**Project 1 Artificial Lifeguard**

1. **Introduction**

Drowning, is a process of experiencing respiratory impairment from submersion or immersion in liquid. When drowning happens, people’s body cannot have enough oxygen and die in short time. According to the WHO issued in 2023, drowning is the third leading cause of unintentional injury death worldwide, accounting for 7% of all injury-related deaths. Children, males and individuals with increased access to water are most at risk of drowning.[1] This relationship is often associated with a lapse in supervision. Only depending on lifeguard’s eyes to search for drowning people is inefficient and untrustworthy. Additionally, many swimming pools and beaches might not have access to trained lifeguards who can monitor people that are drowning, making this problem even more complicated. So keeping eyes on children and high risk people is not always possible. We need a more trustworthy method to identify people who are in danger continuously.

There are few wearable drowning detection systems have already been commercialized. SenTAG[2] is a wrist band based system which sends an alarm when the swimmer is motionless for twenty seconds under a certain depth. However, this systems are only considering the time people stay underwater, not their physiological changes in drowning situation, which lead to a delay in triggering alarm. On the other side, How-Long[3] receives a input from video of a pool and use Hidden Markov Modeling to detect people in early drowning status, but the video taken method cannot cover the situation that people swimming in the sea. As drowning incidents can be dangerous leading to a permanent brain damage or even to death, another research group[4] proposed a concept design of a swimming cap equipped with pressure sensor that could identify people’s near drowning status. These products inspire me about the detection of drowning should be considered in different conditions, for example, when we are solving problem in a swimming pool, we can use a computer vision method to better identify the people who are in danger because of the size of the swimming pool can be perfectly covered by cameras. Besides, when detecting drowning people in the sea, using cameras is improper, so some researchers propose wearable devices to detect people’s physiological changes in the water.

In this case, we need a trustworthy method to identifies people who may be drowning or in need of help, this is the Artificial Lifeguard, a method using machine learning and other techniques to identify the whole pool continuously with a high accurate rate.

1. **The related paper**

During my exploration in the past two weeks, *I picked up a paper named Near drowning pattern recognition using neural network and wearable pressure and inertial sensors attached at swimmer's chest level*[5], it is about using a wearable pressure and sensors to early detect a person’s abnormal physiological changes in order to save drowning people’s life in a very early stage.

In their early research, they developed a wearable airbag system which deflates when the swimmer remains underwater for a long period time and activate the trigger.

Then they found that drowning incidents can be dangerous leading to a permanent brain damage or even to death, so they try to detect drowning condition in a early stage. They require the professional lifeguard to wear a cap equipped with pressure sensor and mimic near drowning pattern. Then they processed the data off line using neural networks. They eventually succeed to classify near drowning pattern with the pressure sensor and normal swimming action.

Their experimentation setting is very interesting, in the last week’s presentation our group discuss about the problem of dataset because it is hard and even impossible to make a big dataset of the action of drowning people to train the model. So we propose to train a big dataset of people who are swimming normally, in order to make the model accurate enough to identify everyone who is swimming normally or keep their heads above the water. On the other hand, the research group ask the professional lifeguard to mimic the motion of a victim facing near drowning situation. This is what we missed before, the professional lifeguard who works for a long time would have enough experience to simulate the real action of a person who is in danger. This is one of the picture they had taken.

图片包含 草, 男人, 照片, 绿色

描述已自动生成

Fig 1. Lifeguard imitating the near drowning behavior (Picture captured from the underwater video)

人在水里游泳

描述已自动生成

Fig 2. Lifeguard imitating the near drowning behavior (Picture captured from the underwater video)

As we can see, the experiment uses two camera to 3D shooting the lifeguard. They set an inertial sensor at the chest level of the swimmer. Using the concept that swimmer will be observed as the vertical motion when they are in near drowning situations, researchers could use the axis to identify the people who are near drowning.

Besides, they also use the pressure sensor to help consider the real situation because in near drowning condition people struggle up and down with the depth changes frequently. The pressure change can be clearly observed. The next step, they use the neural networks to train the nonlinear complex models.

