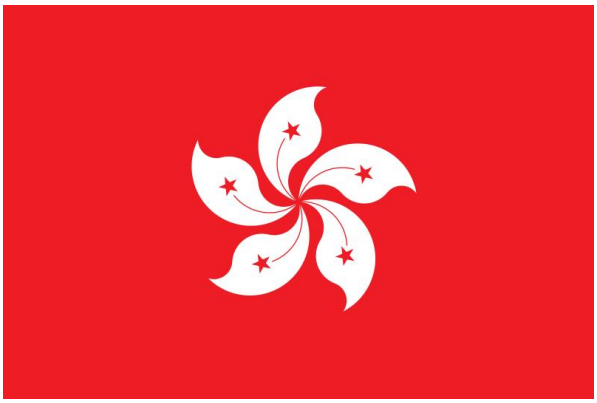

Hong Kong – BLMCSS

JOT – Tisonic

Connecting Over Water – Senior

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Team Profile

We are team JOT from Baptist Lui Ming Choi Secondary School, Hong Kong. This is our team photo:

Ocean(left): Hardware Engineer, Software Engineer, Art Design Work, Presentation

Tyson(middle): Team Leader, Hardware Engineer, Software Engineer

Jason(right): Hardware Engineer, Engineering Notebook, Material Manager

Summary Project Idea

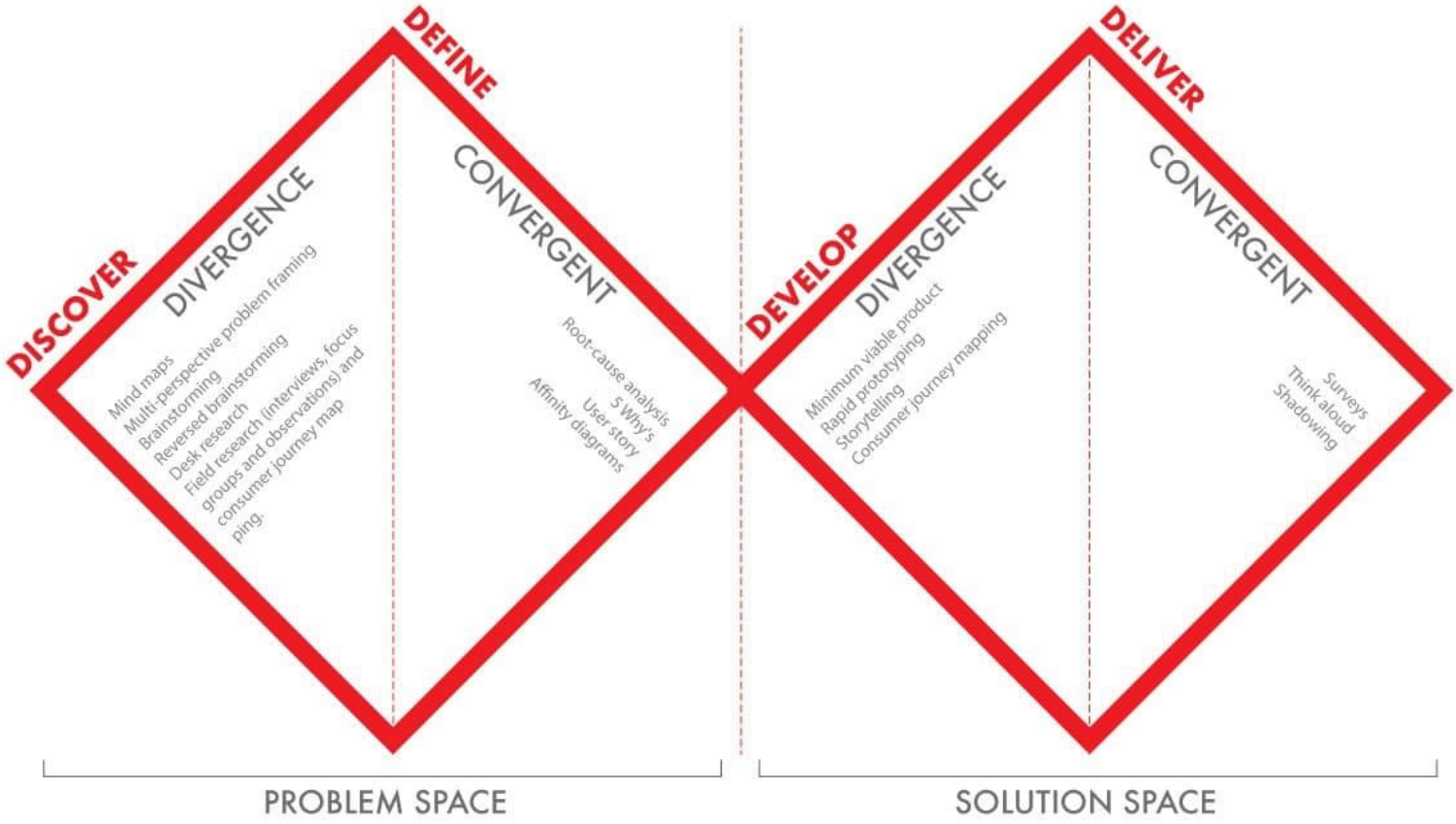
This year, we will target on the topic ‘Connecting Over Water’. Our project is to make shipping over water more efficient, safe and environmentally friendly.

