INTRODUCTION

In this project, our challenge was to build a "sensor-controlled robot" in order to monitor the evolution of water qualities in the area. By far the most important thing in supporting life is water. Almost all the known life forms on planet need water in order to live. This meant that water qualities needed to be measured. So we placed one robot near a lake's shore. Our robot periodically measured the oxygen gas dissolved in water and the alkalinity values, and stored the data in a file. We used a Vernier pH Sensor to measure alkalinity and a Vernier Dissolved Oxygen sensor to measure the quantities of oxygen available to aquatic organism to exist. A simple rise or fall in the level of Oxygen might mean that small life forms might be living in the lake, even maybe some sorts of algae which can be processed for food. Moreover, if the water temperature is to rise in the known atmospheric condition might mean that lava is under the base, which means that the colony is in danger and has to change location. First robot is in a static position and the second one is a mobile robot. This second robot is called "sensor-analyze data robot". Its role in the experiment is to take the experiment data and direct them to the station base.

Figure 1 The "sensor - controlled robot" and the "sensor -analyze data robot"

Why are we looking for dissolved oxygen?

Oxygen needed for aquatic organism to exist is found in the form of dissolved oxygen. Oxygen gas is dissolved in water through aeration, diffusion from the atmosphere and photosynthesis of aquatic plants and algae. In healthy water, oxygen is replenished faster than it is used by aquatic organism. In some places, aerobic bacteria decompose such a large volume of organic material that oxygen is depleted from the water faster than it can be replaced. The resulting decrease in dissolved oxygen is known as the *Biochemical Oxygen Demand.* In a body of water with large amounts of decaying organic material the dissolved oxygen level may drop by 90%. This represents a high BOD. In mountain waters with low levels of decaying organic material, the dissolved oxygen levels may drop by only 10% or 20%, a low BRD.

Interpretation of BOD levels	
BOD level (mg/L)	Status
1-2 mg/L	Clean water with little organic waster
3-5 mg/L	Moderately clean water with some organic waste
6-9 mg/L	Lots of organic material and many bacteria
> 10mg/L	Very poor water quality. Large amounts of organic material in water.

The water from our "planet" can sustain aquatic life if BOD < 10 mg/L.

Why are we looking for ph level of water?

Water contains both hydrogen ions H^+ and hydroxide ions, OH^-. The relative concentrations of these two ions determine the pH value. Water with a pH of 7 has equal concentrations of these two ions and is considered to be a *neutral* solution. If a solution is *acidic*, the concentration of hydrogen ions exceeds that of the hydroxide ions. In a *basic* solution, the concentration of hydroxide ions exceeds that of the hydrogen ions. On a pH scale of 0 to 14, a value of 0 is the most acidic, and 14 the most basic. A change from pH 7 to pH 8 in a body of water represents a ten-fold increase in the hydroxide ion concentration.

The pH of streams and lakes is usually between 7 and 8. Levels between 6.5 and 8.5 are acceptable for most drinking water standards. If it rains on our "planet", rainfall generally has a pH value between 5 and 6.5. It is acidic because of dissolved carbon dioxide and air pollutants, such as sulfur dioxide or nitrogen oxides. If the rainwater flows over soil containing hard-water minerals, its pH usually increases (between 7.5 and 8.5). The measure of the pH of a water probe is very important as an indication of water quality, because of the sensitivity of aquatic organisms to the pH of their environment. Small changes in pH can produce important changes in aquatic life, as shown below:

Effects of pH level on Aquatic Life	
pH	Effects
3.0-3.5	Fish can survive a few hours in this water. Some plants and invertebrates can be found at pH levels this low

3.5-4.0	This pH level is lethal to salmonids.
4.0-4.5	Mayfly and many other insects are absent. Most fish eggs will not hatch.
5.0-5.5.	Bottom-dwelling bacteria begin to die. Leaf litter and detritus begin to accumulate, looking up essential nutrients and interrupting chemical cycling. Plankton begins to disappear. Metals normally trapped in sediments are released into the acidifier water in toxic forms for aquatic life.
6.0-6.5	Freshwater shrimp absent. Unlikely to be directly harmful for fish unless free carbon dioxide is high.
6.5-8.2	Optimal for most organisms.
8.2-9.0	Unlikely to be directly harmful for fish, but indirect affects occur as this level due to chemical changes in the water.
9.0-10.5	Likely to be harmful to salmonids and perch if is present for long period.
10.5-11.0	Rapidly lethal to salmonids. Prolonged exposure is lethal to carp, perch.
11.0-11.5	Rapidly lethal to all species of fish.

With the pH sensor we measure the *alkalinity*. Alkalinity is a measurement of the capacity of a water probe to neutralize acids in the water. Fluctuations in pH are harmful to aquatic life and disrupt developing aquatic organisms. Alkalinity acts as a buffer, helping to keep the pH within tolerable limits.

