INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY
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R&D SHOWCASE 2021

TOPOLOGY ALIGNED LEAST-COST ROUTING MODEL FOR CANALS

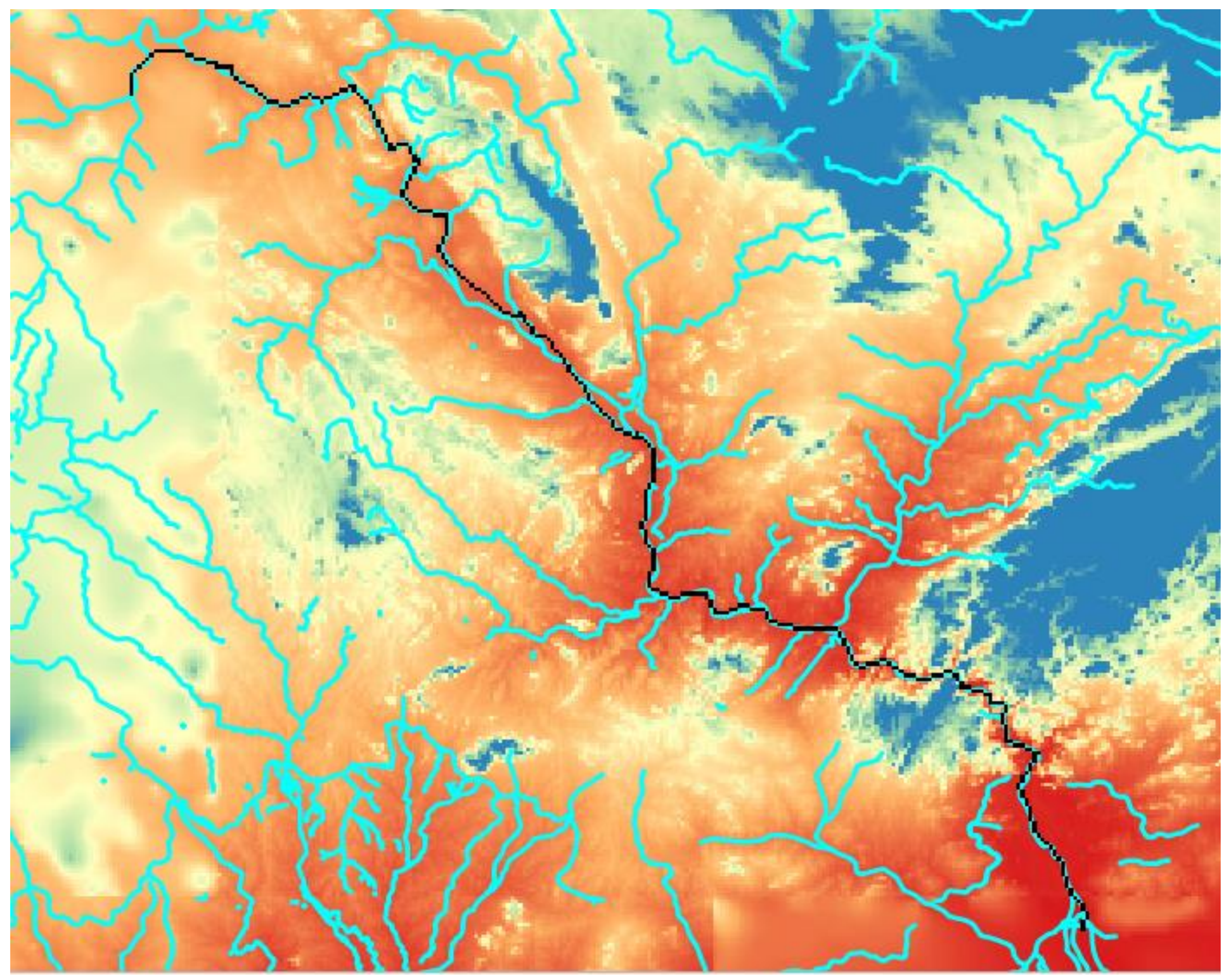
ABSTRACTS

Contour maps and low resolution DEMs have been used by Irrigation engineers and planners to assess the canal routing options, which is time consuming and requires repeated evaluations of the potential paths. So, there is a need to develop robust path planning algorithms, including least cost routing, that takes the topographic and engineering constraints while providing potential canal routing paths. Some recent works have attempted to develop algorithms on synthetic data sets but have not been scaled up on high-resolution data sets, limiting their practical use.

This work develops a generic algorithm to determine the least-cost flow path between two geo-locations, given the grid-based Digital Elevation Models (DEMs) and a unit cost of construction per length. From the numerous paths that are possible between the two points in any given topography, a distinct least-cost path is identified. The proposed approach is evaluated by computing canal routing paths over publicly available real-world datasets across two different resolutions of 1Km and 90-meter from different sources for Indian terrains.

RESULTS

The figure shows the result of the least-cost path algorithm applied on the Godavari river basin belonging to the eastern ghats topography. The black pixels indicate the resultant path on applying the algorithm whereas the blue pixels indicate the real-world canal data. We found an accuracy of over 95% when compared with the reference canal data.



OBJECTIVE

The proposed algorithm takes a grid-based DEM data, a start coordinate and an end coordinate, cost of constuction per unit length, C_c and cost to lift the water along the surface of the terrain upto a height of 10 meters, C_l as the inputs. We use Terra-cost alogrithm to solve the problem. Using the D8 Flow Direction model, at each point, identifying a path is possible based on the slope. We start by finding out the gravitational path from start point to an endpoint. If a gravitational path couldn't be found, we use lift procedure to find out a least-cost path. The cost will be calculated cumulatively from the departing point to its 8 adjacent neighbours till the end point. The cost from start coordinate to the end coordiante is calculated as $LCRM = L_{(S,E)} * C_c + \Sigma\ [(|h(s_u) - h(e_u)|)/10] * C_l$ where u = (0, k) representing the potential lift points along the surface of the terrain. $L_{(S,E)}$ is the path from start coordiante to the end coordinate. $h(s_u)$ is the elevation at a point s_u

100	99	101	97	100
100	98	102	98	99
99	104	97	96	101
98	95	101	95	94
97	96	96	93	92

Table 1: The table describes the elevation values

0	1	∞	∞	∞
1	√2	∞	∞	∞
∞	∞	∞	∞	∞
∞	∞	∞	∞	∞
∞	∞	∞	∞	∞

Table 2: Cost of construction after 3 iterations

0	1	∞	∞	∞
1	√2	∞	∞	∞
2	∞	2√2	∞	∞
∞	∞	∞	∞	∞
∞	∞	∞	∞	∞

Table 3: Cost of construction after 8 iterations

0 → ↓ ↘	1 ↓	∞	∞	∞
1 → ↓	√2 ↘	∞	∞	∞
2 ↓ ↘	∞	2√2 → ↙ ↘	1+2√2 ↓ ↘	∞
3 → ↓	2+√2 ↓	∞	3√2 → ↘	1+3√2 ↓
4 →	3+√2 →	2+2√2 →	1+3√2 →	4√2

Table 4: Final result

Considering the cost of a 10-meter lift being uniform across, arrow indicates the possible flow directions. For the cell (3,1) highlighted in yellow, three paths are possible from (2,0), (2,2) and (3,0). Among all these, the least-cost path is chosen and so, the canal path to (3,1) is from (2,0). Desired path from top-left to bottom-right coordinate would be towards the south-east direction.

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