

# Personalized record of the city wander with a wearable device: a pilot study

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## Abstract

In this paper, we proposed personalized guided walking holidays in the city with wearable devices, which aim to provide a personalized service based on one's interest [Figure 1]. We firstly hypothesize that one's heart rate rises when he/she sees something he/she is curious about, and then test this using our developing prototype device. We conducted an experiment with four participants, in popular holiday walking areas such as Akihabara and Asakusa area in Tokyo. The data

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suggests that heart rate is significantly higher when participants see what they consider an interesting spot when compared with spots they are indifferent towards, implying that our concept is supported by quantitative physiological data responses. Perspectives of this research direction are discussed in terms of the relationship between city and human emotions.

## Author Keywords

Locative experiences; city guide; tourism; mobile media; mobile technology

## ACM Classification Keywords

H.1.2 Models and Principles: Human information processing

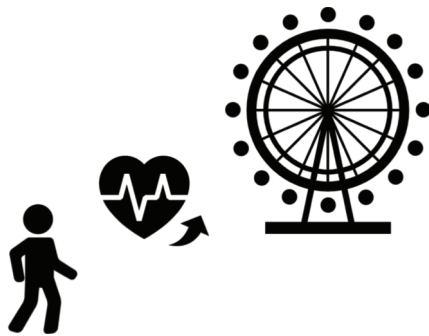
H.5.1 Information Interfaces and Presentation (e.g., HCI): Artificial, augmented, and virtual realities

J.4 Social and Behavioral Sciences: Psychology

## Introduction

Walking Holidays has become a popular hobby in recent years. People enjoy exploring the city by walking, they may take pictures of the views they think are beautiful, and may also go into a nice restaurant that they have never been to before. City walking is a hobby to relax oneself, and to discover new treasure of the city and one's life.

Since everybody has different interest, the routes that would make him or her happy should also be different



**Figure 1.** The basic concept of our study. When the participant sees something he/she is interested in, their heart rate increases.

from each other. In order to provide a better route suggestion based on one's interest, there is a project called "Urban Gems Project" [1] in UK. On the website of this project, people are asked to choose the more beautiful photo out of two, then based on the survey data, routes like "Happy", "Beauty", "Shortest" and "Quite" were generated.

Besides of the need for personal hobbies, city walking can be also used for local promotion. For example, "Hiroshima Cat Street View" [2] gives people the experience of exploring the back streets of Hiroshima through a cat's eyes. Your sight becomes as low as a cat, and you can find some cat-like comment when you are exploring. By combining city walking and cat view, this service is effective for the promotion of Hiroshima's back streets.

In contrast to the traditional travel guide, the GPS-linked content distribution platform "Street Museum" [3], which is developed by Toppan Printing, provides the experience that user can see the world heritage's revival CG when they point their camera at it. Information of the spots is also shown on the screen.

City wander can also be applied as GPS based mobile game. For example, the "GPS Entertainment for Luxembourg" [4]. It is a game that combines real objects on the street with the virtual game stage, player would not be told which way to go next until the player solves the puzzle.

Although there are a lot of works that are related to public relations surrounding city walking, to our knowledge, up until now there has been no service that is totally personalized based on physiological data (in other words, embodied data) such as heart rate, blood pressure, or the amount of sweating. Therefore, in this research, we would like to discuss the possibility of using wearable devices while city wander. Especially, we report a pilot study for considering the relationship

between one's interest and real-time heart rate, in order to provide a more personal city walking service.

### **Combining one's heart rate data with GPS**

Latest advancement of wearable devices makes it easy to obtain physiological data such as one's heart rate with GPS information. This set of multidimensional data is collected and stored in a wearable device, however, this is not usually combined to extract specific information.