Our robotic solution is going to solve safety and environmental problems. We think these measures are important because they may cause the loss of lives of humans and marine animals. We chose this problem so that we can save lives.

If our project is used in real life, it will be able to reduce the number of injuries and deaths in shipping accidents and protect the marine life. By shortening the time of saving people, the route for the ships can be used after a shorter time, which makes shipping more efficient, safe and environmentally friendly.

Our Solution

When we were working on our project, we used the 'Design Thinking Process' to plan and finish our project. The 'Design Thinking Process' includes 4 steps: discover, define, develop, and deliver.



More about Design Thinking Process

1 Discover

We did some research about water problems around the world:

- In USA 2022, there were 4040 ship accidents, 2222 injuries and 636 deaths (USA TODAY)

USA TODAY

- In 2022, about 15000 tonnes of oil is spilled into the ocean. There were 3 large spills (>700 tonnes), 2 in Asia and 1 in Africa (ITOPF)

ITOPF

After the research, we decided to make something that can be able to prevent ship accidents, test seawater and warn ships that polluted the sea.

2 Define

Main Problems:

- Ship might have accidents – ships collide/sink

- Water pollution – ships are illegally dumping waste/accidentally spill oil in the ocean (water pollution by ships may affect marine life) (CBC)

CBC

3 Develop

Our Ideas:

We thought about the topic and what we could make. Throughout the process, we decided to make a boat and a submarine that could test the seawater and save people. We chose this because we think that it will be more practical and have more features.

Usage:

- **Test seawater**
- **Save people from ship accidents**
- **Clear the obstacles of the sunken ships**

First Idea:

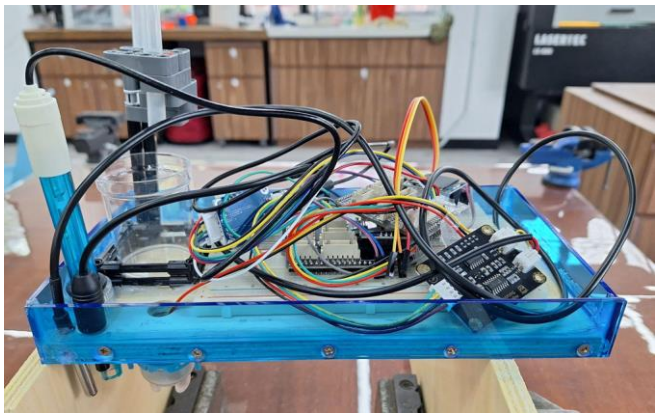
- Boat: test seawater, warn ships that polluted the sea
- Submarine: AI camera: See if there are any reefs or rocks underwater → Warn ships not to get near

Problems of this idea

- Pollutants may be produced by ships before → warning the ships there at that time: not a good idea
- Reefs and rocks stayed there for a long time, can already be shown on the ship's radar more precisely → Scanning it and locating it: not efficient enough

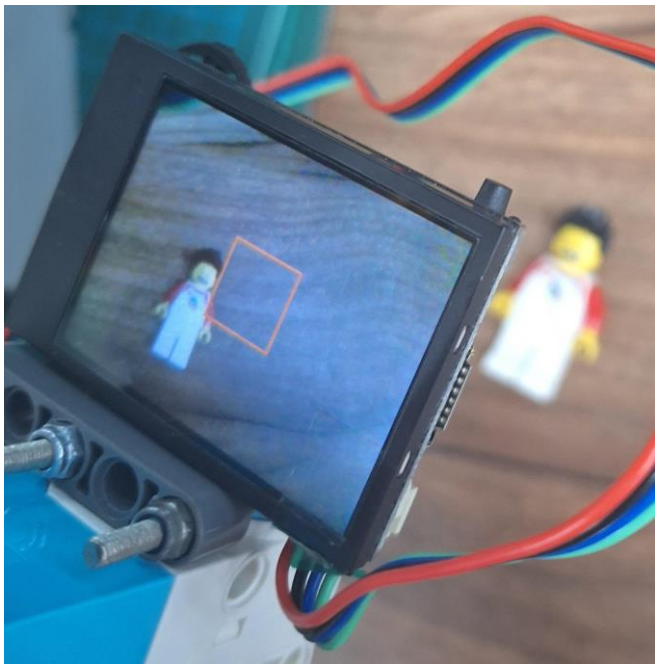
Second Idea:

- **Boat:**
  In general: Go around the sea and collect data of the seawater(pH, temperature, total dissolved solids(TDS), water quality(WQ)), If water is over normal range: notice HQ



