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Improvement of Customer Satisfaction in Amusement Park by Modeling Spontaneous Position Exchange between Restaurant and Attraction

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ABSTRACT

The number of people who visit amusement parks has been increasing every year, resulting in everyday long queues in front of attractions. This negatively affects the satisfaction levels of visitors. In order to improve visitors' experience, a position exchange model is proposed. Particularly, this study aims to model the position exchange behavior of people who are in attraction queue and those in restaurant queue. In order to evaluate the visitors' satisfaction, the effectiveness of proposed model is verified by multi-agent simulation where multiple agents (people) are simultaneously acting based on each rule and received interference with each other. It is expected that the proposed model can be realized on the wearable device which is used to track visitors' activities in real-time. The demonstrated results eventually confirm the effectiveness of our proposed model.

Key words: user satisfaction, position exchange model, multi-agent simulator, amusement park congestion, utility function

1. INTRODUCTION

Recent years witness a large number of visitors to amusement parks in Japan, which was about 78 million in 2017 [1]. However, it does not mean that all the visitors satisfy when visiting the amusement parks. There is the fact that the visitors usually have to wait in long queues in front of each attraction, resulting in the deterioration of their satisfaction levels. Therefore, improving the visitors' satisfaction has been a serious focus of contemporary studies for years. [2] focused on the fact that due to popularization of mobile information terminals and faster communication speed, many people are in an environment where necessary information can be acquired without being caught in time and place. Their proposal is to control the ratio of the visitors who are provided about congestion information in theme park. Moreover, [3] introduced a solution to control the number of visitors gathered at each attraction by issuing a time-designated priority pass like the Disney Fast Pass System, and making the priority pass auction using the electronic market trading system. They solved a contradiction that the customers must queued in order to get a priority pass. Meanwhile, Birenboim et al. [4], investigated the temporal activity pattern of theme park visitors by questionnaire and GPS logger. They collected the visitor data at the PortAventura theme park in Catalonia, Spain. Additionally, they asked some groups of visitors to take part in their study whenever the groups matched the research sample profile (a family at least once child under 11). By doing this way, each group's position was tracked in a whole day by using GPS. As the result, they found some tendency of theme park visitors. For example, visitors prefer dining time at 14:00. This tendency was not related to the seasons or the congestion. In this study, each parameter of simulation models was made, referring to their result. Although there are numerous studies attempting to improve visitor's satisfaction level, however, position exchange model has not been considered yet. By relying in multi-agent simulation, the authors studied and verified the effectiveness of a model in which people can spontaneously exchange their positions between the queues [5]. Therefore, our study aims to model the position exchange behavior of people who are in attraction queue and in restaurant queue for the improvement of their satisfaction.

2. HYPOTHESIS

In Walt Disney World (WDW), in order to improve visitor satisfaction levels, the system called MyMagic+ with MagicBand is utilized. In fact, MagicBand can be used in various applications such as entrance tickets, fast pass, electronic money etc. By using such the system, visitors' activities can be tracked in real-time, for example, what kind of attraction that he/she is queuing. Additionally, we can make queue in cyber space by using this type of system. As the results, it is expected that the proposed model can be realized. In this research, we assumed that we can track visitors' activities in real-time and the visitors can make queue in cyber space. Thereby, the effectiveness of the proposed method is verified with the multi-agent simulator.

3. PROPOSED MODEL AND EVALUATION

In this research, we propose a model in which waiting visitors exchanges their positions in the attraction queue and the restaurant queue to improve their satisfaction. As a nature of human being, some customers become hungry while waiting in the attractions queue, and need to visit the restaurant. However, sometimes, especially during lunchtime, restaurants are crowded. In this situation, by exchanging the positions in the attraction queue and the positions in the restaurant queue, the customer satisfaction is expected to be increased. In this research, visitor's satisfaction is evaluated by comparison between the proposed model and basic model which does not utilize position exchange idea.

3.1 Proposed model

A. Simulation design

Figure 1 depicts the theme park map for our simulation. The theme park is consisted from 50×50 squares. In this map, Green squares are attractions, and red squares are restaurants. They are all numbered as shown in this figure.