The results show that it is possible to detect people who is drown with pressure and inertial sensors.

1. Inspiration and Thought

In a product called Angeleyes[6], it uses aerial cameras cooperating with underwater cameras to detect the movements of every swimmer just same as the research above. Using the aerial cameras has another advantage of identifying the position of the drowning people to save them faster. Then the project uses a smartwatch to send alerts and situations to the lifeguards.

My inspiration is using a smart watch like Apple Watch to detect the physical changes, pressure and depth of the swimmer. If swimmers’ physical conditions are beyond normal, the watch will make a alerting noise. At that moment, the swimmer could make a pre-set finger movement to close the alert or make another action to send an immediate alert to the lifeguards. Of course, if they do not make any action, a signal would also be sent to the lifeguards to make sure there is not any missing drowning person in the pool.

1. **Challenges**

The following is the ChatGPT[7] writing about the challenges of this topic.

*4.1 Technical Limitations*:

**Dynamic Environments**: Computer vision systems need to operate efficiently under a wide range of lighting, water turbidity, and environmental conditions such as rain or fog. The reflection and refraction from water surfaces can significantly hamper the accuracy of visual data.

**Battery and Power**: Wearable devices, especially those continuously monitoring vitals or maintaining active connections, face challenges in sustaining long battery lives. The need for regular recharging can be inconvenient and can result in non-usage.

*4.2 Data Privacy and Ethical Concerns*:

**Surveillance Concerns**

**Data Storage and Security**

*4.3 Cost and Scalability*:

**High Initial Investment**:

**Maintenance Costs**:

*4.4 Reliability and Trust*:

**False Alarms**: The balance between sensitivity and specificity is crucial. Too many false alarms can lead to complacency and distrust in the system.

**Over-reliance**: There's a potential risk that human lifeguards might over-rely on technology, leading to reduced vigilance.

From the ChatGPT’s work, I found out that there is so many limits for us to concern about. Not a good idea with a proper user story can we build a good project. We need to consider its feasibility from multiple areas, such as the environment disturbance, battery problem and even the trust problem. We need to think it over about how we will manage these problems if the project is really proposed. We also need to open our mind out of the mind of engineers because we also need to consider about the legal issues, such as data privacy and ethical concerns as well.

1. Conclusions

As the drowning problem being more and more noticeable, researchers make a lot of products to solve this problem. It could be renewed with the growth of technology and considered more with the hardware and software developing. Now we could use computer vision method and wearable device method to rescue the drowning person in the earliest way we could.

1. **Reference**

[1] “Drowning.” https://www.who.int/news-room/fact-sheets/detail/drowning (accessed Sep. 16, 2023).

[2] “Drowning Detection System from Sentag,” *Sentag*. https://www.sentag.com/ (accessed Sep. 16, 2023).

[3] H.-L. Eng, K.-A. Toh, W.-Y. Yau, and J. Wang, “DEWS: A Live Visual Surveillance System for Early Drowning Detection at Pool,” *IEEE Trans. Circuits Syst. Video Technol.*, vol. 18, no. 2, pp. 196–210, Feb. 2008, doi: 10.1109/TCSVT.2007.913960.

[4] M. Kharrat, Y. Wakuda, N. Koshizuka, and K. Sakamura, “Near drowning pattern recognition using neural network and wearable pressure and inertial sensors attached at swimmer’s chest level,” in *2012 19th International Conference on Mechatronics and Machine Vision in Practice (M2VIP)*, Nov. 2012, pp. 281–284.

[5] M. Kharrat, Y. Wakuda, N. Koshizuka, and K. Sakamura, “Near drowning pattern recognition using neural network and wearable pressure and inertial sensors attached at swimmer’s chest level,” in *2012 19th International Conference on Mechatronics and Machine Vision in Practice (M2VIP)*, Nov. 2012, pp. 281–284.

[6] “AngelEye LifeGuard - Drowning Detection System for Public Pools,” *AngelEye*. https://www.angeleye.tech/en/en-lifeguard/ (accessed Sep. 16, 2023).

[7] “ChatGPT.” https://chat.openai.com (accessed Sep. 17, 2023).