同济大学交通运输工程学院
COLLEGE OF TRANSPORTATION ENGINEERING
TONGJI UNIVERSITY

Aesthetic calculation and analysis of road environment on rural roads

Reporter:
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ABOUT MYSELF

WEIXI REN， Ph.D candidate

B.S., Civil Engineering, Tongji University 2016.9~2020.8

- **GPA:** 90.21(100), Ranking: 1/39
- **Awards:** University-level Tongji Scholarship of Excellence, First Prize (1%)； Outstanding Graduate Award of Tongji University (5%)

Ph.D. Candidate in Transportation Engineering, Tongji University

Research interests

Driver Visual Perception

Driving Risk Analysis

Traffic data analysis

Skills

Computer proficiency: Python, Matlab

Software: AutoCAD, Vissim, Photoshop

Data processing: Naturalistic driving data, Driving simulator data， Eye-tracking data, EMG, ECG, EEG data

METHODOLOGY AND RESULT

Naturalistic Driving Experiment

More than 50000 kilometers

Two-way two-lane rural roads in five Chinese provinces:

Tibet, Anhui, Shandong, Jiangxi, and Zhejiang

Diverse **surrounding landscapes**

Driver	Min	Max	Mean	SD
Age	23	50	32.9	7.1
Gender	9 females (21%)		33 males (79%)	
Driving years	3	22	16	5.4

