Illustrations

Fig. 1: the “Princess” boat

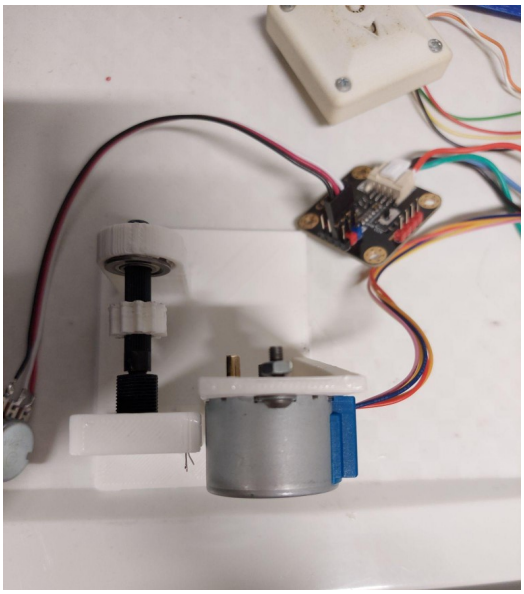

Fig. 2: electronics of the bathymetric sensor

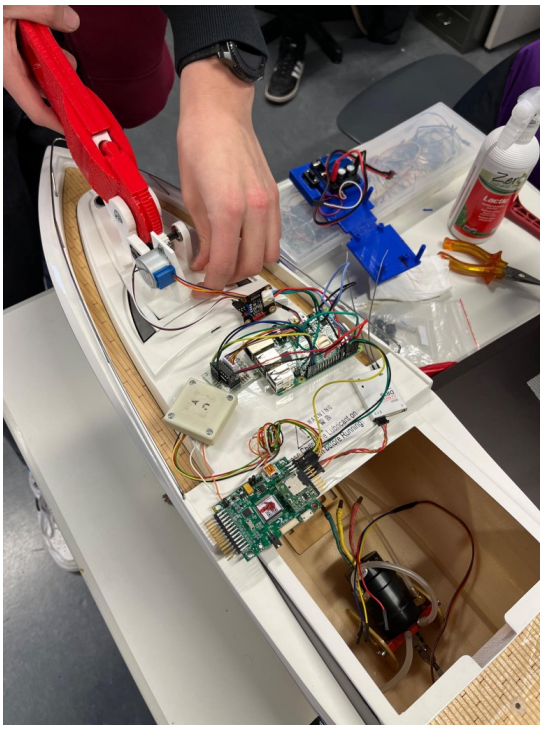

Fig. 3: working on the electronics

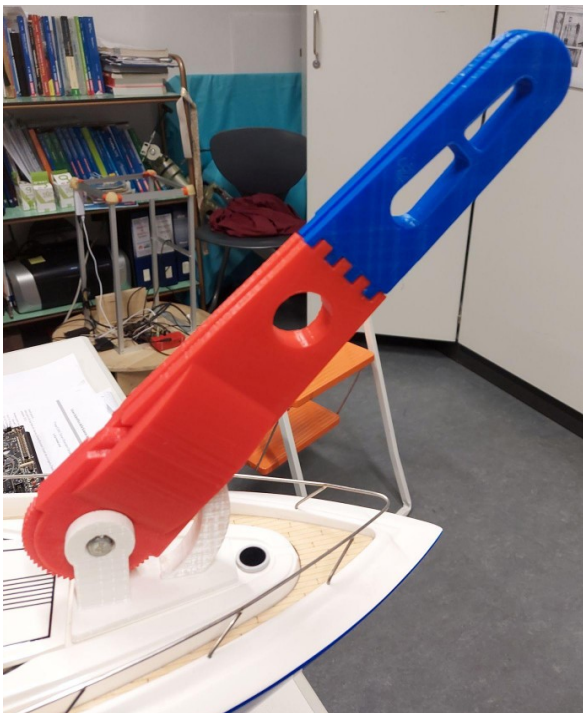

Fig. 4: structure of our bathymetric sensor

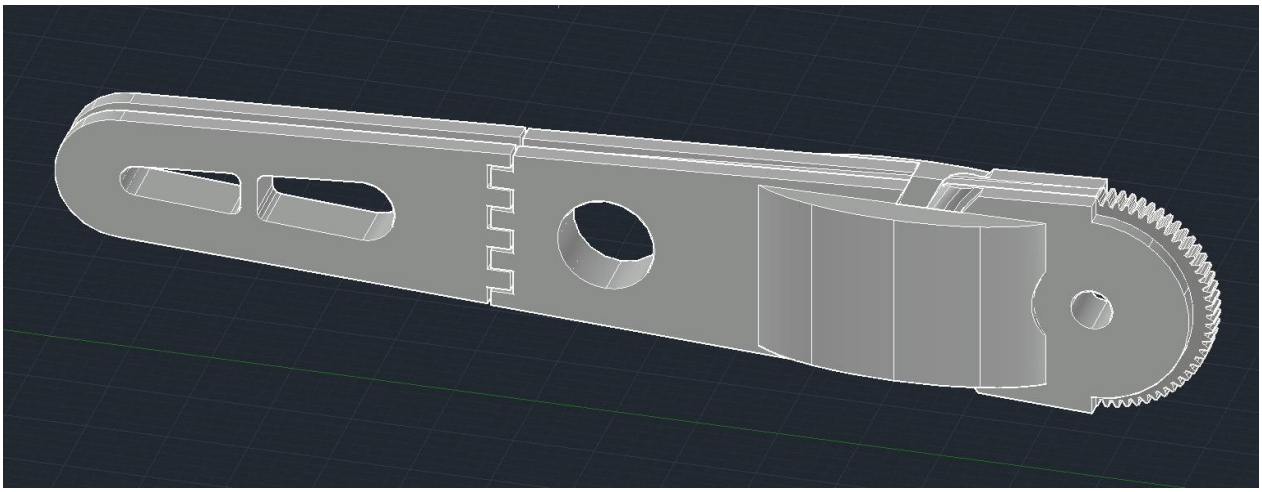

Fig. 5: AutoCAD project of the sensor

Fig 6: the Raspberry Pi and the analog-digital converter installed inside the boat

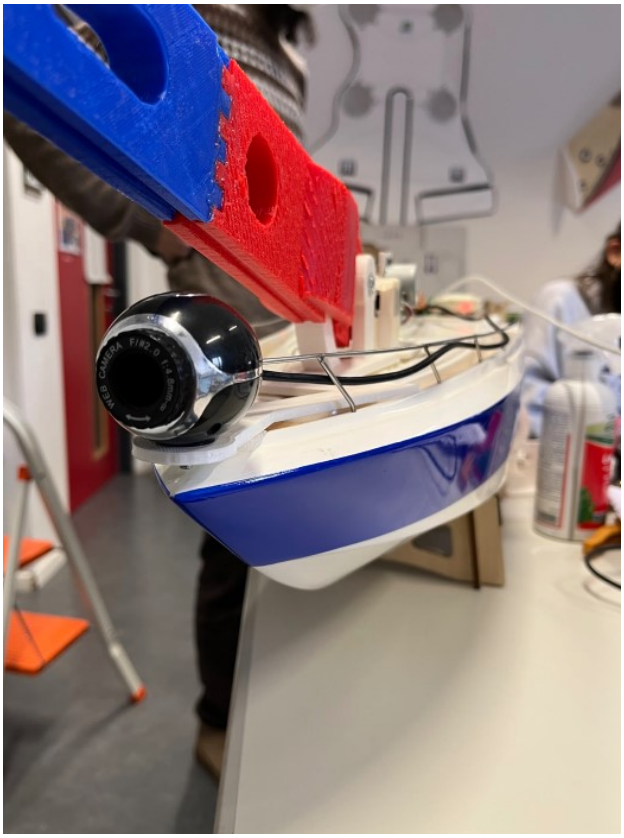

Fig. 7: the on-board cam for the obstacle recognition

```python
# Configura il motore.
def setStep(w): ···

# Riavvolge la lenza.
def forward(delay, steps): ···

# Srotola la lenza.
def backwards(delay, steps): ···

# Connette il Raspberry Pi all'Arduino.
def connection(): ···

# Legge e restituisce i dati GPS.
def get_gps(boat): ···

# Aziona il motore in modo da calare il peso, quando il peso
# fondale riavvolge la lenza e restituisce la profondità del
def play(): ···

# Funzione principale.
def main(): ···


if __name__ == "__main__":
    main()
```

```python
def main():
    boat = connection() # Connessione alla barca.
    # Genera il nome per il file csv in base a data_ora attuale e lo salva in ./data
    filename = "data/" + time.strftime("%Y-%m-%d_%H-%M-%S", time.localtime()) + ".csv"
    print(f"I dati verranno salvati in {filename}")
    # Crea il DataFrame con quattro colonne.
    df = pd.DataFrame(columns=["lat", "lon", "alt", "depth"])
    # Ciclo principale.
    while True:
        setStep([0,0,0,0])
        cmd = input(">>> ")
        if cmd == "quit":
            break
        elif cmd == "get":
            measure = play()
            data = get_gps(boat)
            data.append(measure)
            df.loc[len(df.index)] = data
            df.to_csv(filename, index=False, sep=";", decimal=".")
        else:
            print("Comando sconosciuto.")
    print("Disconnettendo...")
    setStep([0,0,0,0])
```

