

Orbify: Continuous Local-to-Aerial Spatial Representation

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Abstract. Digital spatial interfaces commonly separate local perspective views from broader aerial or plan views. Orbify transforms a spatial model around a viewer-relative curved surface so that nearby content retains perspective-like depth while more distant content transitions toward an aerial or top-down orientation. The result is a continuous representation connecting local detail with wider spatial context. The method is independent of source-model technology and can incorporate three-dimensional spatial data together with routes, sensors and other contextual information.

1. Introduction

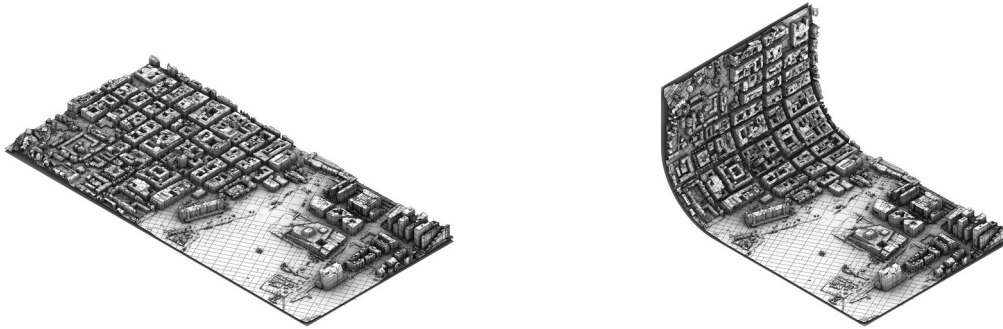
A ground-level perspective supports recognition of immediate geometry, landmarks and action possibilities, while an aerial or plan view exposes route structure and broader spatial relationships. Spatial-cognition research describes these as related but distinct egocentric and allocentric frames of reference [1,2]. The perspective through which an environment is learned affects the spatial knowledge most readily acquired [3,4], and switching between frames can impose measurable cognitive cost [5].

Orbify makes the relationship between near and far space part of the interface itself. Geometry is transformed relative to a point of interest and viewing direction, with the transformation varying by distance. A single image can therefore contain a perspective-like local region, a continuous transition and an aerial or top-down region. The underlying model may come from photogrammetry, LiDAR, GIS, point clouds, meshes, terrain models, imagery or other spatial data; routes, waypoints, tracked objects and live data can follow the same mapping.

The equations below describe one simple mathematical realization of the illustrated geometry. Other curve profiles and scale functions can implement the same continuous local-to-global principle.

2. Curved spatial transformation

The paired diagrams show an undeformed model at left and a transformed model at right. The ground surface rises through a curved transition and then reaches a non-curved distal region. Let d denote forward distance from the viewer, B the bend start, R the bend radius, and F and U the transformed forward and vertical coordinates. A quarter-circle transition followed by a straight continuation can be written as:



$$\theta = \frac{d - B}{R}$$

$$d \leq B : \quad F = d, \quad U = 0$$

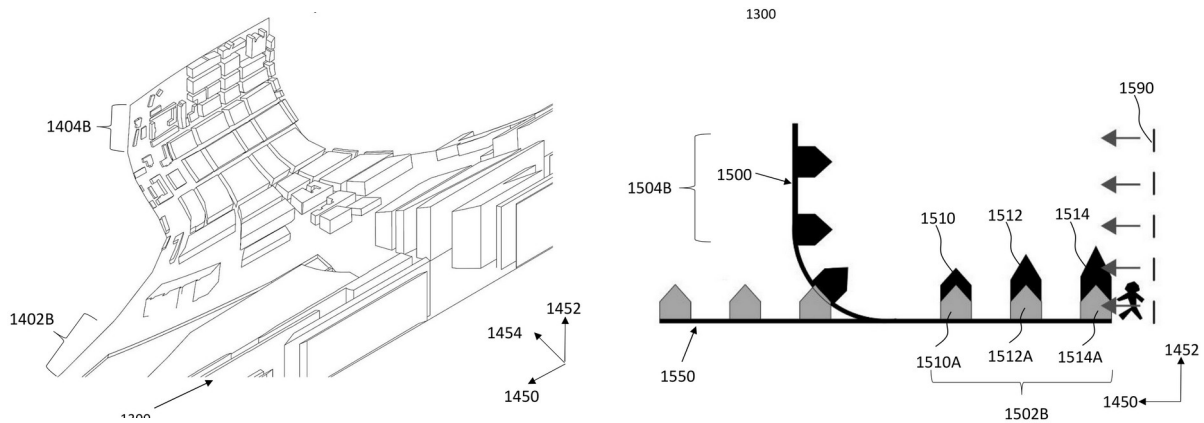
$$B < d \leq B + \frac{\pi R}{2} : \quad F = B + R \sin \theta, \quad U = R(1 - \cos \theta)$$

