Tourism Support for *Bioluminescent Fungi* Using Video Technology

Bidesh Biswas Biki, Kodai Hasebe, Fumito Hamakawa
Graduate School of Engineering, University of Miyazaki, Japan

Satoshi Ikeda, Amane Takei, Makoto Sakamoto*
Faculty of Engineering, University of Miyazaki, Japan

Shuichi Kurogi
Miyazaki Prefectural Museum of Nature and History, Japan

**Corresponding Author*

E-mail: ti22069@student.miyazaki-u.ac.jp, fruits2000jp@yahoo.co.jp

Abstract

Amongst 70 types of bioluminescent mushrooms, more than a dozen is found in Japan. Only in Miyazaki prefecture, there are 11 types of glowing mushrooms. But most of people are not aware of this scenic beauty. So the primary goal of this research is to make a promotional video to attract more people to come to Miyazaki and see the beauty of the bioluminescent mushrooms. After the PV, the research will be extended to VR, using Unity Engine, the project will be capable to give a real time experience for the users.

Keywords: Bioluminescent, glowing mushrooms, Virtual Reality, Unity Engine, Promotional Video (PV), Tourism.

1. Introduction

About from 70 to 100 species of glowing mushrooms have been observed around the world, and more than a dozen of them have been observed in Japan. Miyazaki Prefecture is one of the few places in Japan where 11 different types of glowing mushrooms can be seen, making it one of the few places in Japan that is blessed with such an environment. The most notable of these mushrooms is *Favolaschia peziziformis*. Although *Favolaschia peziziformis* is a very small mushroom, measuring only 6 mm in diameter, it grows on dead billow leaves and fallen leaves, and plays a part in maintaining the ecosystem by breaking down plant fibers and returning them to the soil. If you go to Aoshima Island, a tourist spot in Miyazaki, Japan, at night, you can see their bluish-white glow in the *Livistona chinensis* forest.

This study is part of a collaborative research project with the Pilz Lab of Mushroom Science, Faculty of Agriculture, University of Miyazaki and the Miyazaki Prefectural Museum, Pilz Lab is the only one in Kyushu., to create three-dimensional computer graphics (3DCG) models of 11 species of glowing mushrooms found in Miyazaki Prefecture, and The project also produced an educational promotional video (PV) on *Favolaschia peziziformis* for the general public, which was used in VR to enhance the entertainment aspect of the project. A questionnaire survey was conducted to confirm the usefulness of the educational PV.

2. Research Background

In general, when tourism [1] develops, economic activities in various fields such as lodging, transportation, food and beverage, and travel services become more active, and the economic ripple effects are greater. While there is no prospect of the new coronavirus being contained, the travel industry is becoming active in new attempts such as online tours and virtual tours. In many cases, PR activities, etc., are being promoted by skillfully using easy-to-understand 3DCG and other visual technologies.

VR is an abbreviation of Virtual Reality and is called "virtual reality" in Japan. It is a technology that creates a virtual environment on a computer and creates the illusion of actual being in that space by projecting a 360° image that covers the view of the user wearing special goggles.

Unity is a game engine developed by Unity Technologies in 2004. It is the most popular game engine in the world and is used by one million developers worldwide. It has a built-in "Integrated Development Environment" and supports multiple platforms. It adds physics to objects, which can be edited in real time as the game is played. C#, JavaScript, and Boo can be used as programming languages for writing scripts [2].

3. Development Environment

The development environment is shown in Table 1 with some use of Unity and the corresponding programming language C#.

Table 1. Development environment

Calculator	Precision Tower 3620
OS	Windows10 pro
Software	Blender
	Unity 2018.1.0f2
	SAI 2
	Power Directer1.8

4. Details of implementation

4.1. *Mycena manipularis*

The umbels are 1-3 cm in diameter and the stems are 1.5-4 cm long. It grows in clusters in summer on dead trees of various broad-leaved species and is almost white in color. The back of the umbrella is characterized by a tube hole. The glowing power is weak, and the stem emits a greenish light (Figures 1 and 2)

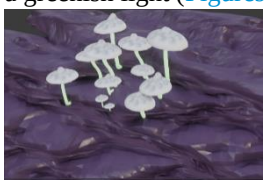

Figure 1: *Mycena manipularis* (day).