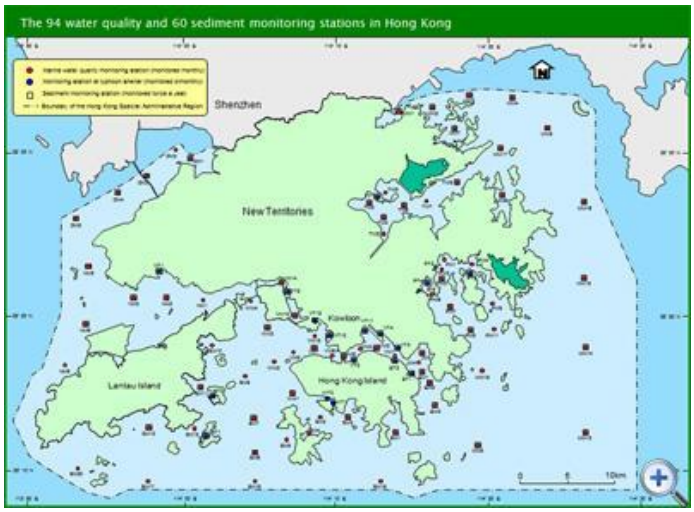
Ship accidents occur: go near the area, use Wi-Fi and GPS to communicate with HQ

- **Submarine:**
  Ship accidents occur:
  AI camera (Huskylens): finds people underwater and saves them



More about Huskylens

We found something similar which has already been made. In Hong Kong, the Environmental Protection Department of the Government has done marine water quality monitoring at 76 monitoring stations every month. (HKEPD)



HKEPD

Our Tisonic is different from those the Government had made, as it can go around the ocean and check water quality from different locations.

OceanAlpha

Also, in 2017, the Water Supplies Department of Hong Kong introduced five autonomous water sampling and monitoring boats from the company OceanAlpha. They regularly monitor water quality in the impounding reservoir to keep track of water quality. (OceanAlpha)

However, our design is to put some sources of renewable energy on the boat, so it doesn't have to go back to a station to charge very often. Ours only has to go back to the headquarters every quarter for checking.

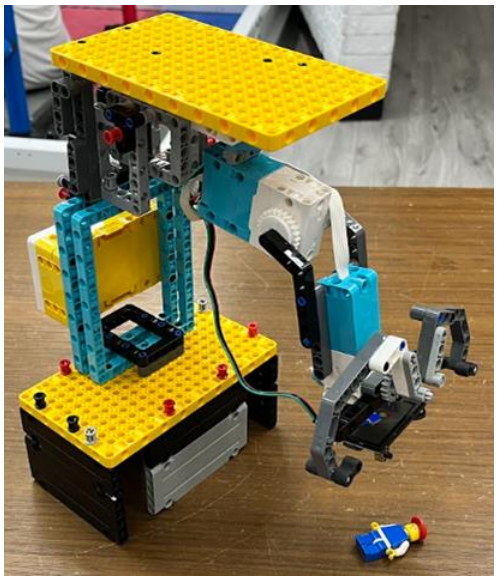
4 Deliver

After planning what we were going to make, we started our making process.