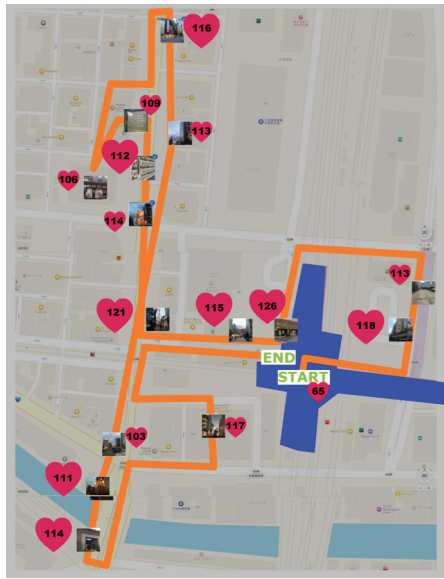
What will happen if personal heart rate information are integrated with the map of city? In this case, user can record personal response to the city that is evaluated by the heart rate data with GPS information. This is interesting dataset since we may be able to grasp how people react to the town based on this visualization. In addition, it may be more interesting if we could estimate one's interest based on heart rate information and taken photos with GPS data if one conducted city wander.

Some software enables to visualize spatial information of taken pictures onto the map. This is good data visualization method to understand what is the overall atmosphere of the city based on personal photos. One may consider that Google Street View can also provide similar experience concept, however, the information is too massive and general to grasp the atmosphere of the city in terms of one's viewpoint. It would be easier for users to personally taken photos rather than machine in order to provide sensual experience to humans, leading to the feeling as if one had visited there.

In the following section, we report our preliminary study of the relationship between one's heart rate and taken photos during city wander in a town, to test a hypothesis that one's heart rate increase may associate with preferred features of the town that one walks.

### **Experiment**

In order to test our hypothesis that one's heart rate would rise when he/she sees something he/she is



**Figure 2.** The route of experiment A2. The positions of pictures taken are also shown. The number indicates the heart rate (average beats per minute) obtained from the Apple Watch.

interested in, we conducted feasibility study with four participants.

Participants (three females and one male) did 30-minutes or longer walking in one of several designated areas in Tokyo with our prototype, the application of iPhone 5s which would record the GPS data and pictures the participant took during the walk, and the Apple Watch on the participant's wrist, which would record one's heart rate during the walking. The participants were asked to take pictures when they saw anything they wanted to have. The heart rate sensor of the Apple Watch would take the heart rate value at the moment when the participant took a picture, and it also recorded the heart rate once every minute. After the walking, participants were asked several questions such as "Which pictures you took are you interested in or indifferent?", "Is the data result synchronized with your feeling?", and "Is there anything impressive during your walking?"

With the quantitative data such as heart rate and GPS data and the qualitative data obtained by the questionnaire, we conducted an analysis of the data. All pictures taken were tagged with GPS information using the built-in function in iOS and the value of the heart rate at the moment when participants took a picture. Based on a subjective, two-alternative choice of the picture (interesting or indifferent), pictures were also tagged with the participants' preference. The dataset of each participant was analyzed using an unpaired two-sample *t*-test.

With regard to the locations for doing the experiment, we chose Asakusa and Akihabara areas. These areas were chosen not only due to the abundant attractive content in these two areas, but also for that their flat terrains, which help to avoid the influence of climbing and descending slopes or hills on the data.

## Result

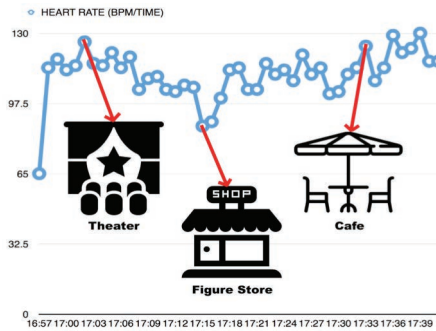
In this feasibility experiment, 185 pictures and heart rate values during the walking. We numbered the experiments as A1~D. A1 was done by the same participant as A2 in different areas (A1 took place in Asakusa area, A2 took place in Akihabara area) and B~D were the result of three different participants in the same area (Akihabara area).

