for a volume

```
Volume : X3DPhysicalNode {
SFString  [in,out]   unit                    "UNI3"
["CENTI3"|"UNI3"|"FT3"|" YD3"|" DL"|"ML"|"L"|]
SFFloat   [in,out]   value          "1"      [-∞ , ∞]
SFNode    [in,out]   metadata       NULL     [X3DMetadataObject]
}
```

Definition of Other Physical Properties

- **Mass node**
  - The Mass node defines a mass unit for an object
  - It is defined by SI (International System of Units) and the basic unit is kilogram (kg)
  - Located below an X3DPhysicalNode; derived from an X3DShapeNode
  - The Unit field specifies a mass unit
  - The Value field specifies a value for the mass unit

```
Mass : X3DPhysicalNode {
SFString  [in,out]    unit        “KG”
                    [”MG”|”G”|”KG”|”LB”|”TON”|”GRAIN”|”OZ”]
SFFloat   [in,out]    value       “1”       [-∞ , ∞]
SFNode    [in,out]    metadata    NULL      [X3DMetadataObject]
}
```

Definition of Other Physical Properties

- **Time node**
  - The Time node specifies the unit for time
  - It follows SI (International System of Units) specification; the basic unit is second
  - Located below an X3DPhysicalNode; derived from an X3DShapeNode
  - The Unit field specifies a time unit
  - The Value field specifies a value for the time unit

```
Time : X3DPhysicalNode {
SFString  [in,out]   unit        “S”      [”S”|”M”|”H”]
SFFloat   [in,out]   value       “1”      [-∞ , ∞]
SFNode    [in,out]   metadata    NULL     [X3DMetadataObject]
}
```

Definition of Other Physical Properties

- **Current node**
  - The Current node specifies the electric current unit for an object
  - It follows SI (International System of Units) specification; the basic unit is ampere (A)
  - Located below an X3DPhysicalNode; derived from an X3DShapeNode
  - The Unit field specifies an electric current unit
  - The Value field specifies a value for the current unit

```
Current : X3DPhysicalNode {
SFString  [in,out]    unit          “A”
SFFloat   [in,out]    value         “1”       [0 , ∞]
SFNode    [in,out]    metadata      NULL      [X3DMetadataObject]
}
```

Definition of Other Physical Properties

- **Temperature node**
  - The Temperature node specifies the unit for an object's or an environment's temperature
  - It follows SI (International System of Units) specification; the basic unit is Kelvin (K)
  - Located below an X3DPhysicalNode; derived from an X3DShapeNode
  - The Unit field specifies a temperature unit
  - The Value field specifies a value for the temperature unit

```
Temperature : X3DPhysicalNode {
SFString  [in,out]    unit          "K"
                                    ["0C"|"0F"|"K"|"0E"]
SFFloat   [in,out]    value         "1"       [0 , ∞]
SFNode    [in,out]    metadata      NULL      [X3DMetadataObject]
}
```

Definition of Other Physical Properties

- **Substance node**
  - The Substance node specifies the unit for an object's substance
  - It follows SI (International System of Units) specification; the basic unit is mol
  - Located below an X3DPhysicalNode; derived from an X3DShapeNode
  - The Unit field specifies a substance unit
  - The Value field specifies a value for the substance unit

```
Substance : X3DPhysicalNode {
SFString  [in,out]    unit          “”
SFFloat   [in,out]    value         “1”       [0 , ∞]
SFNode    [in,out]    metadata      NULL      [X3DMetadataObject]
}
```

Definition of Other Physical Properties

- **Luminosity node**
  - The Luminosity node specifies the luminous intensity for an object
  - It follows SI (International System of Units) specification; the basic unit is candela
  - Located below an X3DPhysicalNode; derived from an X3DShapeNode
  - The Unit field specifies a luminosity unit
  - The Value field specifies a value for the luminosity unit

```
Luminosity : X3DPhysicalNode {
SFString  [in,out]    unit          “”
SFFloat   [in,out]    value         “1”       [0 , ∞]
SFNode    [in,out]    metadata      NULL      [X3DMetadataObject]
}
```

Definition of Other Physical Properties

- **SoundPressure node**
  - The SoundPressure node specifies the sound pressure for an object
  - It follows SI (International System of Units) specification; the basic unit is decibel (dB)
  - Located below an X3DPhysicalNode; derived from an X3DShapeNode
  - The Unit field specifies a sound pressure unit
  - The Value field specifies a value for the sound pressure unit

```
SoundPressure : X3DPhysicalNode {
SFString  [in,out]    unit          “”
SFFloat   [in,out]    value         “1”       [0 , ∞]
SFNode    [in,out]    metadata      NULL      [X3DMetadataObject]
}
```

Examples of Unit Specification

```
<Scene>
  <physical>
    <length unit="INCH" basis = "1" numeral= "DEC"/>
      <Transform scale="1 1 1" translation = "0 0 0">
        <Shape>
          [……..] // Coordinate Point
        </Shape>
      </Transform>
    </physical>
</Scene>
```

- A 3D facial model specified in inch unit
- Capable of defining its real size

Implementation Results

1. Cup → Millimeter (10^{-3})
2. Table → Centimeter (10^{-2})
3. Chair → Centimeter (10^{-2})

Schedule for the Unit VR Proposal

- **NP Document Submission to ISO: December 2008**
- **Working Draft Submission to Web3D Consortium: January 2009**
- **Presentation at SC24 Plenary Meeting: July 2009**

Thank you!