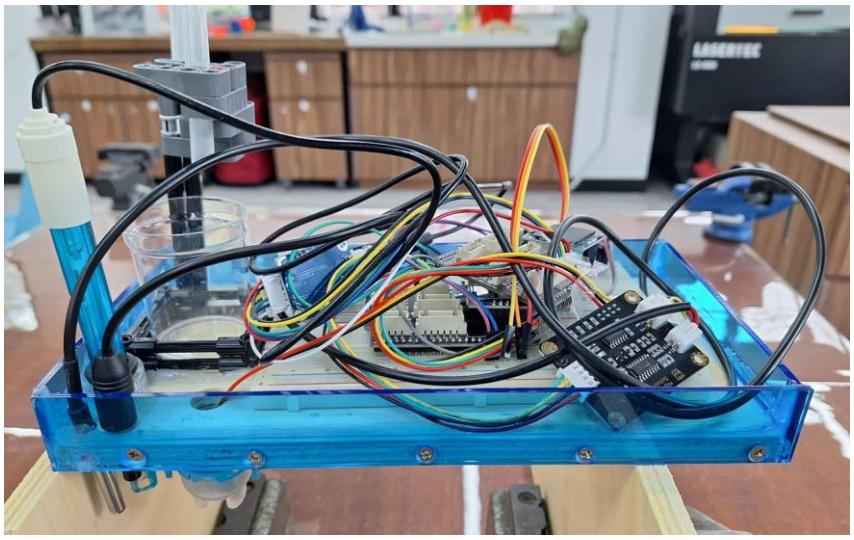
Ocean: boat sensors

Jason: boat + display model

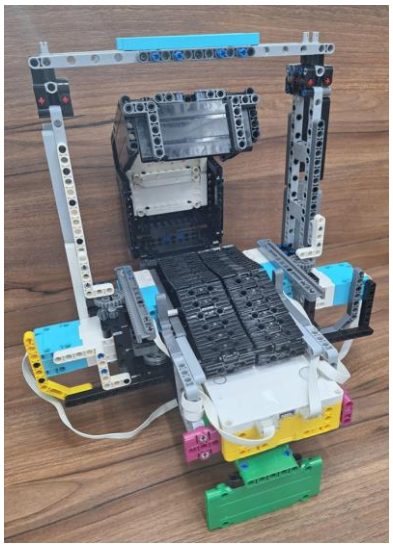
Tyson: submarine + robotic arm model



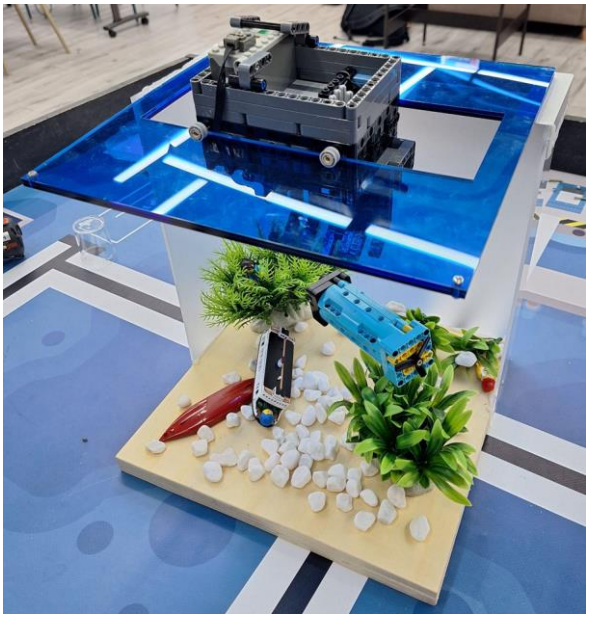
Robotic arm model



Boat



Submarine belt model



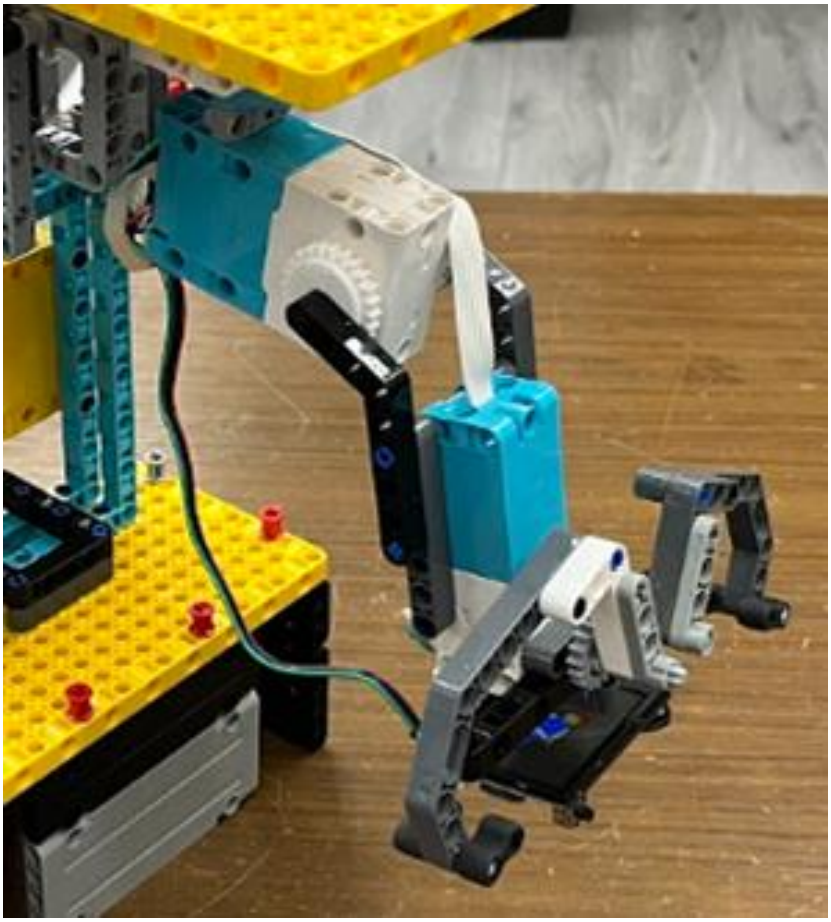
Display model

Throughout the making process, we used different kinds of mechanisms.

