Stand Up, Heroes! : Gamification for Standing People on Crowded Public Transportation

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Abstract. There are quite many commuters who are forced to keep standing on crowded public transportation in Japan, and they often feel fatigue and frustration. Stand Up, Heroes! (SUH) is an EELF-based gamification system to motivate commuters to keep standing. In SUH, they have their own avatars which grow according to their time of standing. As the result of a twelve-week practical evaluation, it is found that SUH can stimulate commuters' motivation during first eight weeks. Growing-up avatars are most effective for stimulation and fun. However, some participants cannot feel fun or stimulation for standing from SUH, because their public transportation which they get on is not so crowded that they can seat on the transportation.

Keywords: gamification, EELF, public transportation, motivation, mobile device.

1 Introduction

1.1 Background

In Japan, most of workers commonly use public transportation such as buses and urban trains for commute. There are so many commuters that the transportation is usually crowded, especially at the rush hour. In this situation, they cannot commute comfortably, and must keep standing on the transportation during long time to their offices. They then often feel fatigue and frustration. Such problematic situations have been one of the Japanese social problems.

As usual, commuters on train usually kill time by reading books, playing games, listening to music tunes, and so on. However, on quite crowded transportation at the rush hour, they cannot do most of such activities because they cannot move there. Moreover, such activities are only for time killing, so their feelings of fatigue and frustrations are piled up during commuting even if they could.

In order to solve the problem on the quite crowded public transportation, we propose a method to gamify the commuter rush hours based on EELF [1], which is one of the frameworks of gamification and aims to motivate users for daily dull and monotonous activities. Based on the proposed gamification method, we implement a new game system named "Stand Up, Heroes!" which motivates users for the troublesome crowded public transportation.

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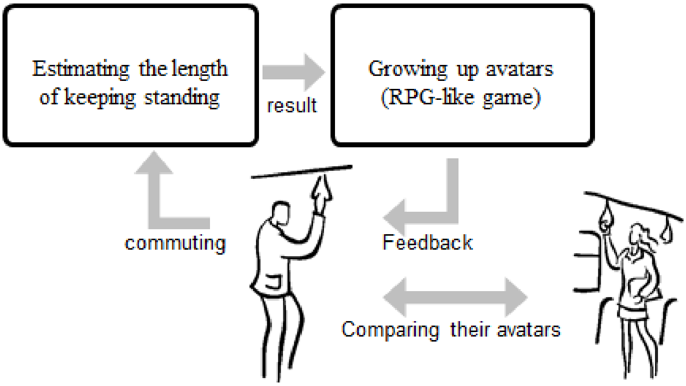

Fig. 1. Concept of SUH

Fig. 1 shows the concept of the game system. "Stand Up, Heroes!" (SUH) recognizes the time and whether to take on public transportation by an accelerometer built in a mobile device such as smartphone, and SUH estimates the level of their effort to keep standing. Then SUH represents an avatar for each commuter which grows up according to his or her estimated subjective effort, and the avatar acts automatically in a fantasy RPG (role playing game) like game system. The longer and harder users keep standing up on public transportation, the stronger their avatars become. Users can compare their avatars' abilities and their finding treasures each other, which leads fun and motivation to keep standing.

1.2 Related Works

SUH is one of the gamification systems, which introduce game mechanism into non-game applications such as office, social networks, and so on [2]. Emotional Flower [3] is one of such systems to enhance social interaction at office. In this system, each office worker has their own virtual flower which grows up according to the time of the owner's positive facial expression. The flowers are shown on a shared display at the office. Weekend Battle [4] is another gamification system in office environment. This system is based on EELF framework. Office workers have their own avatars, and they grow up according to their subjective workload which is estimated based on the number of operations on their PC for work.

