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Title

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Abstract

This is my abstract...

Acknowledgements

This is my acknowledgements...

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Notations

Sample notations Table 1

Table 1: Mathematical notations

Symbol	Meaning
α	learning rate
γ	discount factor
S, s	state
A, a	action
R, r	reward
τ	a trajectory / an episode
G	return
t	a discrete time step
G_t	return at time step t
T	final time step of an episode
π	policy
π_θ	parametrized policy with parameter θ
$\pi(s)$	the action distribution given state s under policy π
$\pi(a\|s)$	probability of action a given state s under policy π
$\mathbb{E}$	expectation
$\mathbb{E}_\pi$	expectation under policy π
$v(s)$	state value of state S
$v_\pi(s)$	state value of state S under policy π
$q(s, a)$	action value of action a on state s
$q_p i(s, a)$	action value of action a on state s under policy π
σ	activation function

Chapter 1

Introduction

This study attempts to implement Location-based Augmented Reality and user Co-creation on Local Revitalization for a campus and aims at generalization to other places.

1.1 Motivations

As the pandemic of COVID-19 spreading throughout the world since 2020, people were forced or encouraged to stay home and restricted from accessing public places, including tourist attractions, shops, workplaces, schools, etc. Humans' freedom in physical space is restricted, which accelerate the progress of digitalization. Not only entertainment but more and more economic and even academic activities are moving online. As the pandemic slowing down recently, despite the resumption of some physical activities, there are places or facilities remaining unused or abandoned due to financial problems, amount of users not recovered, digitalization of activities, and so on.

Removing the unused places or facilities is an alternative, but if it is possible to give them new values or change people's image of them, they can play different roles and keep contributing the society or enrich the environment. In fact, the concept 'Regional Revitalization', which referes to the attempts to vitalize rural towns where population is falling, by making use of local speciality combined with new ideas to develop new and unique industries such as tourism, has been applied around Japan recently. Among cases of Regional Revitalization, some of them adopt location-based Augmented Reality to help enrich the space. Location-based Augmented Reality is defined as Augmented Reality that utilize geographical information to display contents corresponding to a physical location. It has already used in

not merely entertainment, where Pokemon GO is a famous example, but also implemented in tourism and education, which implies its versatility and practicability. With the application of location-based Augmented Reality and the reference of Regional Revitalization, transformation of an unused place or facility without physical reconstruction seems to be feasible.

Current Local Revitalization requires considering local unique specialties or features, which takes resources and time to create suitable contents, not to mention public facilities like schools, business buildings, transport hubs which are usually lack of unique specialties or features usable for revitalization, especially for tourism cases, one of the most common applications of local revitalization. Fortunately, these places have one property in common: users. It may be an alternative for these places to invite users back to create contents based on them, complementing the lack of local uniqueness, attracting more users back and realize their revitalization. We suppose that with the help of Augmented Reality, users can enjoy and create contents with less cost. Although encouraging users back to places where they don't go anymore to create contents becomes another problem, we consider user-user interaction a possible solution since there are works showing positive effects of user-user interaction on users engagement.

Finally, the buildings in our campus are mostly white or silver, and students always describe the landscape as a factory; meanwhile students accessing the campus has become much less after the pandemic. These two reasons has become the initial inspiration for us to add more colors on our campus to make it looks more vivid as well as attract more people to come back.

1.2 Objectives and importance

There are several research questions in this study:

> We examine whether Location-based Augmented Reality with user co-creation does
>
> - Make a place more attractive
> - Change a place's image for users
> - Form interaction between users

In this study, firstly we aim at answering the above research questions, and we expect the results are positive. Furthermore, we try to figure out the possibility to revitalize the campus as a response to our initial inspiration, and generalize the concept and experience to not only campus but also other public facilities or places.

