都市街路の体験的モデリング

山形与志樹・吉田崇紘・松井陽菜

Experiential Modelling on Urban Street

Yoshiki YAMAGATA, Takahiro YOSHIDA, and Haruna MATSUI

Abstract: To design well-being and smart communities, it is important to know what street scapes/layouts are good for people experience with comfortableness, activeness, beautifulness, etc. For that purpose, walkability is one of the key performance indicators expressing the environmental quality of a street. As the first step for creating the well-being smart communities, this study attempts to evaluate the influence of street scapes/layouts by using street images taken by a volunteered geographic information application, Mapillary and a image assessment with machine learning technique. We conduct street experiments in a district in Tokyo, Japan for comparing the score of the quality of street image with the answers of questionnaire on the street. The result suggests that score of quality of images is not consistent with the street experience for people such as comfortableness, secureness, and activeness.

Keywords: 歩行環境指標（walkability）, 街路特性（street layout）, 画像認識（image recognition）, 体験評価（experiential evaluation）

1. Introduction

Walkability is an important key toward sustainable urban development. Walkable neighborhoods have a great potential to contribute to creating low-carbon, climate resilience and high well-being communities (e.g., Leyden, 2003). The influence of walkability on sustainability and human health has been evaluated in urban studies literature. For example, improving walkability decrease Carbon Dioxide emissions in the block (Marshall et al., 2009). However, there are still many issues that need to be addressed as to what is real walkability and how we can evaluate it with measurable indicators (Yamagata et al., 2019). For example, Leadership in Energy and Development for Neighborhood Development (LEED-ND), which is a standard environmental certification system of urban districts, certifies neighborhood's sustainability considering walkability. However, the index was basically developed to be applied to the cities in the western countries (Hanibuchi et al., 2011; Koohsari et al., 2018; 2019). We need to accumulate the knowledge on the system to fit with the specific city environments in other urban contexts such as Japan. Additionally, although some recent papers attempt to use street images (e.g., google's street views) and image assessment tools (e.g., convolutional neural network) for evaluating street layouts including sky view factor and greenery (Middel et al., 2018; Bechtel et al., 2019; Suel et al., 2019), there are a few papers mentioning how to design high well-being streets by using such the bigdata and machine learning methods.

著者氏名　山形与志樹

所属　国立環境研究所地球環境研究センター

E-mail　yamagata@nies.go.jp

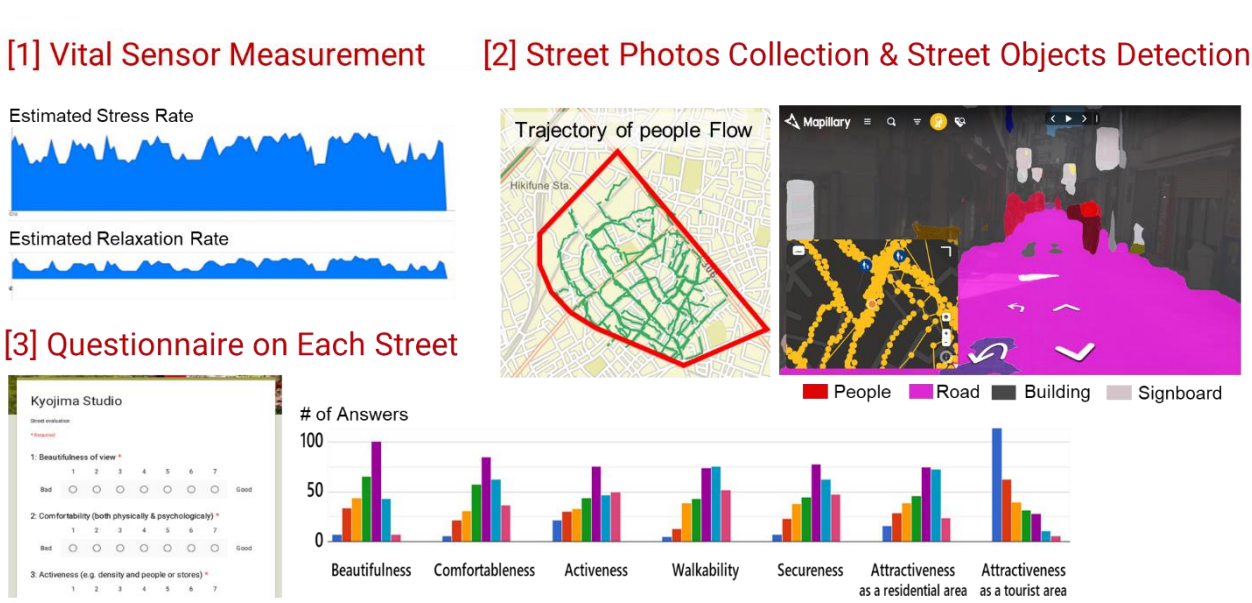

Fig.1 Street experiments in Kyojima district, Sumida ward, Tokyo, Japan

As a step to establish urban systems design with and experiential modelling for walkable green smart communities, we conduct a street experiment with [1] vital sensor measurement, [2] taking street scape, and [3] questionnaire survey (Figure 1). In this paper, we focus on reporting the comparison between street scape evaluation by a neural image assessment and questionnaire investigation on street, although we conducted vital sensor measurement using a sensor developed by Firstbeat Technologies Ltd. (2014). Our study site is Kyojima district, Sumida ward, Tokyo in Japan. The site has Japanese style local communities and various streets types such as narrow winding streets, shopping streets, and newly developed wide car roads.