Fig. 8 e 9: the various functions defined in the Python script and the "main" function where they are recalled

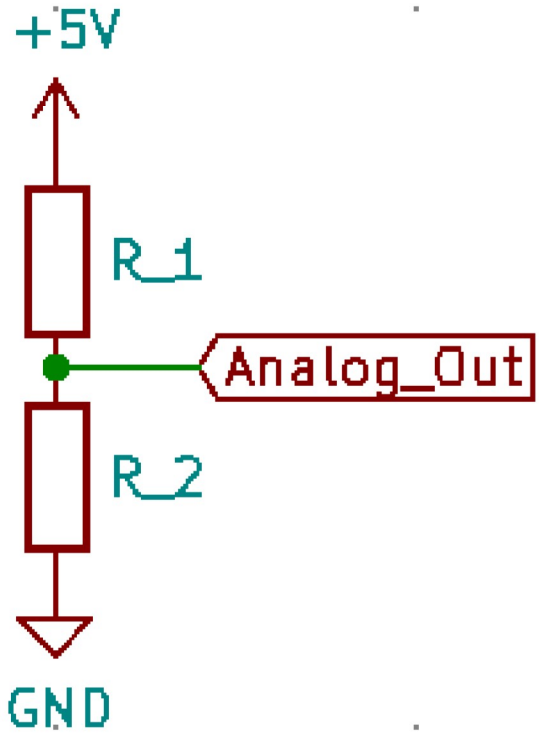

Fig. 10: diagram of the voltage divider used as force-return sensor

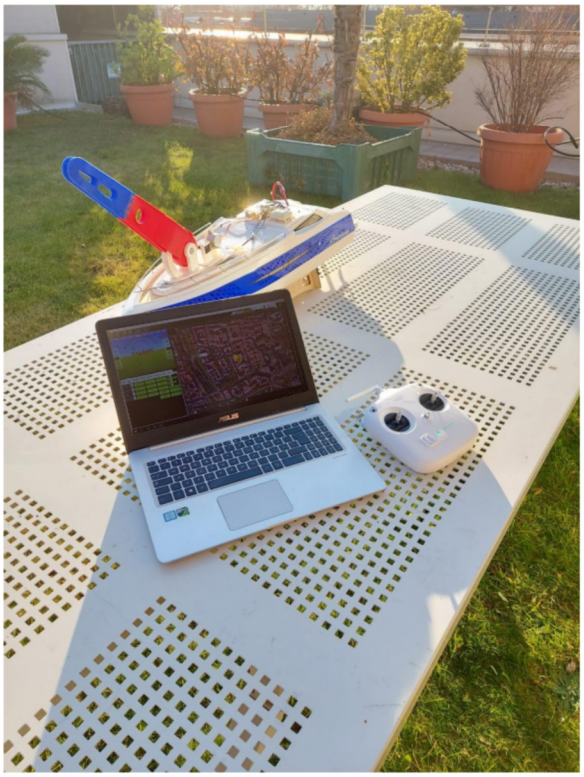

Fig. 11: one of the first tests on the rooftop of the school