Exercise and education is another target of the gamification. GrabApple [5] is an exergame, which means a gamification system for physical exercise, for motivating daily casual exercises. Grammenos et. al propose an exergame for advertising food products [6]. This research aims to make advertisements active so that the exergame can produce positive feeling of the products to players. In education area, Howland et. al propose a language learning system with video game elements such as 3D virtual world, item collection, scoring system, and so on [7]. MIPS (Musical Instrument Practice System) [8] is another one of EELF-based gamification systems for those who practice musical instruments such as piano.

Unlike to above gamification systems, the users of SUH did not perform anything for target activities but only keep standing. In section 2, we discuss some special considerations needed to apply EELF to such activities.

2 Key Issues to Design Gamification on Crowded Public Transportation

Crowded public transportation environment is quite different from ordinal ones such as at office, at home, and so on. For designing gamification to motivate commuters to keep standing in the environment, we pick up four key issues to discuss.

1. **Consider too little space for each commuter:** There is no enough space to manipulate his or her own device and to watch any displays in the environment. The gamification must not require any operations normally, and some non-visible feedbacks, such as audible, touch, and so on, must be provided.
2. **Consider the length of commuting:** In common, a commuter with longer time spent feels much more fatigue than shorter one. The gamification must take time spent in commuting into account.
3. **Consider the difference of commute paths:** Commuters have different paths to their offices each other. If only the time for commuting affects the gamification, some commuters with longer commuting paths always have advantages in game play. In such a case, it is afraid that other commuters with short paths might lose the motivation for using the gamification. It is needed to enable to configure the gamification settings to avoid that the difference of their commute paths has an enormous influence on the fun of the gamification.
4. **Consider the newcomers in the middle of use:** Not all users start using the gamification at the same time, so it should take care of newcomers after introduction.

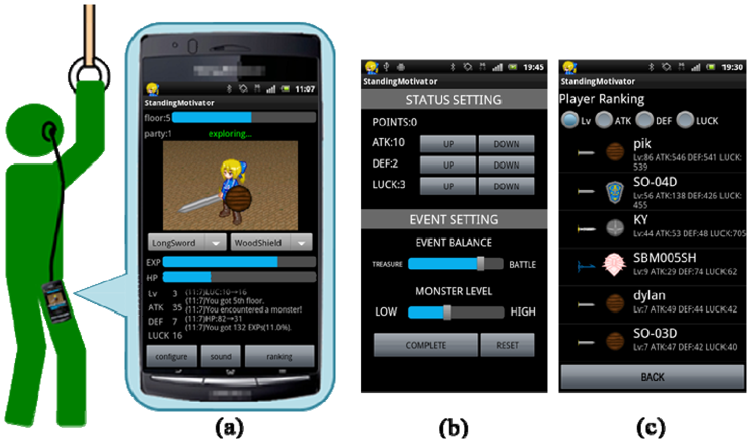

Fig. 2. Implementation of SUH: (a) exploring, (b) strategy configuration, (c) all users' avatars

3 Implementation

SUH (shown in Fig. 2) is implemented as an application on a mobile device such as smartphone. It has two subsystems: transportation-and-standing estimation subsystem and avatar-and-game representation subsystem.

3.1 Transportation and Standing Estimation

At first, this subsystem estimates the type of transportation using an accelerometer and a GPS receiver built in a mobile device. In transportation estimation, the subsystem tries to get the current place of a user, or a mobile device, by GPS receiver. If recognized place is near a station, it decides that the user is on public transportation such as trains or buses. If the place is far from any stations, then it checks the current speed of user's, or a mobile device's, movement. Only when the speed is enough fast as moving on public transportations, it decides the user is now on public transportation. If GPS receiver cannot recognize the current place, for example, when in underground, it reminds the last place where it could recognize successfully. Only if the last place is near a subway station, it decides that he or she is on subway, one of public transportations. This algorithm is shown in Fig. 3. This subsystem samples the current place every one minute, and the threshold of the distance of a "near" station is 30 meters. It means that a certain station is near when the distance between the current place and the station is shorter than 30m.

