This is the presentation of the group project fish farming water monitoring.

The problem

The problem solved by this project is water quality monitoring in aquaculture.
The remote control of water quality parameters for fish aquaculture consists in controlling and measuring many parameters seen so far.

Existing approaches

At the present day there are not existing similar approaches, in the sense by using spectrophotometer. So we can consider this very original and unique. By accepting professor suggestion I focused our attention on the water color parameter. So the problem of determining the presence of many quality and quantity parameter is now oversimplified and consists in determining the water color and in what percentage color is concentrated in the water sample. If I will be able to face and solve this problem we I can also solve the multiple parameter problem.

Your solution system

I we have set up an laboratory experiment for determining the laws and the model for estimation of color parameter from the spectrophotometer measurement.
The set up of the lab experiment can be better understood by this image. You can see here the equipment by which I have done these experiments.

Two types of experiments

I have set up two Types of experiments.
The first consisted in adding to a 2 litres water sample contained in a tank/container , an increasing powder dyes , red, blue, and red and blue mixed together with the objective of determining the color of an unknown sample and its concentration.
From this first graphic obtained by adding increasing red values, we infer that the frequencies (410 nm and) 860 nm have a positive linear correlation between the measured intensity and the percentage of red in the aqueous solution. Therefore are the optimal wavelenghts to detect the concentration of red color in the water solution. These two wavelength corresponds to NIR (860 nm) and violet VIS (410 nm).
From the second graphic we can determine some wavelengths that can be considered optimal points since they can indicate that by increasing the color concentration leads to an increase in the intensity of light signal, for example in 450 nm, the concentration of blue is 5 , and the intensity of light is the highest one. This wavelength in fact correspond to the blue. The wavelength at 860 , which is NIR (near infrared) is an optimal point for detecting the concentration of the mixed solution of red and blue , since the intensity is highest in this point, with respect to other solution.

This third graphic is related to the second type of experiment done with 20 different colors dymes separately added to a sample of water solution and show us different graphic shapes results, so that shape can be considered a sign of each color. In particular at some wavelengths , for example 610 nm, 860 nm, 460 nm,and 535 nm, we can notice a greater differentiation of signals. So these wavelengths can be considered optimal points or more precisely points peculiar of the color sign.

What is normalization ?

It can happened that the spectrophotometer measurement done for to the same sample can have different values. How is possible that the detector measures different values for the same water sample in two different trials ? This can happen because of the position of the detector in the container, that can be different from the previous trial and this can influence the measurements. That is the reason why we need a normalization of signal with respect to pure water for each experiment set up. In order to normalize the value of the signal plotted on the y axis, it should be computed the value by dividing the value of spectra for pure water by the value of spectra for the dymed colored water.

Colour Prediction Models using Multiple Linear Regression

The MLR can be used to predict the output, based on a linear combination of input variables. The output is the color concentration predicted value (y). The input variables are measured values at optimal points.

The model for prediction of color presence and concentration

The objective is for instance to build a model of prediction for the first type of the experiment. My experiment consisted in adding a teaspoon of dyes (red or blue or mixed together) into a water sample. This simulates the increasing concentration in water solution. Basically, the input classes will consist of the 5 dyme levels with increasing gradation in correspondence of which I have measured the intensities of light spectrum using the spectrometer. In order to build a model, I suppose a linear relation between the signal measured and the level of dyme concentration. I have also to make an hypothesis on how many different colors of want to make predictions, and on how many levels of concentrations. For example I wish to build a model on three possible different colors (red, blue and yellow) and two possible levels (high, low) of concentration.
The output class labels for this experiment will be 2 power of three = 8. That is there will be 8 possible output labels. For example yellow low red low blue high. And so on. Once I have defined the input, the output, the linearity dependence I also recall that measuring the intensity in the optimal points they are good candidate point where to measure the intensity of light I will write down thee regression equation for color prediction model (this is a multiple linear regression).

I represents the i-th data sample, while x1 and x2 represents the firs and second optimal points.
Theta1 and theta2 are the parameters of the model and are not know , but must be determined by computing the loss of the function, or the total error of the test data set. So theta1 and theta2 will be the best parameters that minimize the mean square error. They will be determined by using a gradient descent method.
I would need a much larger amount of data, and many, many measurements that I have not had the opportunity to collect since we had only about 40 experimental data. But this is the way.

BEER – LAMBERT LAW

Another way to predict the most quantitative values is to use Beer Lambert's law.
Using this law can be useful with single color concentration experiment to predict the level of concentration.
The law says that the absorbance of a sample is linearly dependent from the molar concentration of the sample, a molar absorption coefficient, and the optical path.
Since the molar concentration in my case is proportional to the color concetration in the solution the law can be used to determine the concetration of a predetermined color in an unknown sample.
Now, applying this law to increasing levels of concentration, I discover a linear law that allows me to know the concentration of an unknown value by measuring the absorbance.
WE can see in my example that for increasing teaspoon color dyme added to the water I have measured decreasing intensity (since the absorbance is the complement of the intensity).
Gradually increasing the number of teaspoons we have increasing values of absorption. We have drawn this grey line which is absorption and blue line which is intensity. As you can see, there is a more or less linear relationship. And so in this case we can estimate the concentration of unknown sample a color by measuring its intensity .

Video demo presentation

Right, let's move to the second part of the presentation.
We see the video on the operation of the buoy Off site. Then we see the video of the operation of the buoy immersed in the sea, Both mechanically and electronically own site, that is in the sea and we see lastly the fundamental components of this buoy made.
So the last points we are committed to develop.