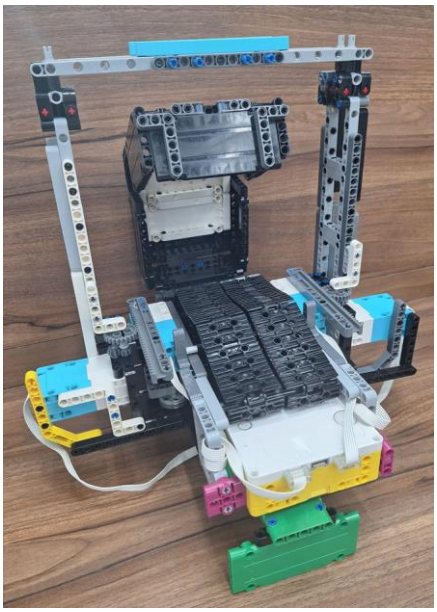
Submarine + robotic arm model:

- Huskylens (AI camera): used to track the position of the people or the obstacles of the sunken ships.

- Arm: uses 3 motors to let it move to any places

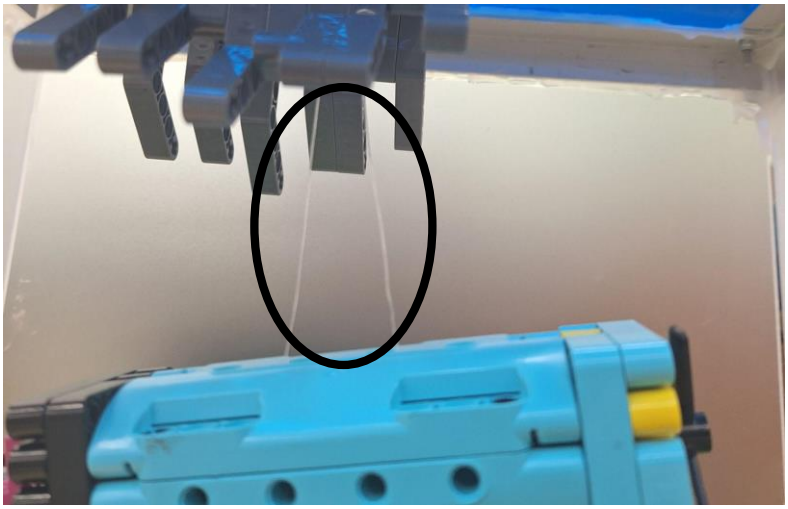


- Conveyor belt: help save victims into the boat after closing the cover



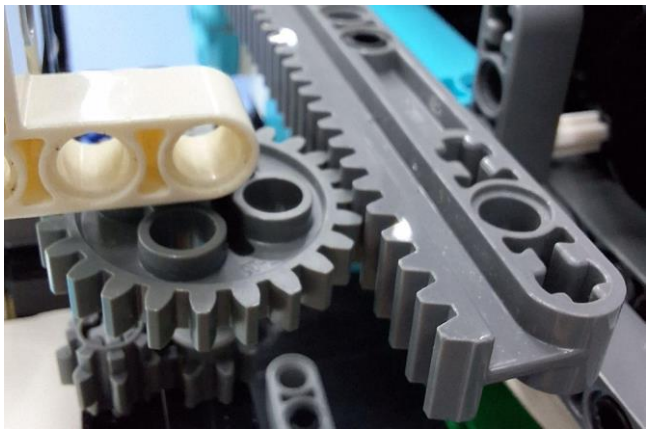
Display Model:

- Use string pulley to simulate the submarine going up and down



Mechanism involved:

Spur gears - to transmit motion and change speed as well as motion strength.



Rack and Pinion - to change the rotational motion into linear motions.

IoT and Electronics

- To send the data from various sensors(pH,...) to the mobile phone of the engineers through the Internet.
- To control the water pump either automatically or manually by the engineers via their mobile phones.

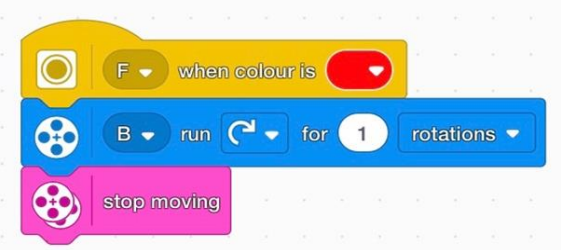
ESP8266 NodeMCU together with Blynk platform

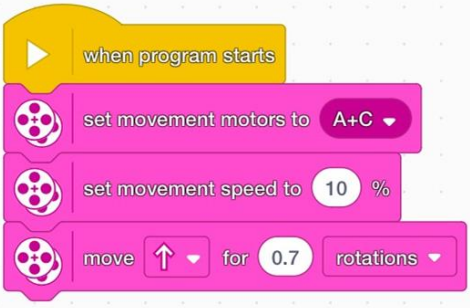
Submarine:
Huskylens Python codes:

```
while True:
    blocks = huskyLens.getBlocksByID(1)

    if len(blocks)>0:
        block = blocks[0]
        cx = block.x #Getting x-axis of the object
        cy = block.y #Getting y-axis of the object
        if cx < 120: #Judging if the obect is the right side of the cmaera then turn left
            panMotor.start(1)
        elif cx > 170: #if left side then move right
            panMotor.start(-1)
        else: #if it is in the target range then stop moving
            panMotor.stop()
        if cy > 110: #Judging if the obect is the up side of the cmaera then turn down
            tiltMotor.start(-1)
        elif cy < 70: #if down side then move up
            tiltMotor.start(1)
        else: #if it is in the target range then stop moving
            tiltMotor.stop()

    else:
        panMotor.stop()
        tiltMotor.stop()
        print("NO")
```

Get the x-axis and the y-axis of the person from the library (Huskylens). Then, judge where the person is in the camera.

