نجربة تلميذ مبدع

Using Machine Learning to Reduce Fatality Rate of Scuba Diving

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◙ ملخص باللغة العربية

هو عبارة عن نظام لحماية الغواصين من المشكلات التي تواجههم لهم تحت المياه كالآتي:

أثناء الغوص، تحدث بعض المشكلات مع بعض الأشخاص، مثل: التشنجات وأمراض القلب والأوعية الدموية، وأفضل طريقة للتأكد من أن الغواص لا يعاني من مشكلات اضطرابية ستكون من خلال معدل ضربات القلب. يستخدم النظام المقترح أجهزة استشعار تسمح باستخدام جهاز استشعار قياس معدل ضربات القلب تحت الماء للغواص، ثم يتم توصيل المستشعر بوحدة تحكم تسمح بفحص قراءات معدل ضربات القلب وإرسالها عبر (سيرفر) معين، ويمكن للمستخدم تعيين مستويات عالية ومنخفضة للحدِّ من ضربات القلب.

بعد وضع هذه الحدود بما يتناسب مع الضغط ، يبدأ النظام في المراقبة، وبمجرد تجاوز ضربات قلب الغواص عتبة معينة ، يرسل النظام تنبيهًا إلى وحدة التحكم التي تنقل هذا عبر (السيرفر) وينبه إلى مركز الإنقاذ البحري والمستخدمين المعنيين، كما يحافظ النظام على تنبيه الغواص لارتفاع ضربات القلب، ويمكن للأشخاص المعنيين مراقبة معدل ضربات القلب وكذلك الحصول على تنبيه بشأن أي خلل صحي قد يحدث للغواص على الفور من أي مكان، ويمكن إنقاذ الشخص في الوقتA المحدد.

تأثير أصوات Orca على سلوك أسماك القرش:

من المعروف أن Orca (Orcinus orca) تفترس الأسماك الغضروفية ، بما في ذلك أسماك القرش الكبيرة والأشعة، وذلك ينتج عن صوت مرتفع للغاية، وينتج ـ في الغالب ـ مكالمات نبضية ، بالإضافة إلى صفارات ونقرات تحديد الموقع بالصدى / النبض تُظهر المكالمات بنية معقدة للتردد والوقت ، تتراوح بين (٥٠٠) هرتز و(٢٥) كيلو هرتز، وتستمر من (٠,٥) إلى (١,٥) ثانية.

تمت ملاحظة سلوك الانسحاب في أسماك القرش التي تعرضت لمكالمات أوركا والأصوات المفاجئة والصاخبة وغير المنتظمة.

ثبت أن الأسماك العظمية تظهر تغيرات في أنماط الحركة، وسلوك التغذية، والتفاعلات الاجتماعية، والسلوك المضاد نتيجة للضوضاء البشرية.

تم استخدام هذا الصوت كحاجز غير مادي بين الغواص وأسماك القرش حتي لا يتم إيذاؤه، وهذا يحدث بشكل سريع دون تدخله عن طريق أحد مستشعرات في النظام تستقبل ترددات المياه، وإذا تحدد أن هناك أسماك قرش، فيتم بث هذه الترددات حتي يبتعدوا عن منطقة تواجد الغواص.

◙ Purpose:

Breath-hold diving is a natural method of submersion performed during various aquatic activities.

While all breath-hold activities expose participants to the same environmental and physiological effects, their magnitude is usually different, as is the preparedness of divers and their ability to adapt to the stress of diving. While some snorkelers may not intend to submerge at all, they are still exposed to the stress of immersion, which may endanger individuals with pre-existing medical conditions.

The underwater environment, with its rapidly changing ambient pressures, presents pathophysiologic challenges that may lead to a variety of unusual conditions for which rapid diagnosis and treatment are critical. In the United States, there are more than 5 million people certified as recreational scuba divers. Given the popularity of scuba diving the world over and the number of diving accidents, every Diver should be aware of the specific hazards and medical conditions encountered underwater.

There are many other problems facing the diver other than the health problems such as sharks' attacks on humans, but the actual number of attacks is hard to determine because of poor reporting in many areas.