Data Collection

GARMIN GDR35 driving recorder → Road environment perceived by driver

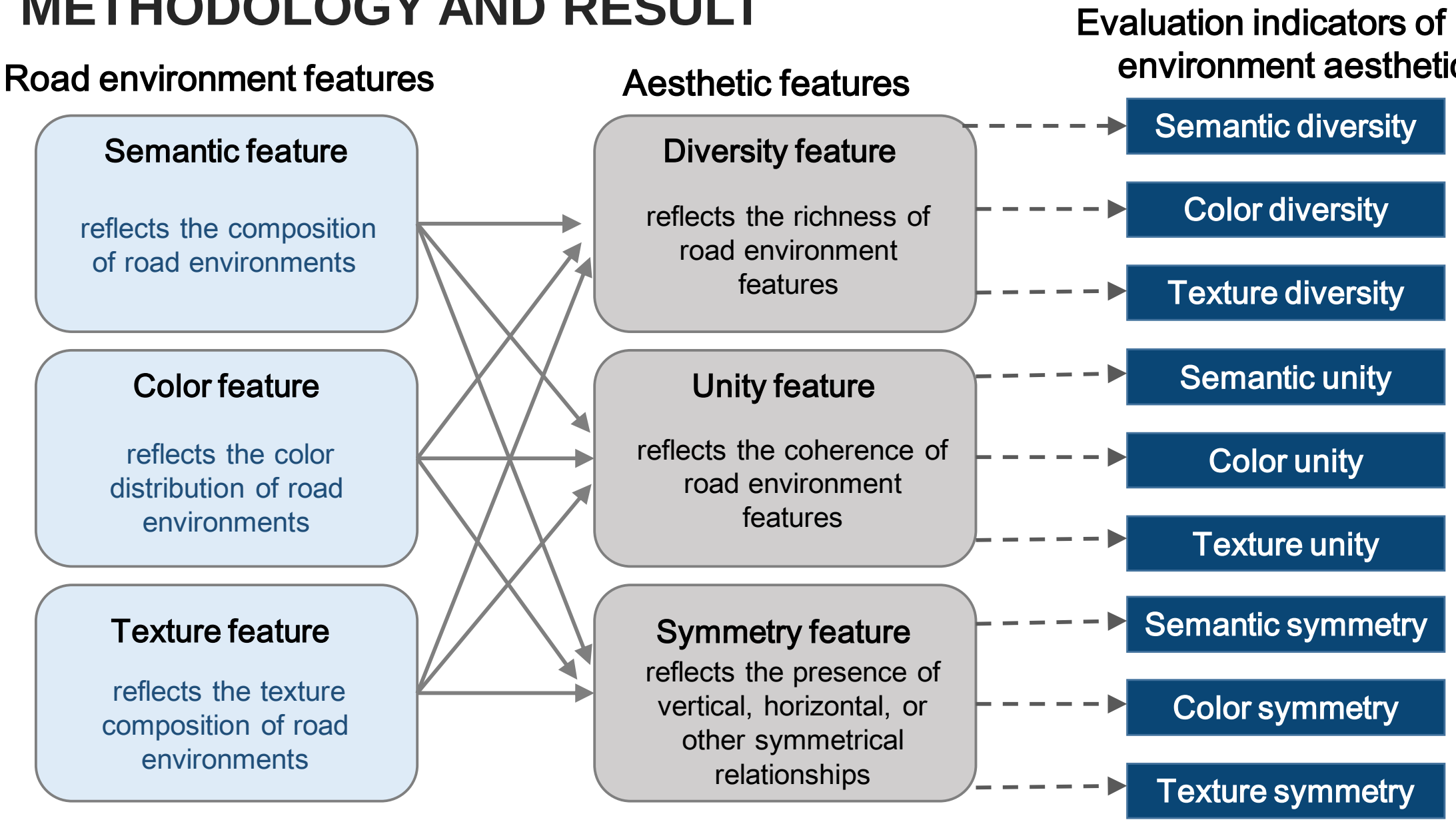
Questionnaire survey

How would you rate the aesthetic score of this road environment?

Dataset

A total of 2,000 road environment images with aesthetic scores were obtained

METHODOLOGY AND RESULT

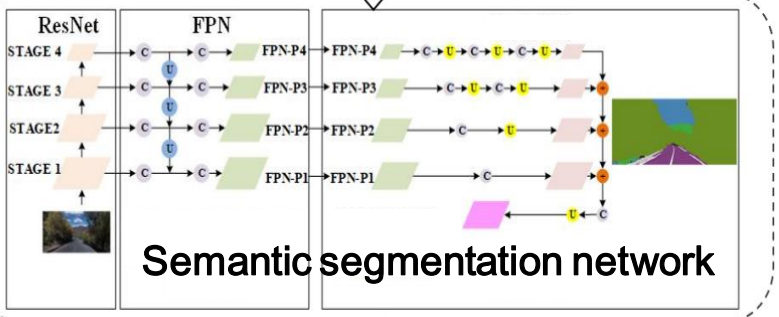


METHODOLOGY AND RESULT

Road environment features

Semantic feature

Road environment



Semantic image

Semantic feature

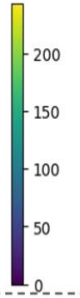
Road 8%
landscape 75%
Protection 3%
Sky 10%