Lego SPIKE block codes:





Boat:
Arduino codes : 1

```
#include <ESP8266TimerInterrupt_Generic.h>
#include "PinChangeInt.h"
#include "OLED12864.h"
#include "OneWire.h"
#include "DallasTemperature.h"
#include "MsTimer2.h"

#define ONE_WIRE_BUS 4

OneWire oneWire(ONE_WIRE_BUS);
DallasTemperature sensors(&oneWire);

OLED12864 oled12864;

float tmpetValue;
float tur_ch2_Value=0;
float ph_ch1_Value=0;
float TDS_ch4_Value=0;

int LED_PIN = 13;
int SET_PIN = 12;
int DS18B29_PIN = 4;
int PH_CH1_PIN = A0;
int PH_CH2_PIN = A1;
int ZHUODU_CH2_PIN = A1;
int ZHUODU_CH3_PIN = A2;
int TDS_CH3_PIN = A2;
int TDS_CH4_PIN = A3;

int flag_sel = 0;


static const unsigned char PROGMEM str_zhuo[] ={
0x00,0x40,0x20,0x40,0x10,0x40,0x17,0xFC,0x84,0x44,0x44,0x44,0x44,0x44,0x14,0x44,
0x17,0xFC,0x24,0x44,0xE0,0x40,0x20,0x48,0x20,0x44,0x2F,0xFE,0x24,0x02,0x00,0x00
};


static const unsigned char PROGMEM str_du[] ={
0x01,0x00,0x00,0x80,0x3F,0xFE,0x22,0x20,0x22,0x20,0x3F,0xFC,0x22,0x20,0x22,0x20,
0x23,0xE0,0x20,0x00,0x2F,0xF0,0x24,0x10,0x42,0x20,0x41,0xC0,0x86,0x30,0x38,0x0E
};


static const unsigned char PROGMEM str_ce[] ={
0x00,0x04,0x27,0xC4,0x14,0x44,0x14,0x54,0x85,0x54,0x45,0x54,0x45,0x54,0x15,0x54,
0x15,0x54,0x25,0x54,0xE5,0x54,0x21,0x04,0x22,0x84,0x22,0x44,0x24,0x14,0x08,0x08
  };


static const unsigned char PROGMEM str_shi[] ={
0x00,0x28,0x20,0x24,0x10,0x24,0x10,0x20,0x07,0xFE,0x00,0x20,0xF0,0x20,0x17,0xE0,
0x11,0x20,0x11,0x10,0x11,0x10,0x15,0x10,0x19,0xCA,0x17,0x0A,0x02,0x06,0x00,0x02
};

void setup() {
  pinMode(LED_PIN, OUTPUT);
  Serial.begin(115200);

  pinMode( SET_PIN,  INPUT );
  attachPinChangeInterrupt( SET_PIN , set_key_deal, RISING );

  MsTimer2::set(1000, TimerInt);
  MsTimer2::start();

  oled12864.init();
}
```