OBJECTIVES

In this project, we will

- Build a robotic device to monitor the water from a “lake”.
- Build a robotic device to show the experiment sensor data.
- Use the NXT to determine the pH and oxygen dissolve level of the water in a lake from our planet

MATERIALS

computer
2 LEGO NXT Intelligent Brick
MINDSTORMS Edu NXT software
LEGO MINDSTORMS NXT Educational Set
2 Vernier NXT Sensor Adapters Vernier pH Sensor and Vernier Dissolved Oxygen

Sensor
Aquarium (a “lake”)

CONSTRUCTION

The first step was to build the controller unit that means the “sensor – controlled robot”. The sensor-controller robot uses one motor for each sensor. Both motor subassemblies are identical, but the sensor holders are different.

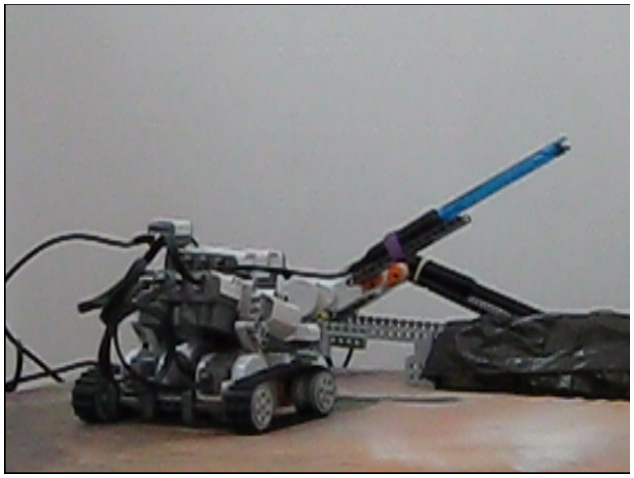

Figure 2 Vernier Dissolve Oxygen sensor and its sensor holder.

The motors are attached to Ports B and C and we attach two Vernier NXT adapters to the lower sides of the NXT; then we plug in the Dissolved Oxygen and pH sensors. Our sample program assumes the temperature sensor is driven by motor B and the dissolved oxygen data are read from Port 2.

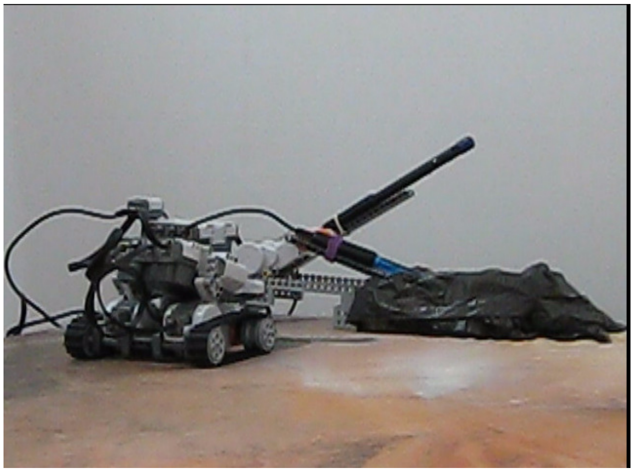

Figure 3 Vernier pH sensor and its sensor holder.

The pH probe is driven by motor C and the pH data is read from Port 1.

Because some Vernier water quality sensors may interfere with each other when used simultaneously, we lower each sensor into the tank one at a time.

The second step was to build the receiver unit, that means the "sensor -analyze data robot".

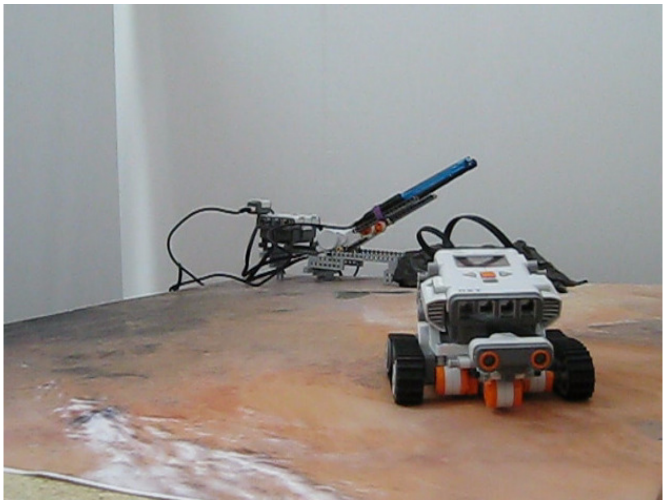

Figure 4 "The sensor-analyze data robot"

We connect the two units together via Bluetooth. The NXT brick supports wireless communication using Bluetooth by including a CSR Blue^{TM} 4 version 2 chip. The NXT brick can be connected wirelessly to three other devices at the same time but can only communicate with one device at a time. It's possible to send programs and sound files between NXT bricks and receive information between bricks during program execution.

First robot makes the pH and the dissolved oxygen level measurements and the other robot "takes" the data and goes to the base station in order to analyze them.