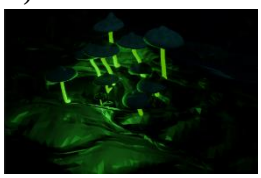

Figure 2: *Mycena manipularis* (night)

4.2. Ayahikaritake *(Roridomyces* sp.*)*

The umbrella is about 1.5 cm in diameter and 4~5 cm tall and white in color. Only the spores are originally glowing, and the whole plant appears to be glowing because the spores are attached to the mucus secreted from the stem and issued by the mucus. In addition, the spores emit light where there is moisture, but not in dry places (Figures 3 and 4).

Figure 3: *Ayahikaritake* (day).

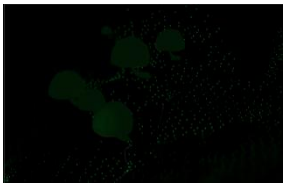

Figure 4: *Ayahikaritake* (night).

4.3. *Cruentomycena orientalis*

The umbel is deep red to blood-red in color, usually umbilicated in the center, and viscid or dry when wet. Folds sparse, drooping, fringed; scapes viscid or dry when wet (Figures. 5 and 6).

Figure 5: *Cruentomycena orientalis (day).*

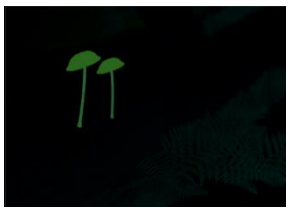

Figure 6: *Cruentomycena orientalis (night).*

4.4. *Resinomycena fulgens*

Mushrooms with umbrellas 2-5 mm in diameter that occur on the rotting bark of Daggi trees during the rainy season and autumn rains. The folds are slightly drooping. The edges of the folds of the umbrella are luminous. The Japanese name "Ginga take" was given to this mushroom because it looks like a glowing "Milky Way" when you look up at a group of *Resinomycena fulgens* (Figures 7 and 8).

Figure 7: *Resinomycena fulgens* (day).

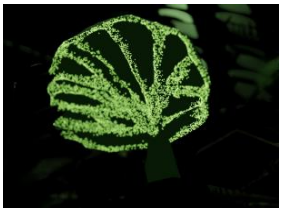

Figure 8: *Resinomycena fulgens* (night).

4.5. *Mycena lux-coeli*

The umbel is bell-shaped or conical, rarely flattened, 15-25 mm in diameter, purple brown in color, not viscous, and powdery. The folds are perpendicular to the petiole, slightly separated from each other, white with a purplish-brown margin.

The base of the petiole is not old and is often white and coarsely hairy with a hollow, cartilaginous interior. Folds and scapes strongly glabrous in the dark (Figures 9 and 10).

Figure 9: ***Mycena lux-coeli*** **(day).**

Figure 10: ***Mycena lux-coeli*** **(night).**

4.6. *Panellus pusillus*

Grows in clusters on dead trees. The umbels are cream-colored and 2-7 mm in diameter. The inside of the umbrella has numerous small tube pores. Light intensity is low, making it difficult to detect (Figures 11 and 12).

Figure 11: ***Panellus pusillus*** **(day).**

Figure 12: ***Panellus pusillus*** **(night).**

4.7. *Omphalotus guepiniformis*

The umbrella is semi-circular in shape, 5 to 30 cm in diameter, and its surface is sticky on damp days, such as after rain. The surface is sticky on damp days, such as after rain. When small, it is orange-brown to yellowish brown, and as it ages, it turns purple-brown or yellowish brown and becomes dull and shiny. The umbrella and the stem do not glow, neither on the surface nor inside. The folds that have been damaged by contact with a hard object will not glow. The peak of luminescence is about 2 to 3 days after the umbrella is fully opened (Figures 13 and 14).

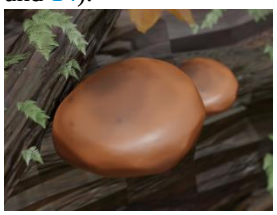

Figure 13: ***Omphalotus guepiniformis*** **(day).**

Figure 14: ***Omphalotus guepiniformis*** **(night).**

4.8. *Xeromphalina campanella*

Bristle-like mycelia are present at the base (Figures 15 and 16).