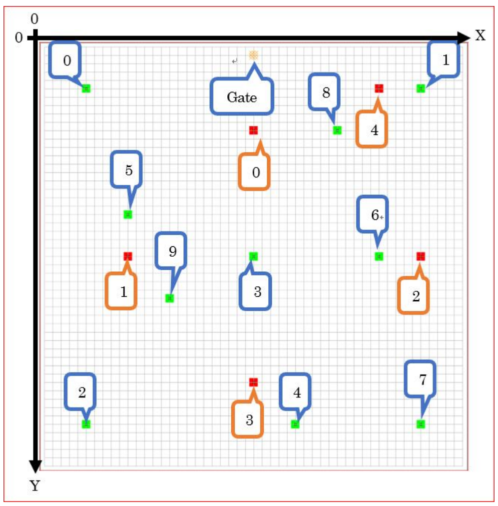


Figure 1: The map of theme park in the simulation

B. Verified Conditions

In this research, we verified the effectiveness of the in - matrix location exchange model. The basic behavioural rules of customers and the exchange system are as follows:

Customers:

1. Determine the target attraction
2. Go to target attraction
3. Queue at the target attraction

The exchange system:

4. Select two people among the customers.
5. Compared the exchange conditions of the two customers
6. Exchange their positions if there is possibility that their satisfaction levels can be improved.

Customers:

7. Play in the attraction.
8. Return to step 1 after the experience time.

Table.1 shows simulation conditions. Steps is a unit of time, thus, 200 steps are converted to about 1 hour. The customers decide their destination following to "Behavior decision" as shown in Table 1. In proposed model, each customer estimates behavior decision value for according attraction and restaurant before deciding to visit. This value plays important role in deciding the desired destination of customer. Initially, both α and β were set up to maintain the balance of three values, "attraction utility value", "number of people in queue" and "straight distance from current location to target attraction".

They are arbitrary coefficients that show the influences on the visitors' behavior decision. In our model, "the popularity of restaurant" P is proposed as shown in Eq. (1) which is a combination of the other functions comprising of "individual preference value U" presented by Eq. (2), "tendency of hungry level in each time value" H presented by Eq. (3) and "changed hungry level by movement value" M calculated by Eq. (4). In the Equation (2), the value of function U is set up so that U decreases exponentially once the amount of playing time of the visitor in the attraction increases. In the Equation (3), the value of function H is set up to be depended on normal distribution. In the Equation (4), the value M is set up that M changes according to moving distance D.

Table 2 shows the condition of attractions and restaurants. In this study, it is set up that the "Max popularity" value of popular attractions and restaurants are higher than the one of not popular attraction and restaurants. Moreover, "time for taking an attraction" is set up randomly from among 15, 20 and 25 when the simulation starts.

$$\mathrm{P} = \mathrm{U} + \mathrm{H} + \mathrm{M} \tag{1}$$

$$\mathrm{U} = \mathrm{i} \times 200^{-(n-1)} \times Rnd() \tag{2}$$

$$\mathrm{H} = 100 \times \frac{1}{\sqrt{2\pi\sigma^2}} exp\left[-\frac{(x-\mu)^2}{2\sigma^2}\right] \tag{3}$$

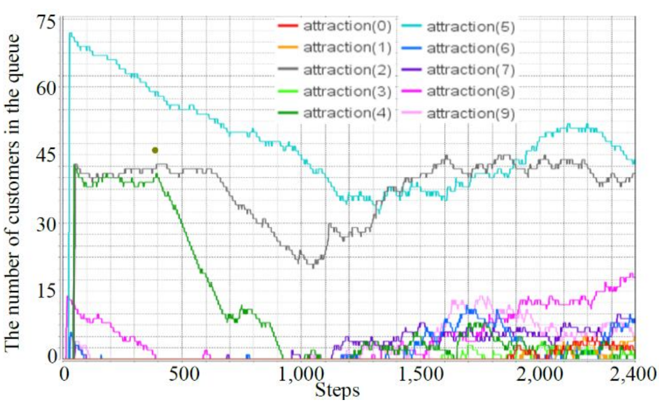
$$\mathrm{M} = \frac{D}{1000} \tag{4}$$

3.2 Evaluation of Queue length

Figure 2 illustrates the simulation result of basic model which does not include the position exchange activities. According to this figure, it can be seen that the popular attractions are more crowded in the first half than in the second half, especially, at the beginning of simulation. Figure 3 is also the simulation result depicting the number of people in the restaurants queue in basic model. In this model, each parameter is set so that the peak of restaurant queue length is located during the middle steps. This result is the same as the one in contemporary study [4].

