# PukuPuCam: A Recording System from Third-person View in Scuba Diving

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## ABSTRACT
In this paper, we propose "PukuPuCam" system, an apparatus to record one's diving experience from a third-person view, allowing the user to recall the experience at a later time. "PukuPuCam" continuously captures the center of the user's view point, by attaching a floating camera to the user's body using a string. With this simple technique, it is possible to maintain the same viewpoint regardless of the diving speed or the underwater waves. Therefore, user can dive naturally without being conscious about the camera. The main aim of this system is to enhance the diving experiences by recording user's unconscious behaviour and interactions with the surrounding environment.

### Author Keywords
Third-person view, Wearable camera, Life log, Augmented sports.

### ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

## INTRODUCTION
Scuba diving is a form of underwater diving where the diver breathes using a self-contained underwater breathing apparatus. The sea is filled with numerous interesting fishes and corals, which is absolutely beautiful especially when shone by the sunlight. Thus, many people enjoy experiencing these amazing underwater sceneries. We aim to prolong these wonderful experiences by logging them, as we believe that the interaction between divers and the surrounding nature is the most invaluable part of scuba diving. Therefore, we propose "PukuPuCam", a system to help record diving experiences from a third person view and allows users to recall their experiences later on. It aims to enhance the diving experience using a new recording method.


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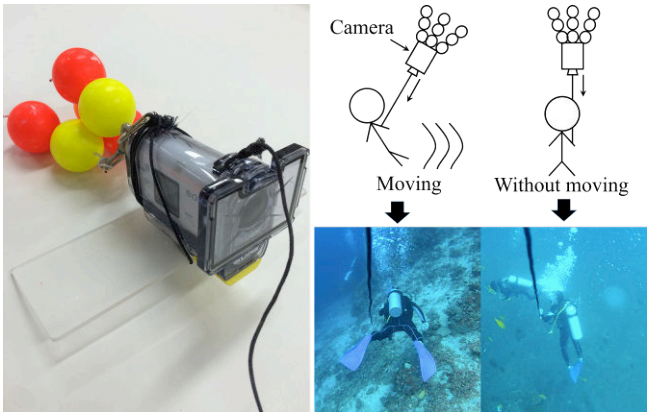


Figure 1. Appearance of "PukuPuCam" and mechanism of camera angle

## RELATED WORK
Numerous studies to design and apply third-person view in various situations have been performed. For example, Higuchi et al. used pilotless plane in order to observe from a third-person view [1]. Daniel et al. apply the third-person view to improve the usability of robots [2]. These researches took complicated positioning control using a pilotless plane. Mepi, a development team in the open source field, shows a method to capture from a third-person view by attaching a camera directly to the users [3]. Here, users will observe themselves in real time by linking the images and the users' view through a head mounted display. Other than that, Yamamoto et al. propose "PukaPuCam", a system to capture the scene from a third-person view using a balloon [4]. This system can capture the users in the center of the photograph by adjusting the buoyant force and the balloon's angle. This system became the base of our automatic camera angle control system (Figure 1). In addition, Ukai et al. created a swimming support robot system, "Swimoid", consisting of a display and motion sensors, allowing users to check their own swimming form [5]. However, we implemented a much simpler structure and focus on augmenting the experience of scuba diving. In the field of art, Monobanda and DUS Architects propose "3DR", an interactive installation to change viewing perspectives [6]. People are invited to put on wearable bird-like sculptures. Through a video screen inside these 'helmets' people see themselves from a distance.