Figure 15: ***Xeromphalina campanella*** **(day).**

Figure 16: ***Xeromphalina campanella*** **(night).**

4.9. *Favolaschia peziziformis*

Favolaschia pezizformis can be observed on Aoshima Island, a tourist attraction in Miyazaki Prefecture. Aoshima is home to approximately 4,300 *Livistona chinensis*, and it is known that *Favolaschia peziziformis* occurs year-round, mainly on dead *Livistona chinensis* leaves. The diameter of the bulbs is about 6 mm, and there are tubular pores on the surface where spores are produced. It is also known to be a food source for insects and small animals such as slugs. We modeled *Favolaschia peziziformis* as the main axis of an educational PV (Figures 17 and 18).

Figure 17: ***Favolaschia peziziformis*** **(day).**

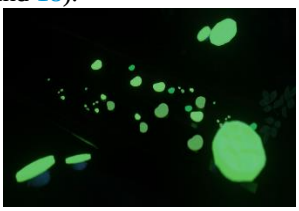

Figure 18: ***Favolaschia peziziformis*** **(night).**

4.10. Lightning Bug

Fireflies in Japan were also modeled, as glowing mushrooms (*Mycena lux-coeli*) and Lightning Bug are often seen together. Currently, there are three species of fireflies in Japan: genji botaru, heike botaru, and hime botaru. Figure 19 shows the actual modeling. When using the radiant node in the shader editor, the problem arose that its mesh was brightened but the light had little effect on its surroundings, so the light solves this problem by setting the light source directly near the mesh, which is illuminated by the radiant node. An image of a Lightning Bug shining is shown in Figure 20.

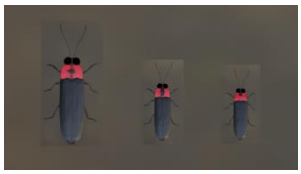

Figure 19: Fireflies in Japan

Figure 20: Fireflies glowing

4.11. Yurukyara

Yurukyara, short for "loose mascot character," is a mascot character that promotes regional awareness and tourism through events and campaigns. The benefits of using Yurukyara in PV include: reducing the rigid impression of educational PV, making it easier for viewers to become familiar with Favolaschia peziziformis itself, and providing appropriate information by conveying a message through Yurukyara. In addition, conveying a message through Yurukyara can lead to appropriate information dissemination, and furthermore, if it attracts media attention, it can be expected to have a significant PR effect. Figures 21 and 22 show the model we created. The umbrella part of the head emits light in the dark.

Figure 21: Yurukyara (day)

Figure 22: Yurukyara (night)

5. Extension to VR

The created PV can be run after being built on an Android device, and when the device is set on Google Cardboard, a VR experience can be had (Figure 23). Tilting the headset horizontally or vertically is reflected in the virtual world.

Figure 23: Terminal Set

The purpose of this project was to create an educational PV about *Favolaschia peziziformis* for public awareness. PowerDirector 1.8 was used for the production. The structure of the video is as follows. First, the video introduces Qingdao Island, mentioning the sea and the *Livistona chinensis*. Next, *Favolaschia peziziformis* during the daytime are shown and their characteristics are described. Then, the glowing *Favolaschia peziziformis* is described. Next, a slug eating an *Favolaschia peziziformis* is shown, and the presentation ends with a panoramic view of Qingdao. The following screen shows the extension to VR (Figure 24)..

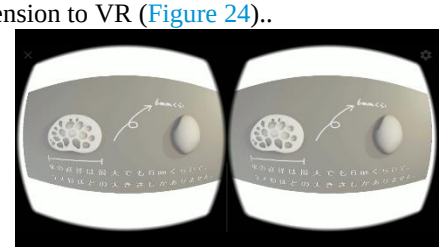

Figure 24:Favolaschia pezizaeformis and rice grains

6. Questionnaire Results

There were five questions, and all questionnaires about the PVs were rated on a scale of 1 to 5 (1: poor to 5: good). The results are shown in Figure 25.

Question 1: Were you interested in the glowing mushrooms?
Question 2: Would you like to visit the tourist attractions?
Question 3: Did you enjoy the VR experience?
Question 4: How would you rate the PV?
Question 5: Did you feel screen sickness?