Table 1: Simulation verification condition

The number of visitors	200
Capacity of each attraction	2
The number of attractions	10
Capacity of each restaurant	4
The number of restaurants	5
Popularity of each attraction	i × Rnd() × $2^{-(n-1)}$ i=0.3, 0.2 and 0.1 n=(the number of times the customer visit the attraction)
Popularity of each restaurant	i × $200^{-(n-1)}$ Rnd() + 100 × $\frac{1}{\sqrt{2\pi\sigma^2}} exp\left[-\frac{(x-\mu)^2}{2\sigma^2}\right]$ + (Moving distance / 1000) i=0.2 and 0.1 x= Current Steps σ= 400 , μ= 800 n=(the number of times the customer visit the restaurant)
Satisfaction level	Summation of popularities
Behavior decision	Popularity-α(the number of waiting visitors) -β(Linear distance from current location to target attraction) α= 0.001 , β= 0.001
Time for taking an attraction	15, 20, 25 steps
Time for moving to next attraction	(Linear distance between attractions)*1step
Theme park opening hours	2,400step
Exchange Condition	Popularity /(The number of customers currently queueing in front of the customer)



exchange. (The horizontal axis is the steps, the vertical axis is the number of customers in the attraction queue.)

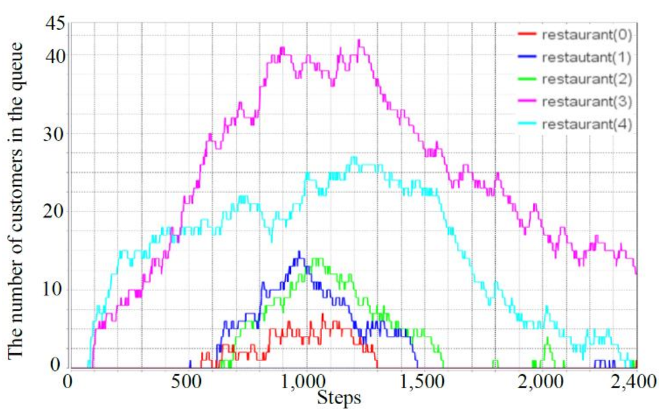


Figure 3: The number of customers in the restaurant queue in basic model.

Figure 4 shows the simulation result of proposed model which includes the position exchange activities, whereas, Figure 5 depicts the number of people in the restaurants queue in proposed model. Comparing to the results in Figure 2, in the first half, the queue length of attraction number (5) in proposed model is smaller. However, in the second half, the queue length becomes larger compared to the one in basic model. As a result, it can be seen that the proposed model reduces the queue length by shifting the visit timing of visitors coming to popular attractions. However, when comparing to the result Figure 3, it can be seen that the queue length in front of restaurant which is shown in Figure 5, is larger. In order to confirm the effectiveness of proposed model, the further analysis in satisfaction level of the visitors is needed.

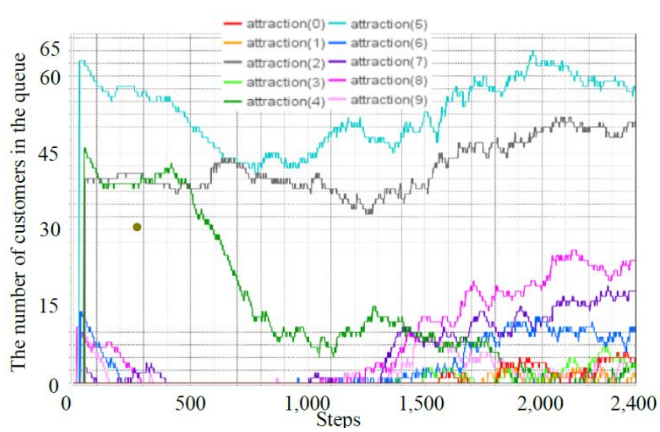


Figure 4: The number of visitors in the queue of attraction in

Table 2: Attractions and Restaurants conditions

Attraction number	0	1	2	3	4	5	6	7	8	9	Restaurant number	0	1	2	3	4
X-coordinate	5	45	5	25	30	10	40	45	35	15		25	10	45	25	40
Y-coordinate	5	5	45	25	45	20	25	45	10	30		10	25	25	40	5
Time for taking each attraction	20	15	25	20	15	25	15	20	25	15		40	40	40	40	40
Max populality	0.1	0.1	0.3	0.1	0.3	0.3	0.2	0.2	0.2	0.2		0.1	0.1	0.1	0.2	0.2

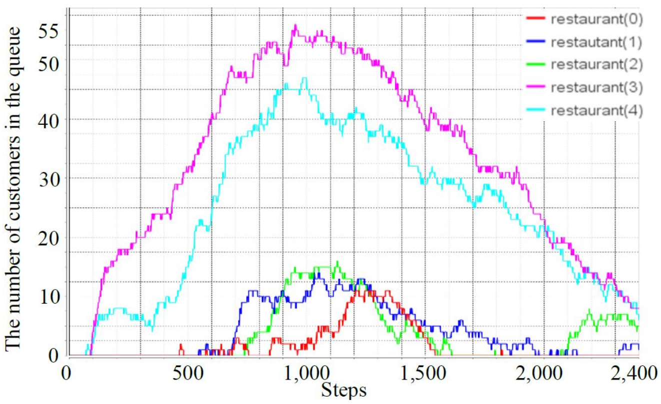


Figure 5: The number of customers in the restaurant queue in proposed model.