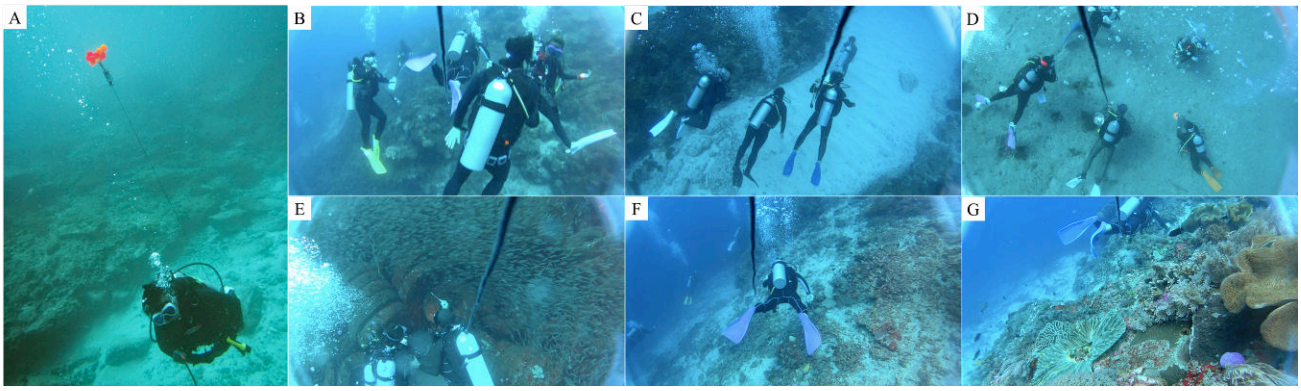


Figure 2. Real environment usage

## PUKUPUCAM SYSTEM

"PukuPuCam" system is composed of a Sony HDR-AS100V Camera, strings and common fishing floats (buoyancy of 25[g]). Figure 1 shows the camera's appearance. The floats, each attached with a flexible material to adjust underwater, are used to control the camera's buoyancy. By altering the tension and buoyancy, users can change the camera angle while diving. Photographing positions also depend on the string's length. Our trials show that 2.3[m] is the minimum length to be able to capture the whole body. Users can adjust the photographing area by changing the length. Before using in a diving situation, the camera was tested in a swimming pool. According to the actual trials, we observed that there are blurriness, parallel to the camera's direction. We attempted to weaken this blurriness by utilizing a stabilizer; an acryl plate (6[cm] × 20[cm]) attached to the bottom of the camera, to absorb the revolving movement caused by the water resistance. The system was implemented to observe users from a third-person view in real time. It aims to not only recall the experience, but also to augment the view and to create interactivity by grasping the situation. As wireless communication is not available underwater, we utilized a film antenna to convert wireless into wire communication. Although, the system do incarnate communication between the camera and the terminal as though it is wireless. In common wire communication, it is necessary to pierce the wire through an electrical cord, and complete it with a high-quality water proof finish to protect the camera from water leakage. However, our method advantages as it does not require such high-quality process for the camera protection.

## REAL ENVIRONMENT USAGE

We conducted trials where divers utilized the system in the real environment, Hatsushima and Atami in Japan (Figure 2). The camera can capture the diver fully even from 4[m] above (A). In addition, the high transparency of the water allows capturing other diving team members (B, C, D), school of fishes (E), and the moments when experiencing a tide (F, G). Divers are commonly equipped with heavy equipments and diving mask underwater, restricting their field of view. However, our proposed system can capture the divers at a wide field area, and through real-time feedback, it can help expand the divers' field of view. Our system can augment flexibility according to the situation.

## CONCLUSION AND FUTURE WORK

We proposed "PukuPuCam", to record one's diving experience from a third-person view, allowing user to recall the experience at a later time. Here, we described about the design and results of actual trials in the real environment. From the results, we observed that our proposed system can capture photographs which helps to augment recording and recalling experiences. However, there are various limitations observed as well. For example, the transparency level differs due to the day-to-day conditions, and low transparency hinders from capturing the whole experience. Surveying and taking into consideration these limitations are essential to further improve the system. Therefore, for future works, we aim to redesign the experience based on the user's feedbacks and to further develop the system as a tool to augment user's experiences from a third-person view.

## ACKNOWLEDGEMENTS

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