Color feature

Road environment

Grayscale Conversion

Heatmap



Color image

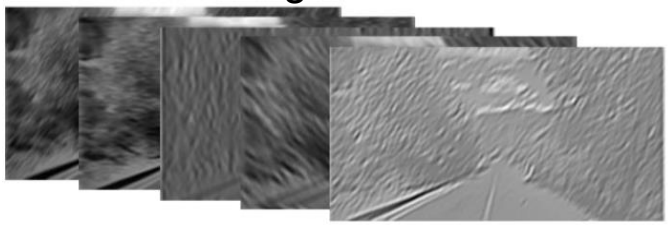
Color feature

Hue 0.34
Saturation 0.28
Brightness 0.3

Texture feature

Road environment

Gabor Filtering



Texture image

Texture feature

Mea 197
Variance 1643
Entropy 7

METHODOLOGY AND RESULT

Diversity feature

Semantic diversity

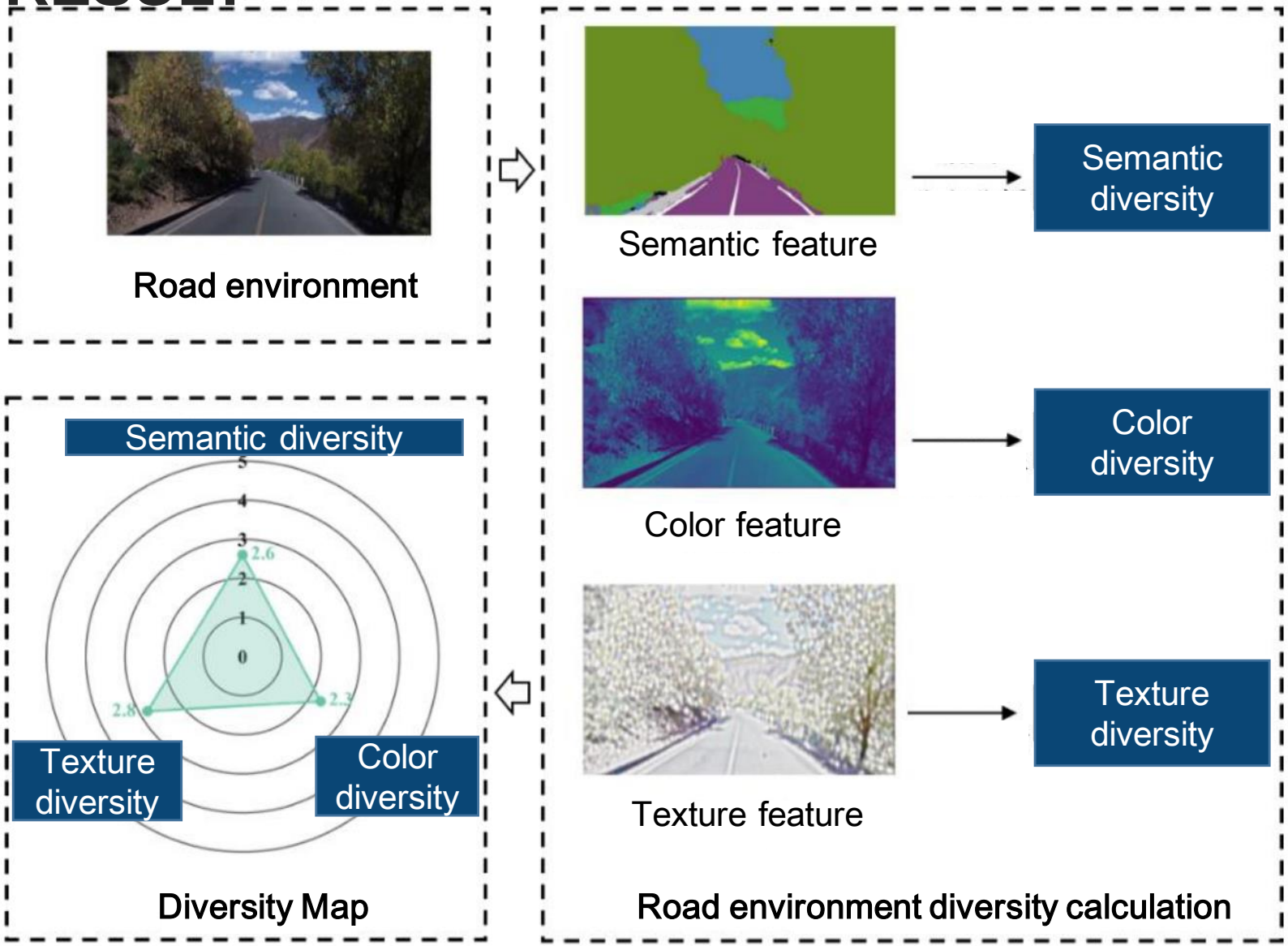
$$Div_{sem} = \sum_{i=1}^{C} p(c_i)\log_2(p(c_i))$$

Color diversity

$$rg = \mathrm{R} - \mathrm{G}$$
$$yb = (\mathrm{R} + \mathrm{G})/2 - \mathrm{B}$$
$$\sigma_{rgyb} = \sqrt{\sigma_{rg}^2 + \sigma_{yb}^2}$$
$$\mu_{rgyb} = \sqrt{\mu_{rg}^2 + \mu_{yb}^2}$$
$$Div_{col} = \sigma_{rgyb} + 0.3\mu_{rgyb}$$

Texture diversity

$$Div_{tex} = \frac{1}{3}[Var(\mu_i) + Var(\sigma_i^2) + Var(H_i)]$$



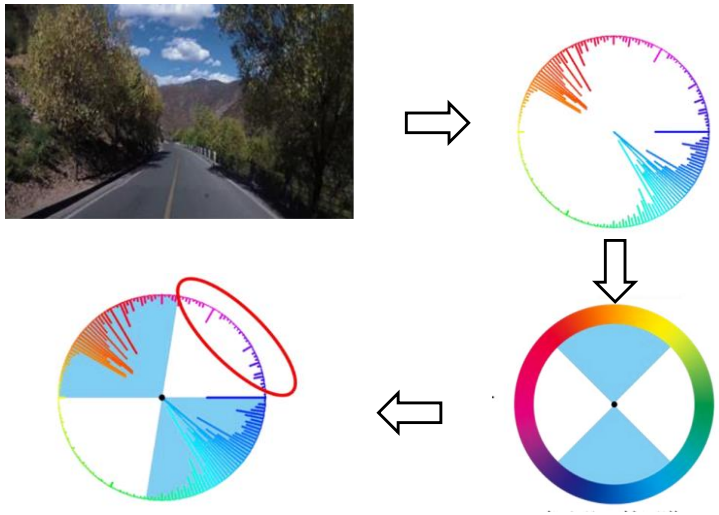
METHODOLOGY AND RESULT

Unity feature

Semantic unity

$$Uni_{sem} = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N} Canny(i,j)}{M \times N}$$