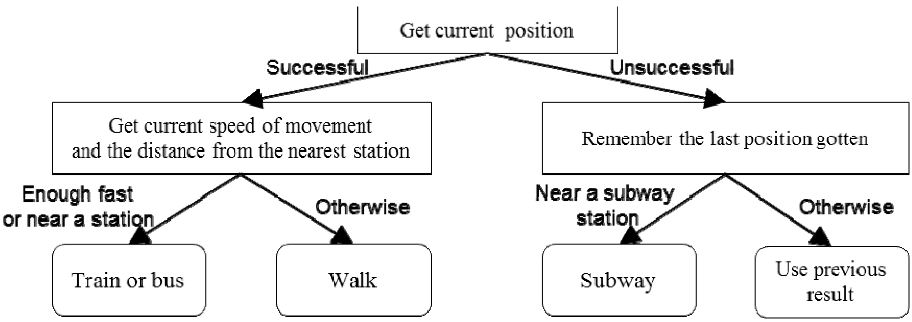

Fig. 3. Estimation algorithm of the type of transportation

We evaluate the accuracy of the estimation method practically. We implemented the estimation method on an Android smartphone as a mobile device, and one of the authors carry the smartphone and move along his commute path, including each 20-minute walk, train, and subway. We gather the log on five round trips of the path. Table 1 shows the result of accuracy, coverage and F-value of the estimation method. These F-values are high, so the subsystem can estimate which type of transportation a commuter uses enough for implementation of SUH.

Table 1. Result of estimating which type of transportation a commuter uses

Type	Accuracy	Coverage	F-value
Walk	.773	.888	.827
Train	.913	.818	.863
Subway	.893	.962	.926

Then, in order to estimate whether a user is standing or not, the subsystem uses the orientation of gravity acceleration (G) of the mobile device in one of the pockets of the user's trousers or pants. The subsystem decides the user standing only when the orientation of G is along to Y-axis. When sitting, the orientation of G moves some different direction which is not along to Y-axis (see Fig. 4). In addition, the subsystem distinguishes walking from standing and sitting, with using the variance of the value of acceleration measured. If we are standing or sitting quietly, our bodies do not move so much, so the acceleration of the mobile device is almost unchanged during standing. By contrast, when we are walking, our bodies continue to move. In such a case, the acceleration value is continuously changing. It means that the valiance on walking is larger than on standing or sitting. This subsystem samples the value of acceleration with 10 Hz frequency, and uses 50 (five second) sampling values for calculating the valiance.

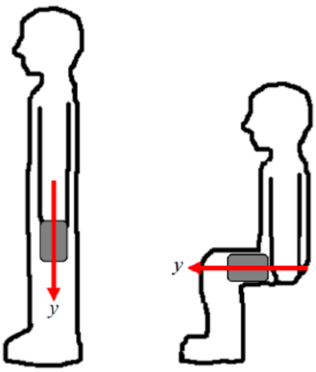

Fig. 4. How to estimate standing by a mobile device with an accelerometer

We evaluated the accuracy of the estimation method practically. We implemented the method on an iPod touch as a mobile device. We recruited eight participants who are undergraduate students, and asked them to commute with the device and to log manually their action below; sitting down on a sheet in public transportation, standing up from the sheet, starting walking, and stopping walking. We consider standing time as the period from standing up or stopping walking to any other action, sitting time as from sitting down to standing up, and walking time as from starting walking to stopping walking. Table 2 shows the result of the accuracy, coverage, and F-value of the estimation method. These F-values are high, so the subsystem can estimate whether a commuter stands, sits, or walks enough for implementation of SUH.

Table 2. Result of estimating a commuter standing, sitting, or walking

Period	Accuracy	Coverage	F-value
Stand up	.790	.868	.827
Sit	.969	.973	.971
Walk	.890	.825	.856

3.2 Avatar and Game Representation

This subsystem automatically executes a RPG-like game and controls each user's avatar. The avatar has abilities shown in Table 3. Experience point is the basic score of the avatar's ability, and the avatar gets the points when the user keeps standing on public transportation. When a certain amount of experience points are gathered, the avatar's level is up, and some other abilities are increased.