7. Consideration

The average score for the question "1. Were you interested in the glowing mushrooms?" was 4 points. The average score was 4 points for the question "Were you interested in the glowing mushrooms? and "Evaluation Item 4: Evaluation of PV," the average score was 4.5.

In addition, the average response to the question "Would you like to visit the sightseeing spot in the evaluation item 2?" the average score was 3.8, which is lower than the other items, but about 70% of the respondents said they would like to go sightseeing.

In addition, the average score for the question, "Did you feel screen-sick?" was 3.8, which is lower than the average score for the other items. the average score was 3.3 points. In mobile VR, especially when using it for the

first time, the focus may not match the movement of the screen, which may cause screen sickness. Therefore, we felt that it is necessary to devise ways to prevent screen sickness and to design the device in such a way that it does not cause eye fatigue.

Future tasks are to make the 3DCG model more realistic while receiving feedback from the Faculty of Agriculture and museum staff, and to improve the quality of each scene while referring to the various opinions received in the open-ended comments section of the questionnaire. We also need to think in detail about how to promote the glowing mushrooms in the Corona Disaster and how to use the 3DCG models we created this time.

8. Conclusion

Based on the feedback we received from the Faculty of Agriculture and museum staff, our future tasks are to make the 3DCG models more realistic and to improve the quality of each scene by referring to the various opinions we received in the free-text sections of the questionnaire. In addition, since we are also conducting research on AR-based exhibition support, we can expect to see AR development of the glowing mushroom PV. Finally, we would like to express our deepest condolences to our collaborator, Dr. Etsuko Harada (Faculty of Agriculture, University of Miyazaki), who passed away in October of the year before last. The Faculty of Agriculture and museum employees will be consulted in order to improve the 3DCG models' realism. Additionally, each scene will be improved in light of the feedback provided in the questionnaire's open-ended comments area. Additionally, we must carefully consider how to employ the 3DCG models we produced this time as well as how to promote the luminous mushrooms in the Corona Disaster.

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Authors Introduction

Mr. Bidesh Biswas Biki

He is a master student at Department of Engineering, University of Miyazaki. His major is Mechanical Systems and Informatics. He works with Machine Learning Classification algorithms and trying to go in depth of Artificial Intelligence.

Mr. Kodai Hasebe

He is a master student at Department of Computer Science and System Engineering, University of Miyazaki.His current research interests are image processing, machine learning, and so on. JSET.

Mr. Fumito Hamakawa

He is a master student at Department of Computer Science and System Engineering, University of Miyazaki.His current research interests are computer graphics, cellular automaton simulation, and so on.

Prof. Satoshi Ikeda

He received PhD degree from Hiroshima University. He is an associate professor in the Faculty of Engineering, University of Miyazaki. His research interest includes graph theory, probabilistic algorithm, fractal geometry and measure theory.

Prof. Amane Takei

He is working as Associate Professor for Department of Electrical and systems Engineering, University of Miyazaki, Japan. His research interest includes high performance computing for computational electromagnetism, iterative methods for the solution of sparse linear systems, domain decomposition methods for large-scale problems. Prof. Takei is a member of IEEE, an expert advisor of The Institute of Electronics, Information and Communication Engineers (IEICE), a delegate of the Kyushu branch of Institute of Electrical Engineers of Japan (IEEJ), a director of Japan Society for Simulation Technology (JSST).

Prof. Makoto Sakamoto

Makoto Sakamoto received the Ph.D. degree in computer science and systems engineering from Yamaguchi University. He is presently an associate professor in the Faculty of Engineering, University of Miyazaki. He is a theoretical computer scientist, and his current main research interests are automata theory, languages and computation. He is also interested in digital geometry, digital image processing, computer vision, computer graphics, virtual reality, augmented reality, entertainment computing, complex systems and so on.

Mr. Shuichi Kurogi

He is a curator of Miyazaki Prefectural Museum of Nature and History. His research interests are wild plants, fungi and lichens in Miyazaki Prefecture. His current research interests are luminous mushrooms, an endangered plant. Member of Japanese Society for Plant Systematics and Mycological Society of Japan..