Color unity



Texture unity

$$Uni_{tex} = \frac{\sum_{i=1}^{M} std(Tex_i)}{M}$$

Road environment

Semantic feature

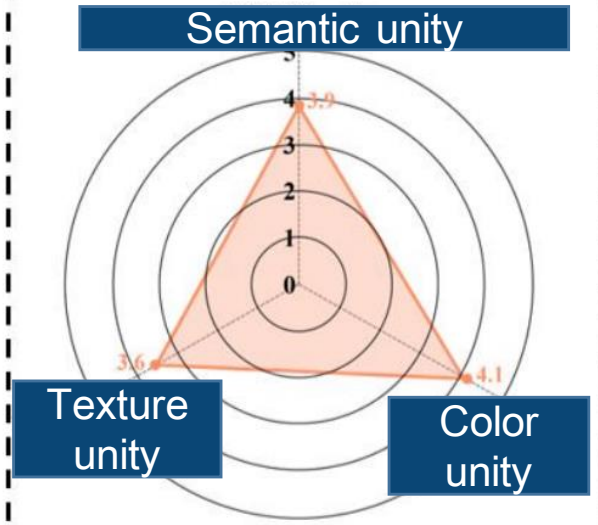
Semantic unity

Color feature

Color unity

Texture feature

Texture unity



Unity Map

Road environment unity calculation

METHODOLOGY AND RESULT

Symmetry feature

Semantic symmetry

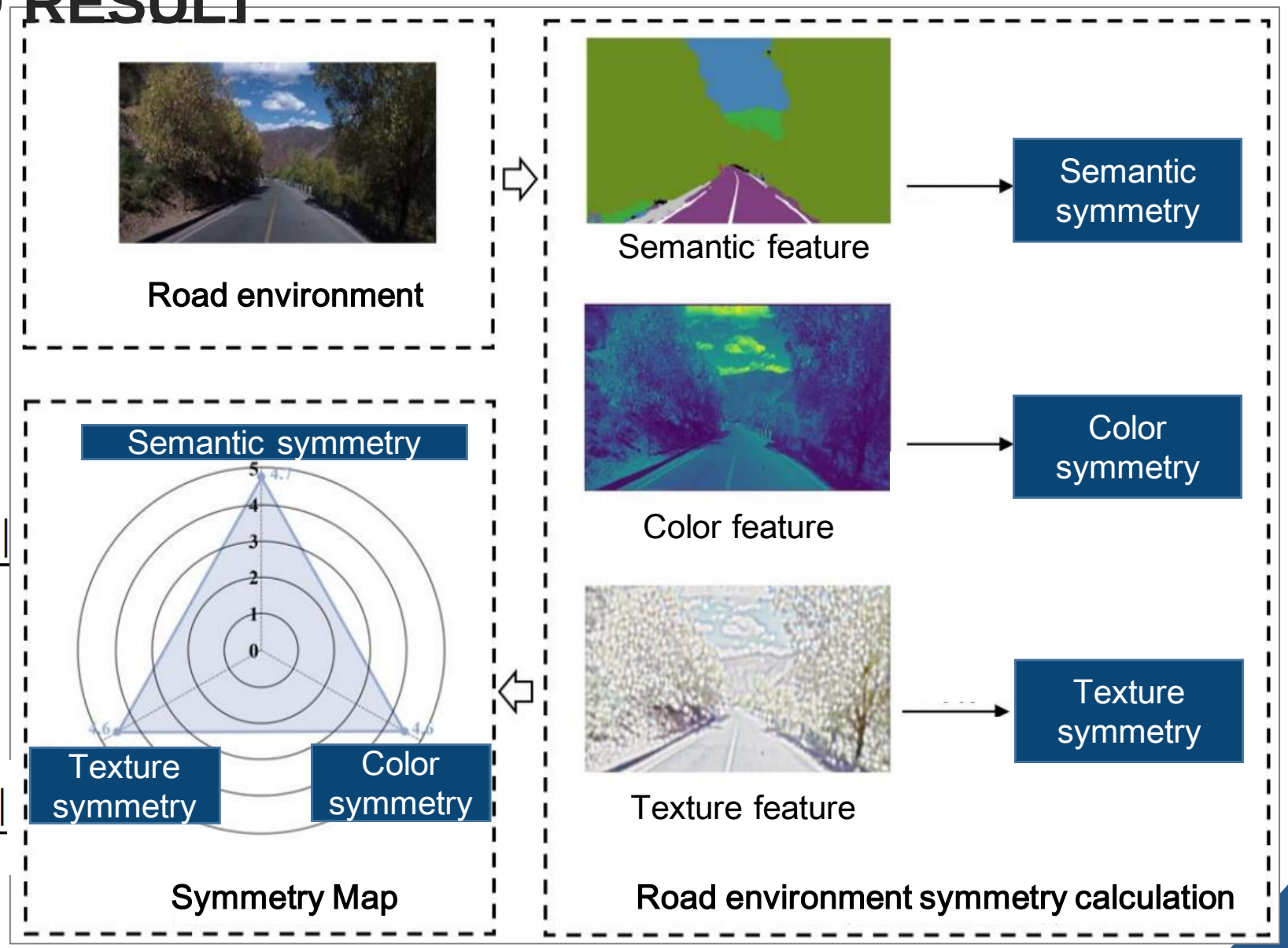
$$Sym_{sem} = \sum_{i=1}^{N} |p_i^l - p_i^r|$$

