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EC601 project 1

Artificial Lifeguard

1.Problem statement

 According to the [World Health Organization](https://www.who.int/news-room/fact-sheets/detail/drowning" \t "_blank), there were 320,000 drownings worldwide in 2016, making it the third-highest, injury-related cause of death. Human lifeguards are the only way to respond to drowning by traditional means. A lifeguard’s jobis to prevent incidents around a pool, on the beach or in the water, and to respond in emergencies. But a lifeguard can’t watch everything all the time, and that’s how accidents happen, says Eliav. “About 90% of the work of any lifeguard is scanning, and just trying to be one step ahead,” he says.[1] With the advancement of AI technology, people are beginning to consider the use of AI instead of traditional human beings to realize the function of recognizing the condition of the water. An Israeli startup called Sightbit has created an AI lifeguard – also called Sightbit – that helps human lifeguards watch the beach and identify potential hazards. However, the accuracy of the system could be improved for beaches with a large number of people, but the program can be applied to pools with a smaller number of people.

2.Applications of Artificial Lifeguard

Artificial lifesaving systems can be used not only in public and private pools, but also to monitor riversides and beaches where drowning incidents have occurred. In public pools, it can help lifeguards to better observe the entire pool and reduce the chances of someone drowning without being rescued; in private pools, iits role is to monitor the pool conditions in private pools without lifeguards, and in the event of an emergency situation in a timely manner to call for assistance to reduce the occurrence of accidents. At rivers and beaches, the system can be used not only to determine if someone is drowning, but also to save a life by throwing a life-saving device, such as a swimming ring, at the same time as a person is found to be drowning.

For private pools, the relaxation that comes with the feeling of privacy is crucial, and no one wants to swim in a private pool with a lifeguard watching. This product can be attached to the service of private pool construction, through the camera and private server, while realizing the privacy protection for private pool customers to provide security services.

3.Design frameworks

Artificial lifeguard is a system that determines the status of a person in a swimming pool through image recognition technology.[2] It consists of the following components: a camera to acquire the video, a server to determine the status of the person in the picture and a sound to send warnings.In order to cope with situations where the water is too turbid for the camera to obtain a clear video, the method of obtaining additional images through thermal imaging and superimposing the two images before analyzing them is considered here.Let's start here with a discussion of the most basic single video as a source of information.The camera records the video and transmits it to the server, which cuts the video at certain intervals (e.g., at 10-frame intervals) and processes it for judgment. With regard to judgment, there are three basic forms of judgment: facial judgment, posture judgment, and behavioral judgment, and I believe that taking posture and behavior as the basis for judgment is a better choice, not only because it can reduce the work of recognizing human face in the picture, but also because the air bubbles produced by human in the process of swimming in the pool are more serious for the interference of the face which is not big in area itself. Through the machine learning training program to have the ability to determine whether the human behavior is normal swimming or encountered some accidents, such a system can replace the lifeguard to complete the function of observing the pool conditions.[3]

Based on the above demand analysis, the following functional requirements are made for the system: one is to be able to continuously record the video of the swimming pool condition and transmit the video to the server, the second is to recognize whether there is human activity in the video screen, and the third is to recognize the specific condition of the active human in the swimming pool. For the first function, there are two ways of transmitting the video, namely, transmitting through Bluetooth and wired transmission, and the preferred method is the wired transmission. For the second function, it can be activated manually or by infrared monitoring, and the manual activation is preferred in private pools because it maximizes the respect for the personal wishes of the owner of the private pool,and the infrared monitoring is better in beach because it can save energy when no one comes by. In the third function, we have obtained an image containing an active person in the pool, Thus, the contour image will be obtained by extracting the depth information from the images. In addition, it is also necessary to define the state of the person in order to differentiate, here my idea is to use the form of blacklist, that is, only training drowning, choking, physical exhaustion and other situations that need to seek help, for these situations accidental situation, it is uniformly regarded as normal state. Before processing the image, denoise and dimension reduction pretreatment is necessary to be conducted.

Because the collected data are images, CV recognition models are more appropriate for identifying the various sitting posture. Herein, Convolutional Neural Network (CNN) is selected to discriminate the composite image, because it has excellent recognition accuracy in image processing. By adjusting the structure of the CNN framework and optimizing the hyper-parameters in each function layer in the CNN framework, the identity accuracy of the CNN-based swiming posture recognition model could be improved.

4. List of papers and open source links

[1] [Can an AI lifeguard make beaches safer?](https://www.cnn.com/travel/article/ai-lifeguards-smart-beaches-spc-intl/index.html)

[2] Shatnawi, M.; Albreiki, F.; Alkhoori, A.; Alhebshi, M. Deep Learning and Vision-Based Early Drowning Detection. Information 2023, 14, 52. https://doi.org/10.3390/info14010052

[3] J. -X. Jian and C. -M. Wang, "Deep Learning Used to Recognition Swimmers Drowning," 2021 IEEE/ACIS 22nd International Conference on Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing (SNPD), Taichung, Taiwan, 2021, pp. 111-114, doi: 10.1109/SNPD51163.2021.9704884.

[4] J. Bergstra, R. Bardenet, Y. Bengio, and B. Kegl, Algorithms for Hyper-Parameter Optimization, Advances in neural information processing systems 24, 2011, 2546-2554.