$$d > B + \frac{\pi R}{2} : \quad F = B + R, \quad U = R + d - B - \frac{\pi R}{2}$$

Within the curved interval, forward distance turns the surface upward. After a quarter turn, the continuation is non-curved. Spatial geometry follows the surface orientation, creating a continuous transition from local view to overview. A larger R spreads the transition over a greater distance; a smaller R compresses it. The non-curved distal region provides a stable area for plan-like reading, overlays and larger spatial relationships.

3. Simulating local perspective while preserving a distant top view

A second part of the transformation controls apparent depth near the viewer. In the left diagram, local portion 1402B is bent and scaled along two orthogonal axes: 1450 horizontally and 1452 vertically. The scale varies with distance along axis 1454 and can decrease toward distal portion 1404B. The side view at right shows the same principle: buildings nearest the viewer are enlarged most, while successive buildings approach their original dimensions with distance.



Near-field enlargement can be described with distance-dependent scale functions. Let s be the horizontal coordinate, h the vertical coordinate, h_c an optional vertical scaling center, and $a_s(d)$ and $a_h(d)$ the horizontal and vertical scale functions at distance d :

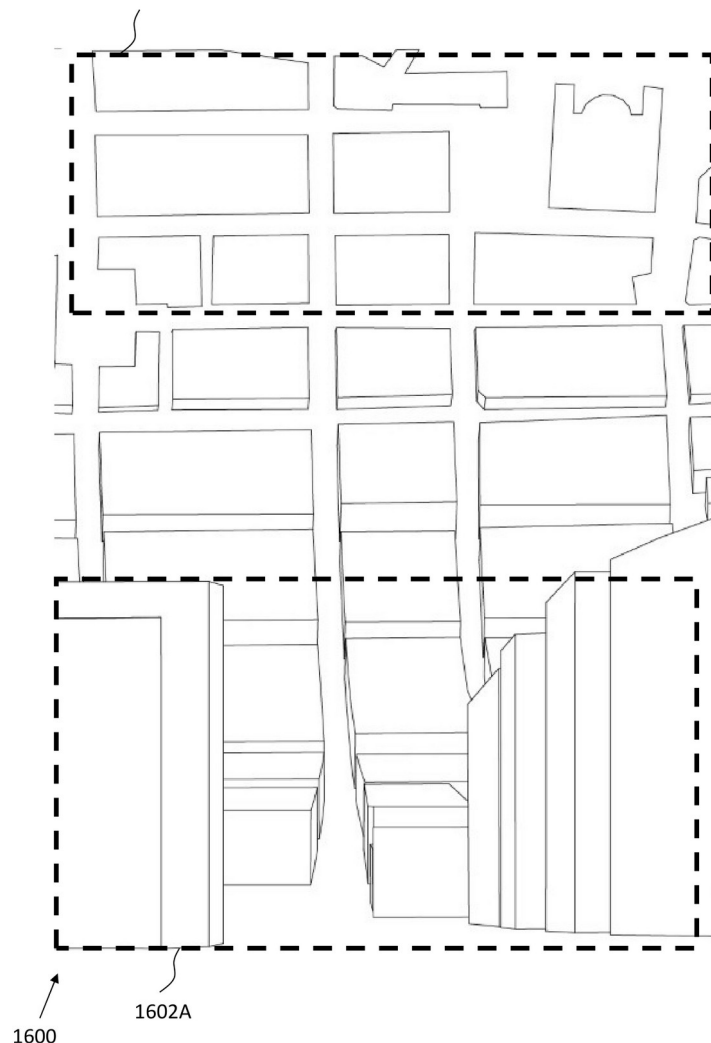
$$s' = a_s(d) s$$

$$h' = h_c + a_h(d) (h - h_c)$$

The horizontal and vertical scale functions may be defined independently. One or both can be larger near the viewer and progressively approach 1 with distance. In the diagrams, scaling occurs along axes 1450 and 1452 and varies along axis 1454. Under parallel or orthographic projection, this can produce a perspective-like local reading while preserving a flatter, more stable distant region.

4. A single image containing local and global spatial information

With parallel or orthographic projection, the transformed model can contain two continuous readings of the same space. In the output below, the lower region reads as simulated perspective because nearby geometry is bent and scaled, while the upper region reads as a top-down view because the corresponding model region is substantially flat and receives little or no local scale deformation.



The key property is continuity rather than a particular screen layout. Local detail, transitional geometry and wider plan context occupy one coherent spatial field instead of separate windows. The transformation can be centered on a person, vehicle, vessel, robot, camera, cursor or other point of interest and oriented to a heading, route or other selected axis.

5. Dynamic spatial interface

The transformation can update continuously as position or viewing direction changes. Curvature, angular extent and local scaling can vary with context, speed, route length, task or display area.