2. Methods

Towards developing experiential modelling, we conducted the street experiments on 14:00–16:00, March 18th, 2019 in the site. The number of participants for the street experiment is 41. We collected 302 answers for the questionnaire of which items are [i] Beautifulness, [ii] comfortableness, [iii] activeness,

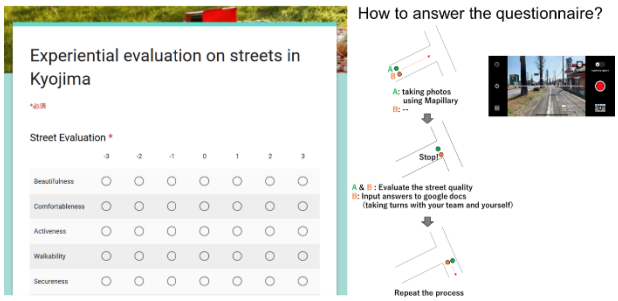

Fig.2 Questionnaire for each street and how to collect street photos

[iv] walkability, and [v] secureness for each street by scoring from –3 as bad to 3 as good (Figure 2). And we collected over 6,000 street photos by a smartphone application: Mapillary. According to Juhász and Hochmair (2016)'s summary, "Mapillary is the first platform to provide detailed street photos based on crowdsourcing, adding to the list of Web 2.0 applications that administer and facilitate the collection of Volunteered Geographic Information. And, Mapillary started its public service in early 2014 and is run by a company located in Malmo, Sweden, with a satellite office in Los Angeles, California."

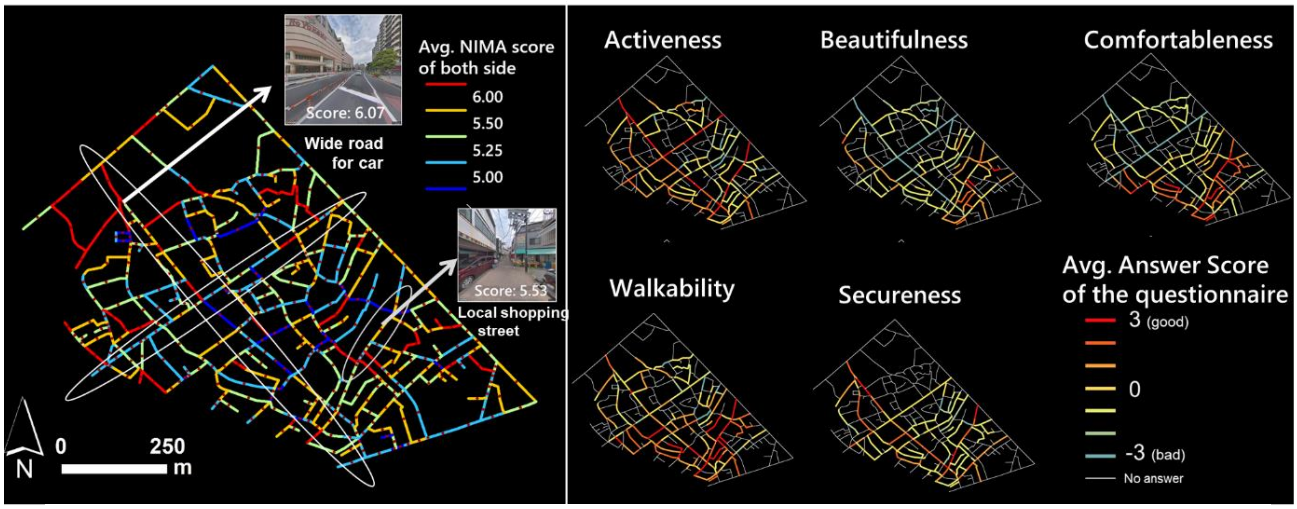

Fig.3 Comparison: image evaluation (NIMA) with answers of the questionnaire

To evaluate street scape in the site, we used a Neural IMage Assessment (NIMA) method proposed by Talebi and Milanfar (2018). The method is based on a convolutional neural network model that can train both technical and aesthetic aspects of images. The model is trained by the large-scale database for Aesthetic Visual Analysis dataset, of which photos are scored by an average of 200 people in response to photography contests. Each trained image is rated with scores from 1 to 10.

We compare the score between average value on the answer of the questionnaire and the average NIMA value for each street.

3. Result and discussion

Figure 3 shows the comparison result. The NIMA result which means an evaluation of the quality of “images” is almost the same score for wide road (6.07) and local shopping street (5.53), and is not consistent with intuition in terms of walkability and comfortableness. This is probably because the NIMA model is not "an evaluation of the quality of “streets". On the other hand, according to the results of the questionnaire, on wide roads, activeness and secureness are high and beautifulness is low. Also, walkability is high on the shopping street. The correlation coefficients between the NIMA score and each questionnaire item are close to 0.

This comparison suggests that score of quality of images is not consistent with the street experience for people. Towards designing well-being streets for people, it can be said that arrangement of street layout information that is truly comfortable for people is required.

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