As for the importance of this study, firstly we tend to revitalization locations in general, different from current cases of Local Revitalization that are usually applied on rural region and in tourism or education orientation. Also, we let users comprise the contents, instead of considering specific characteristics of each location and customize the contents on the side of service provider. Last but not least, we attempt to prove a possibility, focusing less on improving Location-based Augmented Reality in technology aspects like the accuracy of geographical information or object displayment.

1.3 Overview of this paper

This paper consists of 6 chapters, beginning with this chapter for introduction. Chapter 2 explains background knowledges and concepts behind this study, including pandemic's impact, Local Revitalization, Location-based Augmented Reality and Co-creation. Chapter 3 introduces previous studies related to ours, and compares our work with them to make our work's importance more explicit. Chapter 4 explains the methodology in this study, including a concept model, prototype we built, and details of user experiment. Chapter 5 conducts analysis and discussion on presented results from the user experiment. Chapter 6 draws a conclusion, mentions limitation in this study, and proposes possible future works.

Chapter 2

Backgrounds

2.1 Pandemic's impact

Google has been collecting their users' mobility data since the beginning of 2020 [1] [2]. Results indicate that people do access public places, including transit stations, workplaces and parks, less than before pandemic started spreading. The pandemic also accelerate the process of digitalization [3], which also resulted in a decrease of people commute physically. There are also investigations indicating that more than tens of thousands of store closed in Japan during the pandemic. Other investigations show that remote working has becoming a permanent phenomenon around the world [4]. In Japan, government even made a policy to discourage employees to commute physically. The above situations resulted in more unused facilities left on the society. The U.S. government holds about 45,000 underused or underutilized buildings according to an investigation by Harvard Business Review [5].

2.2 Local Revitalization

Local Revitalization is proposed by Japanese government, aiming at combining local unique features or specialties and new ideas or technology, in order to stimulate rural economics to balance the gap between cities and rural areas [6].

Common approaches include improving quality or design of existing local products with new techniques, launching new industries with local features, and broadening promotion on SNS or other media. Of course, a standard does not exist in the field of Local Revitalization, and there are different cases adopting diverse approaches, such as inserting real landscapes or local products into dramas or animations to attract audience, or inviting artists

to create graffiti at shopping streets to get their customers back [7][8][9].

As the development of Augmented Reality, there are also cases implementing Augmented Reality in their revitalization projects, such as placing a virtual castle on a historical ruin [10] and displaying interactive digital contents beside local physical exhibits [11][12].

2.3 Location-based Augmented Reality

Augmented Reality (AR) utilizes camera on smartphone or glasses to capture the landscape of real world, and then displays digital contents on the captured landscape so as to combine digital information with reality. Location-based Augemnted Reality makes use of geographical information such as GPS data or feature points of a landscape, so that displayed contents are located corresponding to a specific location. Pokémon Go is one of the famous cases of Location-based AR, which displays virtual characters 'pokemons' based on geographic coordinates around the world and requires players to move physically to catch them [13]. The game has earned more than 5 billion dollars since its launch 5 years ago [14], indicating the enormous popularity it possesses.

Beside entertainment, Location-based AR is also applied in tourism and education cases, including displaying educational resources on a tablet when getting close to a spot in an archaeological site [15], or asking a user to challenge a quiz on one's smartphone when approaching a historical building [16].

2.4 Co-creation

Co-creation, in business context, is defined as a company involving its customers in the creation of products or services to suit customers' own context [17]. In a general context, it is also defined as any act of creativity that is shared by two or more people [18]. Co-creation can happen not merely between a company and its customers but also in occasions where value creation is conducted by ordinary people together [19].

Furthermore, cases of co-creation with Augmented Reality implemented also emerged in recent years. Anttoni Lehto et al. presents an adoption of co-creation which allowed students to initially create contents for a location-based AR learning platform [20]. Jorge Bacca et al. proposes a framework to utilize co-creation in designing motivational augmented reality for vocational education and training [21].

