Planning bicycle infrastructure based on quickest route method

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Purpose of the Research: To develop a model for bicycle infrastructure planning that allows choosing the quickest route considering that speed varies according to human physical abilities.

Objectives:
- Identify the criteria that have the most significant influence on bicycling travel time
- Develop a model of estimating travel time that accounts for maximum power available to the rider
- Solve bicycle route choice problem to minimize travel time
- Propose location of bicycle ways based on fastest routes

Findings from Literature
- Safety is an important concern for all types of riders
- Time is the most important factor for utilitarian cyclists
- Bicyclists ride faster if they feel safe on the road
- A commuter cyclist would rather cycle 1.76 miles on a flat route than bicycling one mile on an uphill slope of 2-4 percent
- Women prefer flat or moderate terrain while men prefer moderate to steep slopes
- Speed varies significantly based on the topography

Lack of existing methods:
Infrastructure planning framework does not consider travel time along the routes proposed. Current bicycle models assume average speed along the route and among routes and travel time is proportional to average speed along the route and among proposed. Current bicycle models assume not consider travel time along the routes

PLANNING BICYCLE INFRASTRUCTURE BASED ON THE QUICKEST OR EASIEST ROUTE METHOD

1. Identify the criteria that have the most significant influence on bicycling travel time

Factors that affect bicycling travel time

- Speed
- Physical Condition (age of rider)
- Gender
- Slope
distance

Travel Time

Shortest route

Human Power

2. Develop a model of estimating travel time that accounts for maximum power available to a rider

Model of Route Choice

- Length
- Speed
- Output Power
- Work
- Easiest Route

Conceptual Model of Route Choice

3. Solve bicycle route choice problem to minimize travel time

Two scenarios of Route Travel Time

Scenario 1—Travel time calculated based on constant speed
Scenario 2—Travel time calculated based on Power Model

4. Prioritize bikeways location

Quickest or Easiest Route Method

- To estimate time for integrating transit and cycling;
- To prioritize bikeway infrastructure;
- To evaluate the levels of difficulty for different routes;
- Can be integrated into personalized route planning software

Application to Practice

- To calculate time for travel forecasting models;
- To develop a model to estimate bicycling speed based on relationship between human power and road topography
- Model allows to predict realistic bicycling travel time
- Optimal route can be solved with time (quickest) or work (easiest) impedance

References

Key Results
- Developed a model to estimate bicycling speed based on relationship between human power and road topography
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Speed—Power Relationship

\[ \text{Speed} = \frac{W_{\text{max}}}{K_a + m g (s + c_a) + K_c V_c^2} \]

Model Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerodynamic-drag factor (K_a)</td>
<td>0.3871</td>
</tr>
<tr>
<td>Riding velocity (V)</td>
<td>6</td>
</tr>
<tr>
<td>Mass (m)</td>
<td>95</td>
</tr>
<tr>
<td>Acceleration due to gravity (g)</td>
<td>9.81</td>
</tr>
<tr>
<td>Slope (s)</td>
<td>varies</td>
</tr>
<tr>
<td>Coefficient of rolling resistance (c_a)</td>
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</tr>
<tr>
<td>Maximum power output (W_{max})</td>
<td>200</td>
</tr>
<tr>
<td>Convergence parameter (K_c)</td>
<td>9.5</td>
</tr>
</tbody>
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External Power Relationship

\[ P_{\text{ex}} = \frac{1}{K_a + m g (s + c_a) + K_c V_c^2} \]

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