Boat:
Arduino codes: 2

```
void loop() {

  update_tmp();

  if(flag_sel == 0){
    get_tur_ch2_value();
    update_show_zhuo();
  }else if(flag_sel == 1){
    get_ph_ch1_value();
    update_show_PH();
  }else if(flag_sel == 2){
    get_tds_ch3_value();
    update_show_TDS();
  }
  delay(100);
}
void set_key_deal(){
    flag_sel++;
    if(flag_sel >= 3){
      flag_sel = 0;
    }
    Serial.println("SET KEY");
}
void update_tmp(){
  sensors.requestTemperatures();
  tmpetValue = sensors.getTempCByIndex(0);
}

void TimerInt(){
  static int ledState = LOW;
    if (ledState == LOW) {
      ledState = HIGH;
    } else {
      ledState = LOW;
    }
    digitalWrite(LED_PIN, ledState);
}

void get_tur_ch2_value(){
  tur_ch2_Value = analogRead(ZHUODU_CH2_PIN);// read the input on analog pin 0:
  tur_ch2_Value = tur_ch2_Value * (5.0 / 1024.0); // Convert the analog reading (which goes from 0 - 1023) to a voltage (0 - 5V):
  tur_ch2_Value = -0.0192*(tmpetValue-25) + tur_ch2_Value;
  tur_ch2_Value= -865.68 * tur_ch2_Value + 3347.19;

  if(tur_ch2_Value<=0){tur_ch2_Value=0;}
  if(tur_ch2_Value>=3000){tur_ch2_Value=3000;}
}
#define ARRY_LENGTH 10

void get_ph_ch1_value(){
  float PH_VALUE = 0;
  int pv[ARRY_LENGTH];
  for(int i = 0; i < ARRY_LENGTH; i++ ){
    pv[i] = analogRead(PH_CH1_PIN);
    delay(1);
  }
  for(int i = 0; i < ARRY_LENGTH; i++){
    for(int k = i; k < ARRY_LENGTH; k++ ){
      if( pv[i] < pv[k] ){
        int tmp = pv[i];
        pv[i] = pv[k];
        pv[k] = tmp;
      }
    }
  }

  if( tmpetValue > 42 )  pv[ARRY_LENGTH/2] += 5;
  else if(tmpetValue > 28){
    pv[ARRY_LENGTH/2] += 5*(tmpetValue - 28)/14;
  }

  PH_VALUE = pv[ARRY_LENGTH/2];
  PH_VALUE = -5.887*(PH_VALUE*5/1024) + 21.677;
  if(PH_VALUE > 14.1){
    PH_VALUE = 14.1;
  }
  if( PH_VALUE < 0 ){
    PH_VALUE = 0;
  }
  ph_ch1_Value = PH_VALUE;
  if(ph_ch1_Value<=0){ph_ch1_Value=0;}
  if(ph_ch1_Value>=14.6){ph_ch1_Value=14.6;}
}
```

Boat:
Arduino codes: 3

```
void update_show_TDS(){
  oled12864.clear();
  oled12864.show(0,2,"TDS");
  oled12864.drawBitmap(64, 0,  str_ce, 16, 16, 1);
  oled12864.drawBitmap(80, 0,  str_shi, 16, 16, 1);
  oled12864.show(2,0,"TM ");
  oled12864.show(2,3,(float)tmpetValue);
  oled12864.show(3,0,"TD ");
  oled12864.show(3,3,TDS_CH3_VALUE);
  oled12864.display();

  Serial.print( tmpetValue );
  Serial.print( "  " );
  Serial.println( TDS_CH3_VALUE );
}

int getMedianNum(int bArray[], int iFilterLen)
{
      int bTab[iFilterLen];
      for (byte i = 0; i<iFilterLen; i++)
    bTab[i] = bArray[i];
      int i, j, bTemp;
      for (j = 0; j < iFilterLen - 1; j++)
      {
    for (i = 0; i < iFilterLen - j - 1; i++)
          {
      if (bTab[i] > bTab[i + 1])
            {
    bTemp = bTab[i];
          bTab[i] = bTab[i + 1];
    bTab[i + 1] = bTemp;
       }
    }
      }
      if ((iFilterLen & 1) > 0)
  bTemp = bTab[(iFilterLen - 1) / 2];
      else
  bTemp = (bTab[iFilterLen / 2] + bTab[iFilterLen / 2 - 1]) / 2;
      return bTemp;
}
```

Testing:

We kept on testing our models while making them. Although we won't do most of it in water, there were many challenges in programming the Arduino and its sensors. Since we bought the sensors from another place, there were some bugs while connecting them to the Arduino board, for example the library cannot be loaded into the program and the sensors gives out random text. We kept on testing until it works normally.

Evaluation:

We think that our project was nicely planned and defined from the beginning. Our job distribution was clear and we worked well together. Although we were in a bit of a rush as we had other work to do, we still managed to finish the project quickly and efficiently.

Reflections:

Tyson: It is a great experience for me. I learned a lot about Huskylens' function. How to use it to track or recognize objects. I got more interested in it. I hope to do more projects about AI cameras in the future.

Ocean: Although writing the programs for the Arduino and its sensors are time-consuming and hard, I still learnt a lot about C++ programming throughout the process.

Jason: It was challenging but fun to make a project by ourselves. Although making the model more realistic is hard, I still managed to do it by adding some plastic water plants and little stones.

