Coordinate Systems
Introduction

- This overview of coordinate systems for georeferencing provides a brief description of local & global systems for use in precise positioning, navigation and geographic information systems for the location of points in space.
Used co-ordinate systems

- There are many different coordinate systems based on a variety of geodetic datum, units, projections and reference systems in use today.

<table>
<thead>
<tr>
<th>Datum</th>
<th>Coordinate System</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAD 83</td>
<td>Geodetic Latitude, Longitude</td>
<td>Deg:Min:Sec</td>
</tr>
<tr>
<td>WGS 84</td>
<td>World Geographic Reference System</td>
<td>Deg:Min:Sec</td>
</tr>
</tbody>
</table>
Two dimensional coordinate systems are defined with respect to a single plane.
Polar Coordinates in a plane

Point referenced by Radius and Angle of directed line $r = 3.5$, $\Theta = 60^0$
3-d Cartesian Coordinates

Three dimensional coordinate systems can be defined with respect to two orthogonal planes.
Three dimensional coordinate systems can be defined with respect to two orthogonal planes.

X = r cos (φ) cos (Θ)
y = r cos (φ) sin (Θ)
z = r sin (φ)
2-D coordinate transformation

Transformation from polar into rectangular coordinates

\[ x = r \sin \Theta \]
\[ y = r \cos \Theta \]
Linear conformal, similarity or Helmert transformation

\[ X = A + Cx + Dy \]
\[ Y = B - Dx + Cy \]

\((X,Y)\) – Coordinate System 1 (Terrain coordinates)
\((x,y)\) – Coordinate System 2 (Image coordinates)

\((A,B,C,D)\) – Transformation parameters

\[ C = \cos \alpha \]
\[ D = \sin \alpha \]

\[ A = \text{Shift in } x \text{ direction} \]
\[ B = \text{Shift in } y \text{ direction} \]
The position on Map & Image

Topographical Map

(7,12)

(20,4)

Satellite Image

(2,9)

(10,3)
Affine Transformation

\[ X = A + Cx + Dy \]
\[ Y = B - Ex + Fy \]

\((X,Y)\) – Coordinate System 1 (Terrain coordinates)
\((x,y)\) – Coordinate System 2 (Image coordinates)

\((A,B,C,D,E,F)\) – Transformation parameters

\[ C = m1 \cos \alpha \]
\[ D = m1 \sin \alpha \]
\[ E = m2 \sin \beta \]
\[ F = m2 \cos \beta \]

\(A = \text{Shift in x direction}\)
\(B = \text{Shift in y direction}\)
Helmert Vs Affine Transformation

Translation of the axes or change of origin, corresponding to the coefficients A and B in both equations

Change of scale from one grid system to other

Rotation of the axes of one grid system with respect to other directions in the other
References:

http://www.cnr.berkeley.edu/~gong/textbook/
http://www.science.edu.sg/ssc/virtual_ssc.jsp
http://www.map-reading.com
http://www.gsd.harvard.edu/gis/manual/projections/fundamentals/
http://www.w3.org/TR/SVG/coords.html