

Automated outline and landmark generation of footprints based on 3D-models

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Abstract:

The lack of widely applicable methods to objectively define the margins of footprints remains a central problem in ichnology, especially when the margins are indistinct. Any characterisation of footprint shape is thus unavoidably affected by the subjectivity of the observer. Interpretive outline drawings remain the main means for capturing footprint shapes, although outlines drawn by separate ichnologists can drastically differ especially when conflicting preconceptions about the responsible trackmaker taxon are involved. The resulting subjectivity equally affects measurements and landmark coordinates. As was argued in a recent publication, results of quantitative analyses based on subjective data can only be equally subjective.

To address this unsolved issue, a program is presented that generates objective outlines, landmarks, and measurements based on 3D-models of footprints in a single step. The program fits the model to the horizontal plane and extracts a fixed number of contour lines. Relevant contours are selected, and the points of the steepest slope detected along the footprint wall. The resulting outline is then rotated so that the digit impressions point upwards. For tridactyl footprints, an automatic landmark generation is implemented, from which objective measurements can be derived. The method was tested on tridactyl dinosaur tracks from the Lower Cretaceous of Münchehagen, Germany, reproducing results made by an earlier study based on interpretive outlines. While not an adequate replacement of interpretive drawings, generated outlines may form an objective basis for the latter. Most importantly, the method for the first time allows for fully objective quantitative analyses of footprint shapes.

Keywords: vertebrate ichnology, objective data analysis, shape analysis, landmark detection, algorithm