◙ Background research:

It was found that SCUBA diving can cause severe injuries such as Pneumomediastinum, which is air escaping from the lungs into the chest cavity, Decompression sickness, a disorder in which nitrogen dissolved in the blood and tissues by high pressure forms bubbles, and Seizure, a sudden, uncontrolled electrical disturbance in the brain. The annual fatality rate (AFR) of SCUBA diving is 16.4 per 100,000. The major cases of death are arterial gas embolism, when gas bubbles enter or form in the arterial vasculature and occlude blood flow, and asphyxia, a condition arising when the body is deprived of oxygen, causing unconsciousness or death. All the current solutions for SCUBA's high AFR proposed by the Diving Alert Network (DAN) focus on checking equipment, first aid after the injury, and other guidelines for divers. There is no rapid emergency system to help

injured divers who would probably die if not treated quickly. When considering shark attacks, there is two attributes of the problem. One is the injures and fatality resulting from the attacks on humans. The international shark attack file (ISAF) reported that sharks have attacked humans 2785 times of which only 439 was fatal in the last 60 years. The second attribute of the problem is shark random killing and overfishing which result in killing more than 30 million sharks annually. One solution for the shark attacks problem is shark nets. But these nets kill more turtles, dolphins, and rays than sharks.

Hypothesis:

While diving, your life will be dependent on the breathing oxygen tanks. The Divers Alert Network (DAN) had recorded 169 Diving fatalities during 2016. In 87.5% of the cases, the death is a result of lack of oxygen or cardiovascular condition. The presented hypothesis relies on modern technology to measure four factors: oxygen level, heartbeat frequency, depth, and location of the diver.

When the amount of oxygen reaches a certain limit and the depth is more than 25 meters, an automatic message will be sent to the rescue center on the beach and the nearest ship or boat linked to the server of the device containing a distress with an explanation of the problem and Diver location and depth.

The problem of cardiovascular conditions and panic due to an equipment failure will be solved by a heartbeat sensor. Heartbeat normally changes significantly in the case of panic or medical conditions. In these cases, an automatic message will be sent to the rescue center on the shore and the nearest ship or boat connected to the device server containing a distress explaining the problem and the location of the diver via GPS. When discussing the sharks' problem, countries have resorted to the use of some traditional methods such as taking them out of the water to kill them that is creating an ecosystem disaster. So, a separate part of the device will be for prediction of the presence of sharks by Machine Learning.

Materials:

- Arduino Uno / raspberry pi
- Heartbeat sensor
- Camera OV7670
- Sound Detector
- LCD display

- Wi-Fi Module
- Opencv library
- Google cloud

Procedures:

First, setting up the circuit and coding the components of the first part:

1. The components of the circuit were connected with each other with the following arrangement: heartbeat sensor – Uno board – relay – Wi-Fi Modul. (Figure.1)
2. The application "Arduino" was used to code the heartbeat sensor with the relay and the Wi-Fi module. (Figure.2) indicates part of the codes we have written for the Arduino.