Table 3. Abilities of an avatar

Ability	Description
Level	Indicates comprehensive power of the avatar
Experience point	Indicates basic score of the avatar's ability
Vitality	The avatar can keep exploring while Vitality is positive
Attack	Affects the additional experience point when encountering a monster (If Attack is high, the point is increased)
Defense	Affects the decrement of vitality when encountering a monster (If Defense is high, the decrement is small)
Luck	Affects the probability of getting an equipment item when finding a treasure

In the game, the avatar explores a "dungeon," and the subsystem shows the progress of the exploration (see Fig. 2(a)). This progress is represented by audible feedbacks for satisfying the issue 1 mentioned in Section 2.

The avatar explores the dungeon only when the owner of the avatar keeps standing on public transportation. The longer he or she keeps standing, the deeper floor of the dungeon his or her avatar explores in. The avatar gets more experience points when the avatar explores in the deeper floor. It means that the avatar of the user who keeps standing for longer time is naturally stronger than others, which satisfies the issue 2. When the user stops standing because of getting off public transportation or sitting down on a sheet, the avatar returns to the first floor of the dungeon, and takes a rest until he or she stands up again.

An occasional event happens during exploring the dungeon. There are two types of events; encountering a monster and finding a treasure. In "encountering a monster" event, the avatar must fight against a monster. After the battle, the avatar's vitality point is decreased instead of getting additional experience points. If the vitality is below zero, the avatar dies and returns to the first floor of the dungeon. In "finding a treasure" event, the avatar finds either a healing potion, which cures the avatar's vitality point, or an equipment item, which can change the avatar's appearance.

There are commuters with shorter commuting paths, so their avatars might lose every time against the avatars of commuters with longer commute paths. To avoid the unfairness and to satisfy the issue 3, users can configure some settings to change the strategy of avatars' growing-up (see Fig. 2(b)), including:

- Changing the ratio of monster/treasure encounter: when the possibility to encounter monsters is high, an avatar can get more scores for growing up while increasing the possibility of its death.
- Changing the balance of gaining avatars' parameters at their level-up timing.

The avatar's abilities are reset at the beginning of every week to avoid accumulating too much difference of abilities between avatars. This covers the issue 4. However, this restart might make the motivation of long-term users decreased. To avoid this, equipment items are not reset at the beginning of week.

In addition, the subsystem shows all the users' avatars with the results of exploration such as their abilities and treasures via a web server (see Fig.2(c)). This representation is only visual and it is aimed users to watch the results out of public transportation.

4 Evaluation

We conducted an empirical experiment to evaluate the effect of SUH for solving the problem on crowded public transportation. We asked nine participants who commute to their offices or schools everyday by public transportation including trains and subways. We installed SUH to their Android smartphones, and they freely used SUH on their commute for twelve weeks. At the end of each week, we asked them to answer the questionnaire about their motivation for keep standing and the fun of SUH. We also asked them which component of SUH is fun. The questions are shown in Table 4.

Table 4. The questionnaire

Question	Answers
You feel motivation to keep standing with SUH.	From -2 (strongly disagree) to +2 (strongly agree)
You feel fun with SUH.	From -2 (strongly disagree) to +2 (strongly agree)
Which components of SUH is fun?	(A) Watching your avatar's growing-up (B) Configuring the strategy of your avatar's growing-up (C) Collecting equipment items (D) Changing the appearance of your avatar by equipped items (E) Comparing others' avatars to yours

The result of the questionnaire is shown in Fig. 5. As the result through the first eight experiment period, the average score of questionnaire about both motivation to keep standing and fun is slightly higher than zero. It indicates that SUH can motivate participants to keep standing and SUH is enough fun to motivate them. However, the average score is not so high. As the result of interviews after the experiment, three of participants whose average score is lower than zero told us that they had not met crowded trains on their commute paths. They had no chances to play with SUH, so they did not stimulate their motivation to keep standing nor feel fun.

