**Research context and motivation**

Nowadays, the number of divers who want to practice the activity at technical level grows more and more. The Rebreather apparatus can be used to carry out such an experience. This underwater breathing equipment seems to be a complex system, but it is based on a very simple experience: the reuse of the exhaled gas.

The Rebreather is controlled by an electronic system, a wrist wearable unit (WWU). It is a specialized device that monitors all vital parameters and makes life easier for the diver.

**Adopted methodologies**

**Human model algorithm simulation and results**

**Potential Failure identification considering its severity**

**FMECA Analysis on standard and new structure. Criticality: ppO₂ reading • Solenoid valve control • HUD management**

**Future work**

- **Goal**: Create a real-time safety underwater network to allow a full communication and localization system.
- **Problem**: Difficult to achieve due to the multi-path propagation, reflections, time variation of the channel, small available bandwidth and strong signal attenuation.
- **Specs**: Small, wearable and low power devices.
- **Define methodologies, technologies and procedures for the implementation of underwater communication networks for surveillance and monitoring of critical sea infrastructures.
- **Determine the performance characteristics of digital transmission over underwater channels as a function of transmission frequency, signal modulation environmental characteristics.**

**List of attended classes**

- 01RXQVR - Pattern recognition and neural networks (05/05/2017, 8 CFU)
- 01RONKG - Python in the Lab (20/04/2017, 4 CFU)
- 01OFRV - Tecniche innovative per l’ottimizzazione (4 CFU)
- 01RISRV - Public speaking (16/02/2017, 1 CFU)
- 02PKLRO - Ottimizzazione in condizioni di incertezza (6 CFU)
- Innovation For Change mod.1 (28/01/2017, 6 CFU)
- Innovation For Change mod.2 (01/04/2017, 6 CFU)

**Submitted and published works**


**Novel contributions**

- **Control techniques implementation** to manage the oxygen partial pressure level (ppO₂) into the breathing loop.
  - The diver selects the desired ppO₂ (setpoint). When the ppO₂ falls below the setpoint, the uC opens an electronic solenoid valve that adds oxygen into the loop until the setpoint is restored.
  - It is not a standard system because the oxygen can be injected but can not be removed.
- **Architectural changes for Reliability enhancement**
  - In the classical implementation a certain level of redundancy is used to achieve fault tolerance, but an intervention of the diver is necessary to recover from most failures, so that long and expensive training is necessary for safe use of an eCCR.
  - Introduction of hot redundancy for recovering from the most common faults is one of the used techniques.

**Addressed research questions/problems**

- **EMC Compliance**
  - 1. Radiated Emissions
  - 2. Radiated Immunity
  - 3. Electrostatic Discharge (ESD)
- **DIN EN 14143:2013-10 compliance** (Respiratory equipment – European Standard) that specifies the minimum requirements for self-contained re-breathing diving apparatus in order to ensure a minimum level of safe operation.
  - Research of new techniques to ensure a FAIL SAFE, FAULT TOLERANT and DEPENDABLE system in order to be able to operate in case of malfunctions.