Color symmetry

$$Sym_{col} = \frac{\sum_{j=1}^{M}\sum_{i=1}^{\frac{N}{2}} |Col(P(i,j)) - Col(P(M-i,j))|}{M * N}$$

Texture symmetry

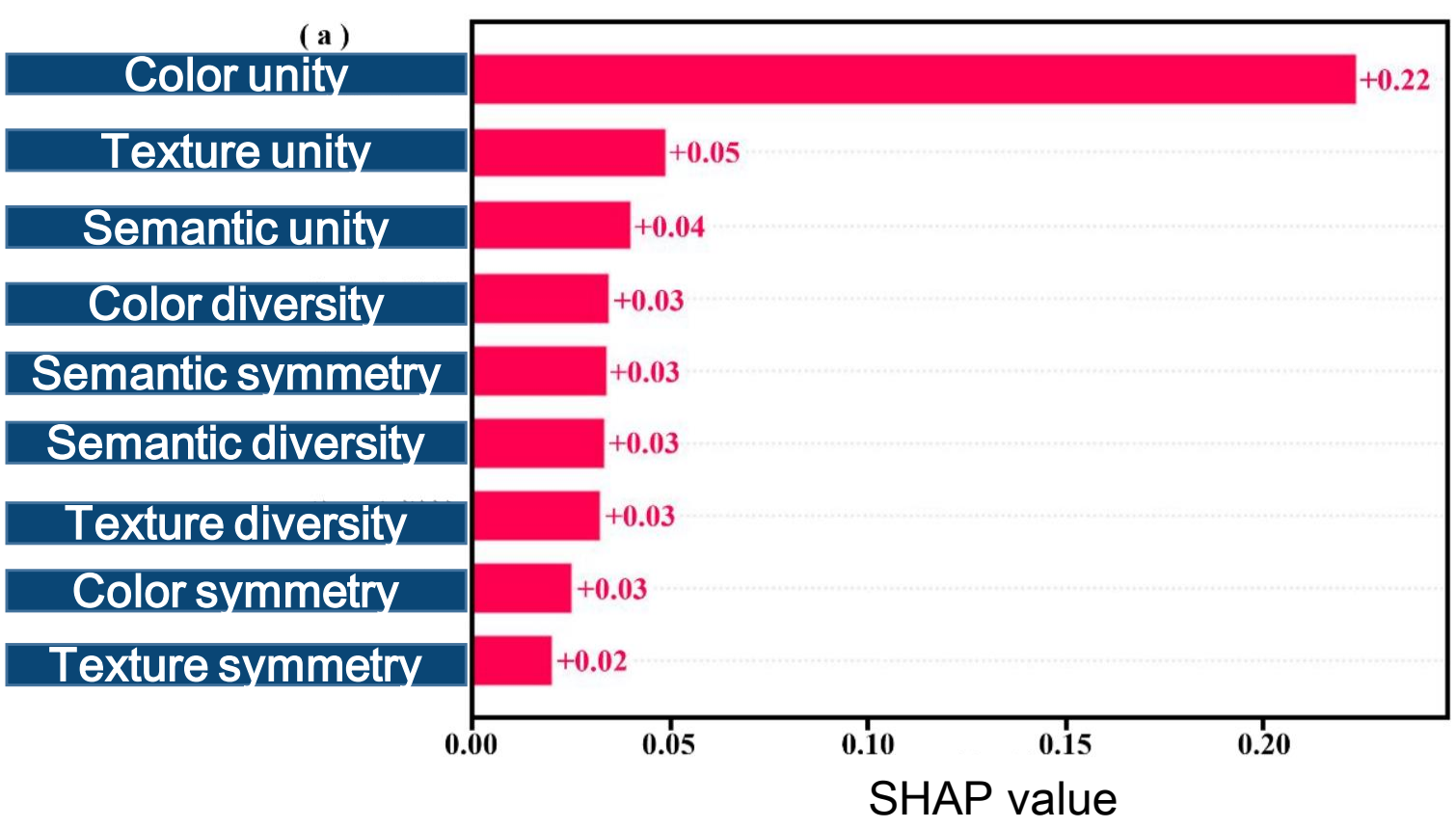
$$Sym_{tex} = \frac{\sum_{j=1}^{M}\sum_{i=1}^{\frac{N}{2}} |Tex(P(i,j)) - Tex(P(M-i,j))|}{M * N}$$