Experiment No.	Participants	Interested Pictures	Indifferent Pictures	Sig.
A1	a (Female)	54	12	Significant
A2	a (Female)	13	8	Significant ( $p < 0.05$ )
B	b (Female)	13	7	Significant ( $p < 0.05$ )
C	c (Female)	35	10	Significant
D	d (Male)	30	3	Not significant

**Table 1:** The relationship between number of pictures taken while waling in the city and participants' interest. Participant A2 started from Akihabara station, and the heart rate fluctuated during the walking. Please note that heart rate was not always in ascending fashion, implying that the walking itself was not the only reason for heart rate variations. Small pictures also show the photos the participant took during the walk. See Figure 2 for a representative result of Participant A2.

To visualize the trend of the heart rate data, Figure 3 shows the variations of the heart rate of Participant A2. When Participant A2 found a theater and a café, the heart rate increased. On the other hand, the heart rate dropped when A2 found a store, which A2 mentioned later was not of interest. Other than these tagged points I picked up in experiment A2, most of the other points in all the experiments also show a correspondence of the participants' personal interests. This trend suggests that the increase in the heart rate may be associated with the participants' interest.

Quantitative data and its statistical analysis showed that our hypothesis was supported by the data. Table 1 summarizes the number of pictures that participants took during this feasibility study. It shows that participants tended to take more pictures when they were interested. To correlate with these behavioral



**Figure 3.** The heart rate graph of experiment A2, showing heart rate changes during the walk.

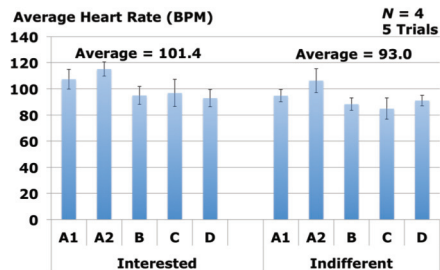
responses (taking pictures) with the heart rate data of participants, we calculated averaged heart rates for each participant when they were interested in or indifferent to the pictured scene (Figure 4). Using unpaired *t*-test, we found that there was a significant difference in averaged heart rate between moments where they took interesting and indifferent pictures in four out of five trial. In addition, statistical analysis with repeated one-way ANOVA showed that there is a significant difference in averaged heart rate between interesting and indifferent pictures that participants subjectively reported, suggesting that heart rate is a good indicator of personal preferences.

User feedback also told us that our study is attractive enough during the walking. In the subjective questionnaire feedback, participants told us that “It is happy to see my emotion on the heart rate graph”, “The graph matches to my feelings during the walking” and other comments that expressed that it was interesting to walk with wearable device because it visualized the physiological response of the participant during the walk in the city.

### Discussion and Future Work

In this study, we have proposed a novel holiday walking system and have tested the feasibility of the concept. Data from our user study supported the hypothesis that one’s heart rate rises when one sees something one is curious about. Using our proposed city walking, people could enjoy a more personal service that suggests unfamiliar spots that the person may like, and help the user to realize a new attractive aspect of the city based on one’s own interest.

To have a deeper study in the future, we are currently designing and developing the device to collect more accurate quantitative data in a more sophisticated way. Since the application on iPhone and the heart rate measuring system were not fully integrated during the feasibility study, we plan to implement greater integration between the 9-axis inertial motion sensors



**Figure 4.** The average heart rate of Interested Pictures and Indifferent Pictures in all 5 experiments. When the participants saw something he/she is curious about, the heart rate is greater than the heart rate during normal walking.

and GPS in iPhone, and the heart rate sensor in Apple Watch, for collecting location and geographical (how steep the slope is) data and physiological responses of the user to walking in the city. We also would like to launch a web-based service, which may achieve customized routing for holiday walking.

In the future, our proposed concept can be used for personal training or rehabilitation by walking in the city. Recent map services such as Google maps also provide altitude information [5], so future device could also judge how much exercise is done during the walk. If our proposed service were connected with fitness services such as Fitbit [6] or UP by Joebone [7], it could be another interesting web service for suggesting a recommended route that is beneficial both for physical exercise and for one’s personal interests.

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