Because the transformation operates on spatial model data, scene content and secondary information can remain spatially registered as the representation changes. Routes, waypoints, labels, tracked objects, sensor fields, traffic, weather and other live information can share the same geometry. The principle can be applied to navigation, remote supervision, autonomous-system interfaces, spatial computing and control-room environments where local action must be understood together with wider context.

6. Relation to prior work

Orbify builds on a broader lineage of focus+context, multi-perspective and multi-scale visualization. Lorenz et al. (2008) describe multi-perspective views of virtual 3D landscape and city models using global space deformation with a standard linear projection [6]. The Perspective Wall integrated detail and overview on a continuous surface [7]; distortion-oriented interfaces explored magnification while retaining context [8]; and Worlds in Miniature explored simultaneous access to different spatial scales [9]. Orbify further develops this line of work through a viewer-relative local-to-aerial transformation

combining curved deformation with distance-dependent scaling. Section 3 allows horizontal and vertical scaling to vary independently and fade toward the distal region, supporting a perspective-like local reading while retaining a stable aerial region. The distal region can resolve into a true orthographic top-down view, allowing maps, routes, tracks, waypoints and other 2D or 3D information to be composited without perspective tilt or parallax. For content in the top-view plane, orthographic projection preserves uniform scale and parallelism, supporting direct reading of distances and bearings and clean alignment with 2D map layers. This is a practical further development of the broader multi-perspective approaches in the cited work. More generally, clear and predictable transitions can support stable interpretation of a transformed spatial view [8,10].

Spatial-cognition research provides a complementary foundation. Egocentric representations are organized around the observer, while allocentric representations encode relations among objects and locations [1,2]. First-person and map-based learning support partly different forms of route and survey knowledge [3,4]. Orbify builds on these complementary frames by making the transition between them continuous and spatially legible rather than requiring a discrete mode switch.

7. Conclusion

Orbify proposes a spatial representation in which first-person detail and map-level overview form one continuous view. By bending a model relative to a point of interest and, where useful, applying stronger scale deformation near that point, the representation can preserve local perspective-like information while progressively exposing an aerial or orthographic overview. The geometry may be cylindrical, spherical, piecewise or otherwise task-specific; the core principle is a continuous relationship between the near field and the larger world around it.

About Orbify

Orbify.eu develops spatial-interface technology for representing, understanding and navigating complex three-dimensional environments. The company was founded by Karsten Huitfeldt and Kai Reaver, PhD.

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