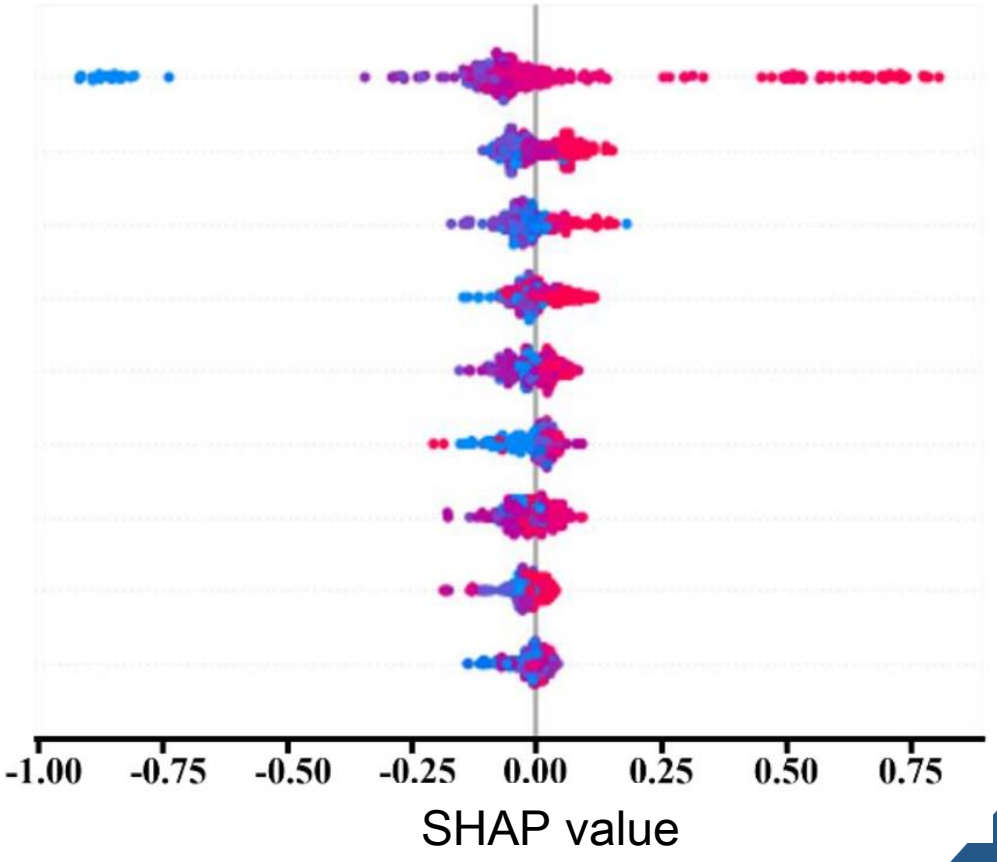


METHODOLOGY AND RESULT

XGBoost Algorithm. XGBoost (Extreme Gradient Boosting) is an ensemble learning algorithm based on gradient-boosted decision trees, which can effectively perform data regression.

SHAP. SHAP is a method from game theory that explains how much each feature contributes to the final prediction, making the model's decision-making process clearer.





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THANKS!