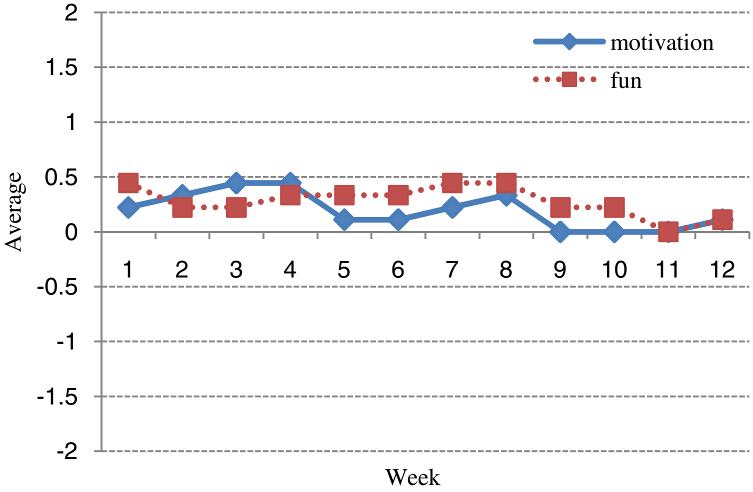

Fig. 5. Result of questionnaire: motivation and fun

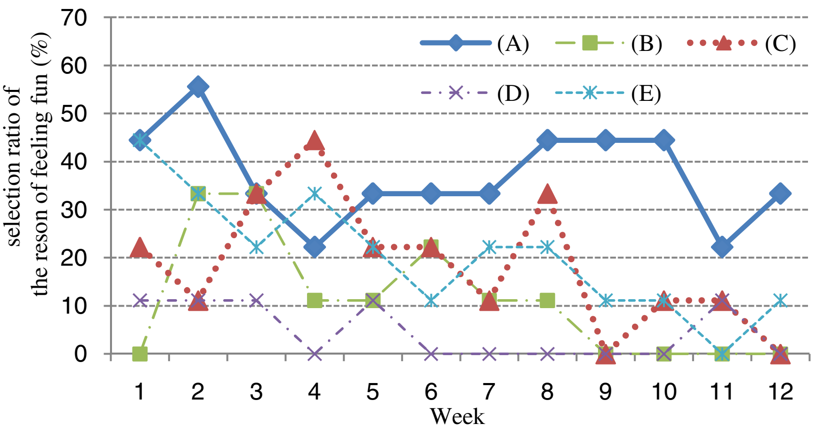

Fig. 6. Result of questionnaire: the reason of feeling fun

Fig. 6 shows the result of components which the participants feel fun from. As opposed to the previous expectation, collecting equipment items (C) stimulate their motivation during only the first half of the experiment. As the result of the interviews, some participants pointed out that they could not get new equipment items at the latter half of the experiment period because they had collected most of them. It indicates that the equipment items are too few to keep their long-term motivation of the participants. By contrast, watching avatars' growing-up (A) affects all through the experiment period. This is the same result of the long-term use of another EELF-based entertainment system [9], so the clear feedback of their effort is important to stimulate their motivation to keep standing.

5 Conclusion and Future Work

SUH is a gamification system to motivate commuters to keep standing on crowded public transportation. It estimates the level of their effort to keep standing, and shows their avatars growing up according to the level. As the result of a practical evaluation, it is found that SUH can stimulate participants' motivation for keeping standing on public transportation, but the effect is decreased because equipment items for motivating long-term users are too few to keep their motivation.

In future, we plan to enhance the SUH based on crowd density of public transportation. The effort to keep standing on the heavily crowded public transportation is higher than on the lightly crowded one even though the commuting time is the same, so it is needed to know the crowd density for estimating the level of effort to keep standing more precisely. Weppner and Lukowicz [10] propose a crowd density estimation technology based on the number of Bluetooth devices such as mobile phone which people have. We will evaluate the technique for SUH enhancement.

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