Fig. 12 e 13: floating and measuring trials in an inflatable pool

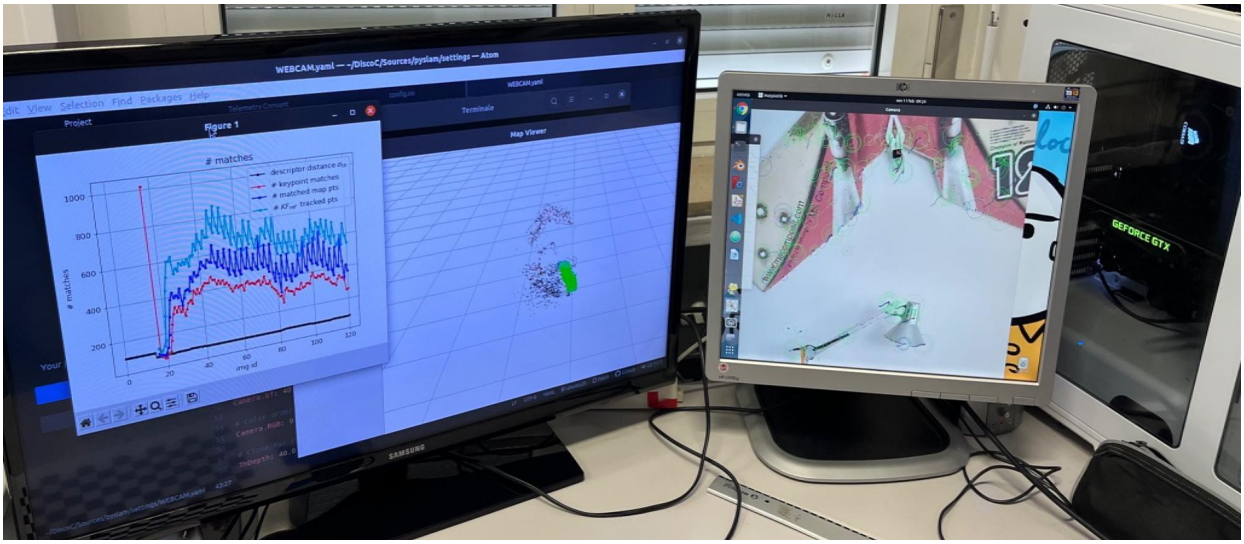

Fig. 14: check of the obstacle recognition system with a test video

Fig. 15: the drone in an artificial lake by the Talvera river

Fig. 16: the boat during navigation

Fig. 17: test measurement of the seabed

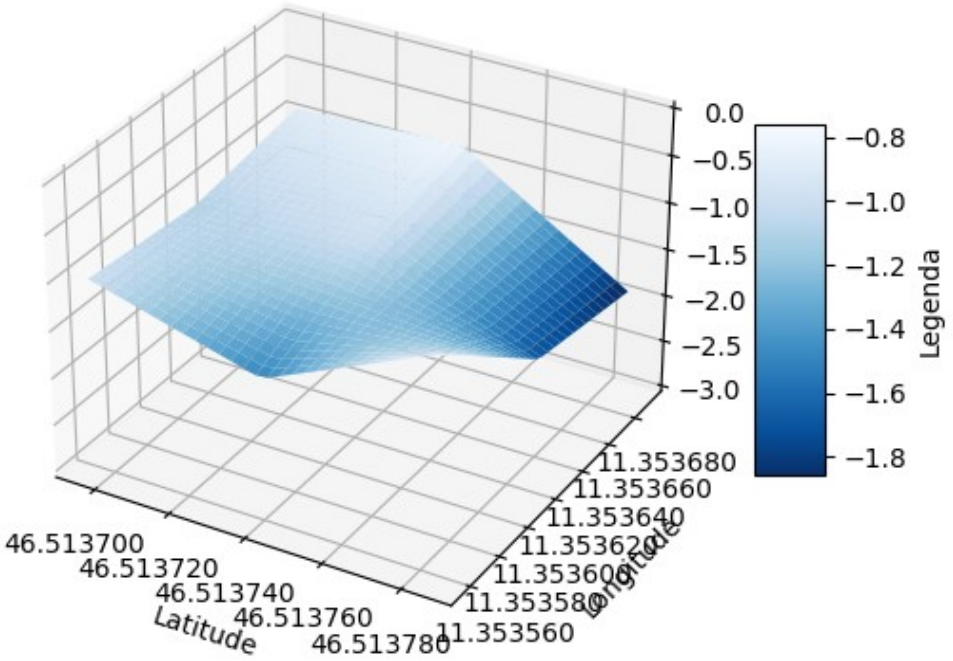