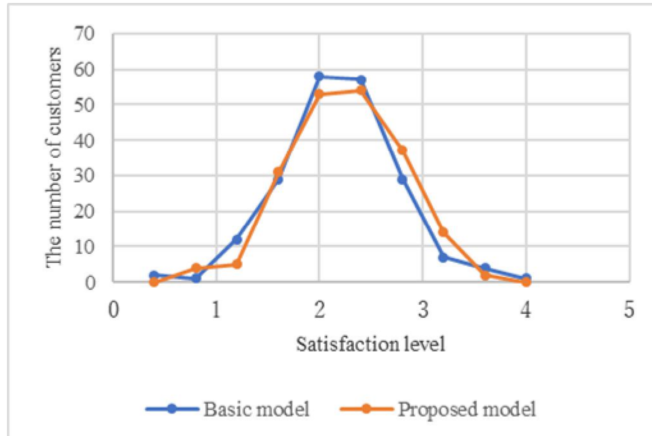


Figure 6: Comparison of satisfaction level distribution.

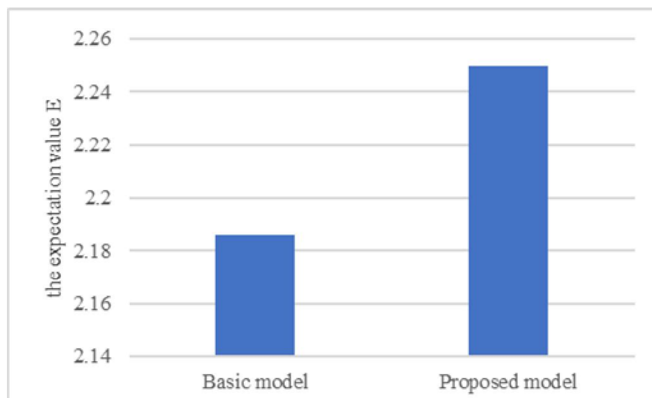


Figure 7: Comparison of expected satisfaction level.

3.3 Evaluation of Visitors' Satisfaction

In this section, we focus on evaluating the visitors' satisfaction, especially the distribution of satisfaction level in both models. In fact, the satisfaction level is calculated by summarizing popularity value of each attractions which the visitor experienced. Figure 6 illustrates the comparison of satisfaction level in basic and proposed model. Accordingly, the number of visitors who have satisfaction level being over 2.5 in proposed model, is higher than the one in basic model. However, there is higher number of visitors who have satisfaction level under 2.5 can be found in basic model.

In order to verify the effectiveness of the proposed method, we also introduce the expectation value E of the satisfaction level for the entire visitors as an evaluation index which is shown below.

$$E = \frac{\sum R \times n}{N} \quad (5)$$

In Eq. (5), R is the degree of satisfaction, n is the number of visitors who have the same satisfaction level, and N is the number of visitors. Figure 7 shows the expected value E of the basic model and proposed model in a comparison.

According to Figure 6 and Figure 7, the satisfaction level of the proposed model is a little bit higher than that of basic model, demonstrating the effectiveness of the proposed model. This is because there are only few visitors want to exchange positions in the queue among customers. In fact, the position exchange between the queues of restaurant queue and attraction has been performed in only eighty-nine times. This is the probability of whether or not each customer exchanges position once in a day.

4. CONCLUSION

In this research, we propose an exchange model that allows the visitors exchange their position between attraction queue and restaurant queue for the improvement of their satisfaction level. From the simulation results, the effectiveness of the proposed model was confirmed. Accordingly, the satisfaction level of our proposed model is higher than the one of basic model, although longer queue length of attraction and restaurant is found in proposed model. The effectiveness is still modest due to the small probability of exchanging each customer's position in the queue. Thus, it is necessary to thoroughly examine the setting conditions and clarify the relation between each condition and satisfaction level. In addition, there are some parameters such as meals, toilets and fatigue will be considered in the future works.

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