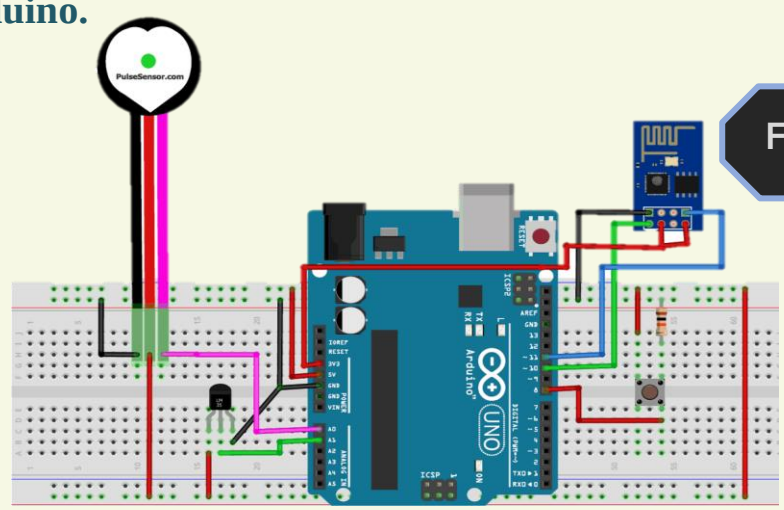

Figure.1

```
sketch_oct04a §
#include <LiquidCrystal.h>
  LiquidCrystal lcd(6, 5, 3, 2, 1, 0);
  int data=A0;
  int start=7;
  int count=0;
  unsigned long temp=0;


  byte customChar1[8] = {0b00000,0b00000,0b00011,0b00111,0b01111,
  byte customChar2[8] = {0b00000,0b11000,0b11100,0b11110,0b11111,
  byte customChar3[8] = {0b00000,0b00011,0b00111,0b01111,0b11111,
  byte customChar4[8] = {0b00000,0b10000,0b11000,0b11100,0b11110,
  byte customChar5[8] = {0b00111,0b00011,0b00001,0b00000,0b00000,
  byte customChar6[8] = {0b11111,0b11111,0b11111,0b11111,0b01111,
  byte customChar7[8] = {0b11111,0b11111,0b11111,0b11111,0b11110,
  byte customChar8[8] = {0b11100,0b11000,0b10000,0b00000,0b00000,
  void setup()
  {
  lcd.begin(16, 2);
  lcd.createChar(1, customChar1);
  lcd.createChar(2, customChar2);
  lcd.createChar(3, customChar3);
  lcd.createChar(4, customChar4);
```

```
sketch_oct04a §
  lcd.createChar(5, customChar5);
  lcd.createChar(6, customChar6);
  lcd.createChar(7, customChar7);
  lcd.createChar(8, customChar8);


  pinMode(data,INPUT);
  pinMode(start,INPUT_PULLUP);
  }


  void loop()
  {
   lcd.setCursor(0, 0);
   lcd.print("Place The Finger");
   lcd.setCursor(0, 1);
   lcd.print("And Press Start");

    while(digitalRead(start)>0);

     lcd.clear();
     temp=millis();
```

Figure.2

Second, setting up the circuit and coding the components of the section of the shark attack:

1. The other components of the circuit were connected with each other with the following arrangement: Sound sensor - LM386 - Camera OV7670 - Uno Board. (Figure.3)
2. The same application to write the code was used, but we used "python" programming language to write the machine learning part. (Figure.4)

```
#include <SD.h>
#include <SPI.h>
#include <Audio.h>

void setup() {
  // debug output at 9600 baud
  Serial.begin(9600);

  // setup SD-card
  Serial.print("Initializing SD card...");
  if (!SD.begin(4)) {
    Serial.println(" failed!");
    while(true);
  }
  Serial.println(" done.");
  // hi-speed SPI transfers

  // 44100kHz stereo => 88200 sample rate
  // 100 mSec of prebuffering.
  Audio.begin(88200, 100);
}

void loop() {
  int count = 0;

  // open wave file from sdcard
  File myFile = SD.open("test.wav");
  if (!myFile) {
    // if the file didn't open, print an error and stop
    Serial.println("error opening test.wav");
    while (true);
  }

  const int S = 1024; // Number of samples to read in block
  short buffer[S];

  Serial.print("Playing");
```

Figure.4

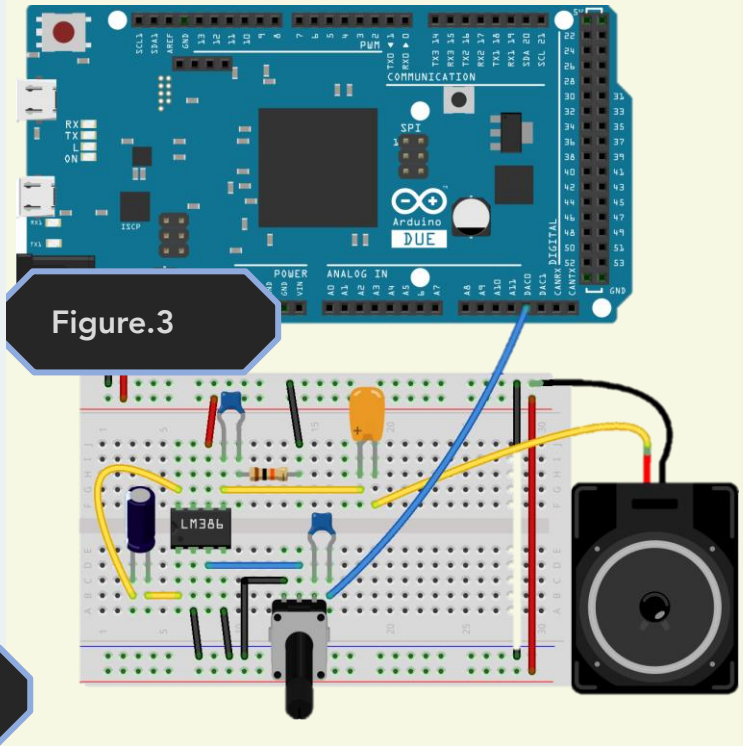

Figure.3

◙ Data Analysis:

◙ Machine learning:

Data analytics technique that teaches computers to do what comes naturally to learn from experience. Machine learning algorithms use computational methods to “learn” information directly from data without relying on a predetermined equation as a model. The algorithms adaptively improve their performance as the number of samples available for learning increases. Deep learning is a specialized form of machine learning.

◙ Project Mechanism:

While diving, some problems occur with some people, such as convulsions and cardiovascular conditions. The best method to ensure that the diver doesn't suffer from a problem that will be through the heartbeat frequency. The proposed system uses sensors that allow the underwater heart rate sensor for a diver to be used. The sensor is then attached to a controller that

allows the heart rate readings to be checked and transmitted over the Internet. The user can set high as well as low levels of heartbeat reduction.

After setting these limits proportional to pressure, the system begins to monitor and once the diver's heartbeat exceeds a certain threshold, the system sends an alert to the control unit that transmits this over the Internet and alerts to the marine rescue center and the concerned users. Also, the system keeps the diver alerted to heartbeat rise. The people concerned may monitor the heart rate as well as get an alert for any health defect that may happen to the diver immediately from anywhere and the person can be saved at the specified time.

◙ The effect of orca sounds of the behavior of sharks:

Orca (*Orcinus orca*) are known to prey on cartilaginous fishes, including large sharks and rays. They are

highly vocal and mostly produce pulsed calls, in addition to whistles and echolocation clicks. The pulsed

calls exhibit a complex frequency and time structure, between 500 Hz and 25 kHz and lasting 0.5–1.5 s.

Withdrawal behavior has been observed in sharks exposed to orca calls and abrupt, loud, irregular sounds.

Bony fishes have been shown to display changes in movement patterns, feeding behavior, social interactions, and antipredator behavior as a consequence of anthropogenic noise. Sound has been used successfully as a non-physical barrier to fish movement.

When eight species of sharks where exposed to the playback an orca call sequence. When sounds were playing, reef and coastal sharks were less numerous in the area, were responsible for fewer interactions with the baited test rigs, and displayed less ‘inquisitive’ behavior, compared to during silent control trials.

◙ Medical conditions in SCUBA diving:

◙ DECOMPRESSION SICKNESS:

Decompression sickness occurs when inert gas comes out of solution, forming bubbles following the reduction of surrounding pressure (decompression). This commonly occurs with breathing compressed air while diving. As the diver descends and is exposed to elevated environmental pressure, increased amounts of inert gas dissolve in the tissues. This is in accordance with Henry’s law, which states that the amount of gas dissolved

in a fluid is directly proportional to the partial pressure of that gas. The amount of inert gas dissolved depends on the depth and the duration of the dive. If the diver ascends too quickly, the inert gas taken up during the dive exceeds solubility at the reduced pressure and leads to bubble formation in tissues and in venous blood. The extent of bubble formation depends on the depth and duration of the dive and the rate of the ascent.

◙ ASPHYXIA:

The failure or disturbance of the respiratory process brought about by the lack or insufficiency of oxygen in the brain. The unconsciousness that results sometimes leads to death. Asphyxia can be caused by injury to or obstruction of breathing passageways, as in strangulation or the aspiration of food (choking) or large quantities of fluid (near-drowning or drowning).

◙ Conclusion:

After researching the problem and testing the project, it was found that fatality in scuba diving is a real disaster with a rate of 16.4 deaths per 100,000. Also, health problems and injures that occur during diving can be fatal. Although sharks rarely attack humans (1 in 3 million), the public fear from sharks is a huge obstacle for saving them from finning and overfishing. About 73 million sharks are hunted for fun, in shark nets, and for their fins. The AI-supported system can warn nearby boats and emergency centers of endangered divers and inform them with the location, depth, and situation of the divers. Furthermore, the system can protect divers from shark attacks by noticing the change in heartbeat frequency, sound, and nearby moving object.