Fig. 18: bathymetric map realized with data obtained during the testing

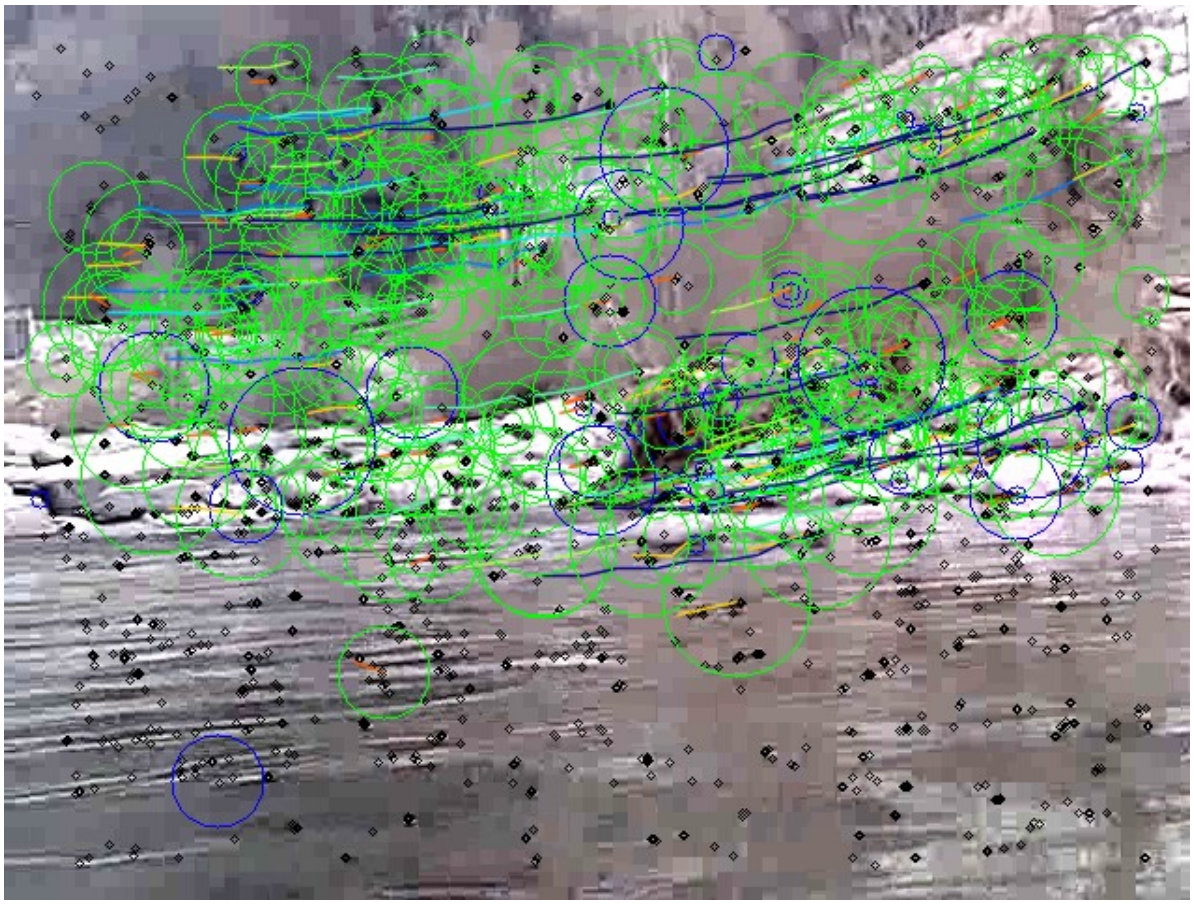

Fig. 19: a processed image of the obstacle recognition algorithm

Fig. 20: before avoiding the obstacle

Fig. 21: whilst avoiding the obstacle

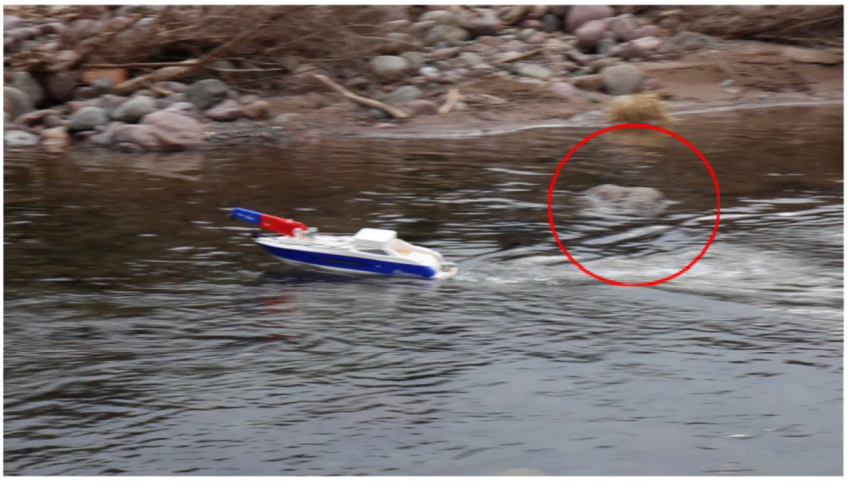

Fig. 22: returning on the route after avoiding the obstacle