Impact to Society

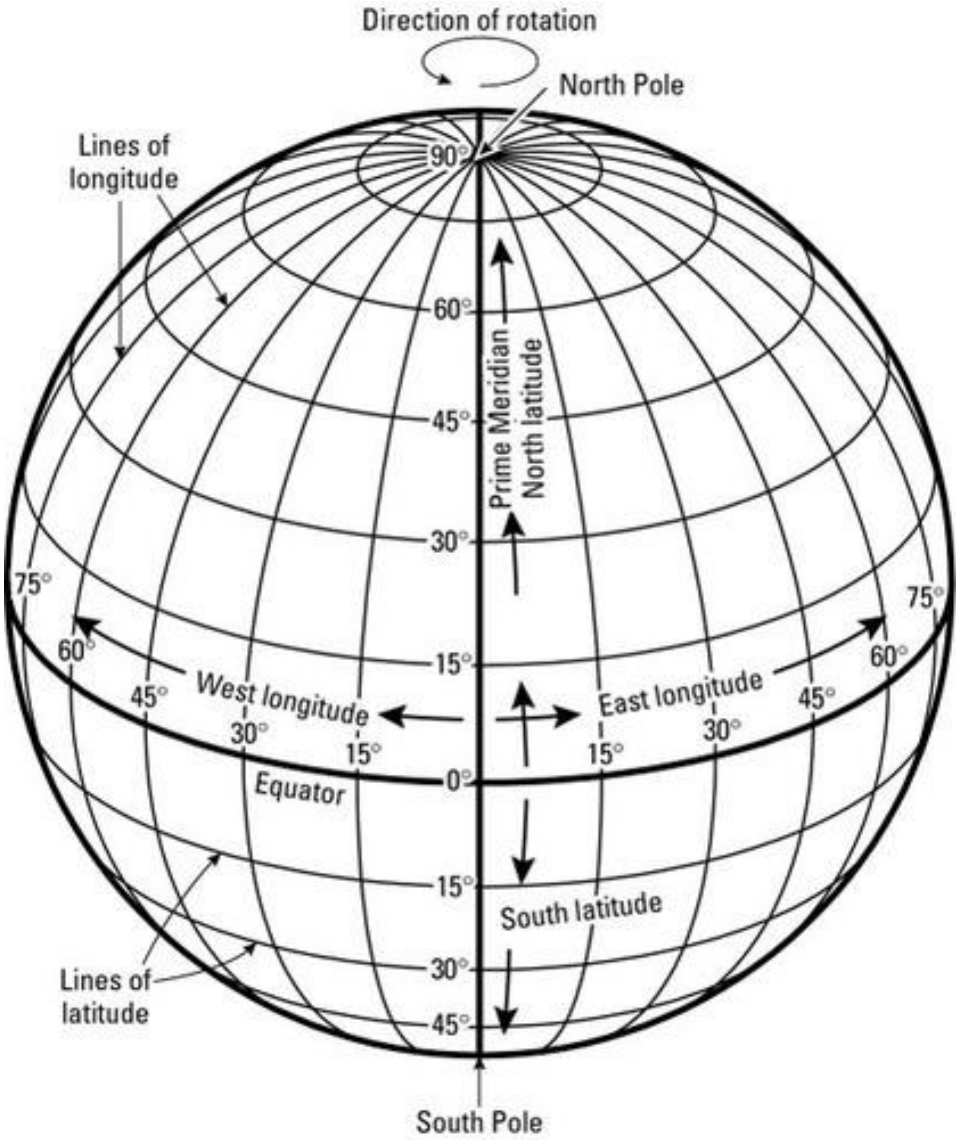
The development of our project would have a profound social impact. First, the ship's ability to collect and study seawater can greatly improve our understanding of marine ecosystems. These data can help scientists and researchers monitor the seawater, and study the impact of human activities on the marine environment.

The deployment of a submarine from a ship during a ship accident represents a major advance in rescue operations. This not only can save lives from ship accidents, it can also teach the well-being and safety of people at sea.

Our boat and submarine's effectiveness in rescuing victims and rapid emergency response would provide a sense of security and trust in the marine community. In addition, collecting and studying seawater can let people around the world know about pollution problems and raise awareness of the importance of protecting the sea.

Overall, our boat and submarine would have a great positive impact on society. This would increase scientific knowledge, improve marine safety, and promote greater awareness of environmental protection.

For further development, after improving Tisonic, we believe that our idea can be brought into mass production and covered around the world. Also, we will divide the ocean into different small areas by the number of ships passing or the number of species of sea animals and how endangered they are. This can let Tisonic save people and protect the ocean more efficient.



Innovation

Partners

The main mission of International Maritime Organization (IMO) is to establish and maintain a comprehensive regulatory framework for international shipping. Its mandate encompasses safety, environmental issues, legal matters, technical cooperation, maritime security, and shipping efficiency.

Partners

Our Tisonic system's main purpose is to ensure safe navigation at sea and ensure smooth maritime traffic, which aligns with IMO's objectives. Additionally, as IMO is a United Nations agency, collaborating with IMO would be a beneficial approach for the further development of Tisonic. We aim to achieve a wide coverage range and ensure availability in segmented maritime zones. Therefore, partnering with IMO would be a great method to achieve these goals.

Sources

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HK Government Marine Water Quality – https://www.gov.hk/en/residents/environment/water/water/marinewater.htm

This LEGO robot can really see! (using Gravity: HUSKYLENS) – https://youtu.be/1Q485MoQaPM?si=otqr6yBwufOtvQVL

Credits

Mr.Lee – Teacher, Coach
Mr.Cheung – Teacher, Coach
Mr.Mok – Technician
Henry – Friend
Ethan – Friend
Benson – Friend
Syrus – Friend
Isaac – Friend