Chapter 3

Related Works

Chapter 4

Methodology

4.1 Proposed model

4.2 Prototype

4.3 Questionnaires

4.4 Experiment

4.5 Sample section

Sample template [22]

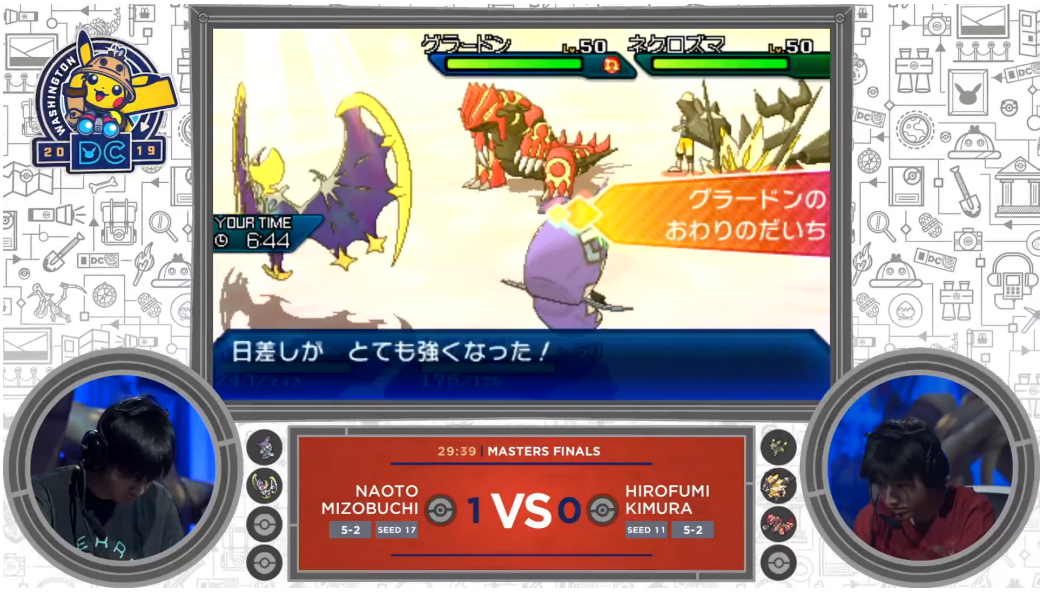

Figure 4.1: Screenshot of the Grand Finals of the Pokemon Video Game Championships 2019 held in Washinton D.C.

Chapter 5

Results and Discussion

5.1 Motivations

5.2 Image of Campus

5.3 User-user Interaction

5.4 Discussions

Chapter 6

Conclusion

6.1 Conclusion

6.2 Limitations

6.3 Future Works

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APPENDIX A - Machine Specs

Table 6.1: Machine specs

Item	Value
CPU	Intel Xeon E5-2690
Memory	188G
OS	18.04.5 LTS (GNU/Linux 4.15.0-121-generic x86_64)

APPENDIX B - Derivation of the simplest form of policy gradient

Derivation of the simplest form of policy gradient is provided below.

$$\begin{aligned}
\nabla_\theta J(\pi_\theta) &= \nabla_\theta \, \mathbb{E}_{\tau\sim\pi}[R(\tau)] \\
&= \nabla_\theta \int_\tau P(\tau|\theta)R(\tau) \\
&= \int_\tau \nabla_\theta P(\tau|\theta)R(\tau) \\
&= \int_\tau P(\tau|\theta)\nabla_\theta log P(\tau|\theta)R(\tau) \\
&= \mathbb{E}_{\tau\sim\pi}[\nabla_\theta log P(\tau|\theta)R(\tau)] \\
&= \mathbb{E}_{\tau\sim\pi}[\nabla_\theta log \pi_\theta(a_t|s_t)R(\tau)]
\end{aligned}$$

This is a expectation, which can be estimated with a sample mean. Denote the estimated policy gradient as $\hat{g}$:

$$\hat{g} = \frac{1}{D}\sum_{\tau\in D}\sum_{t=0}^{T}\nabla_\theta log \pi_\theta(a_t|s_t)R(\tau)$$