INTRODUCTION

We will measure the radiation level and observe that the radiation level is quite normal for human body. In this activity we want to measure the UV radiation level and to find the appropriate fabrics to protect us. As we already know, clothes can protect us from the harmful effects of ultraviolet radiation based on the type of fabric, the tightness of the weave, and the color. While sunscreens are rated with an SPF or sun protection factor, clothes are rated with a UPF or ultraviolet protection factor.

What are ultraviolet radiations and why we must protect against them?

Ultraviolet (UV) radiation is defined as that portion of the electromagnetic spectrum between x rays and visible light. The UV spectrum is divided into *Vacuum UV* (40-190 nm), *Far UV* (190-220 nm), *UVC* (220-290 nm), *UVB* (290-320), and *UVA* (320-400 nm).

UVC is almost never observed in nature because it is absorbed completely in the atmosphere, as are Far UV and Vacuum UV. Accidental overexposure to UVC can cause corneal burns, commonly termed welders' flash, and snow blindness, a severe sunburn to the face. While UVC injury usually clears up in a day or two, it can be extremely painful.

UVB is typically the most destructive form of UV radiation because it has enough energy to cause photochemical damage to cellular DNA, yet not enough to be completely absorbed by the atmosphere. UVB is needed by humans for synthesis of vitamin D; however, harmful effects can include erythema (sunburn), cataracts, and development of skin cancer. Individuals working outdoors are at the greatest risk of UVB effects.

UVA is the most commonly encountered type of UV light. UVA exposure has an initial pigment-darkening effect (tanning) followed by erythema if the exposure is excessive. Atmospheric ozone absorbs very little of this part of the UV spectrum. UVA is needed by humans for synthesis of vitamin D; however, exposure to UVA has been associated with toughening of the skin, suppression of the immune system, and cataract formation.

What is an ultraviolet protection factor?

A UPF factor indicates the amount of UV light that is absorbed by your clothes. For example, a shirt with a UPF factor of 50 will allow only $1/50^{th}$ or 2% of the surrounding UV light to penetrate to your skin. Lightweight, light-colored, or loosely woven clothes have much lower UPF ratings than dark, tightly-woven clothes.

In this project, we build a sensor-controlled robot to test the effectiveness of various fabrics. We use a Vernier UVB Sensor and a Vernier NXT Sensor Adapter connected to NXT to measure UV levels and determine the best fabrics. The mobile robot moves back and forth under a canopy. The canopy is built from LEGO beams or bricks and 6 squares of fabrics are positioned on the canopy. After the robot travels the length of the canopy, testing each fabric, it will position itself under the most effective one.

OBJECTIVES

In this project, we will:

- use a UVB Sensor to measure UVB light.
- use a UVA Sensor to measure UVA light
- determine the amount of UVB light allowed through various fabrics.

MATERIALS

- computer
- LEGO NXT Intelligent Brick
- LEGO MINDSTORMS NXT Educational Set
- MINDSTORMS Edu NXT v2.0 software
- Vernier UVB Sensor
- Vernier UVA Sensor
- Vernier NXT Sensor Adapter
- a UV lamp
- 4 squares of fabrics

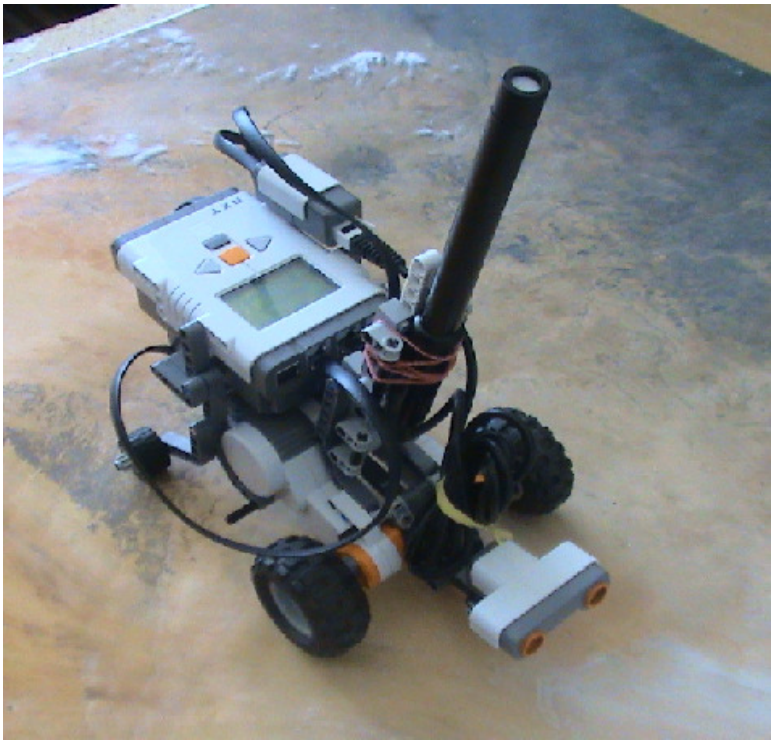

Figure 1 The UV tester

CONSTRUCTION

The base for this robotic device is a basic Four-Wheel Cart. We connected the UVB Sensor to the Vernier NXT Adapter; then we connected the Adapter to Port 1 on the NXT.
Our robot will travel back and forth under a canopy built from additional LEGO pieces. An example is shown below.

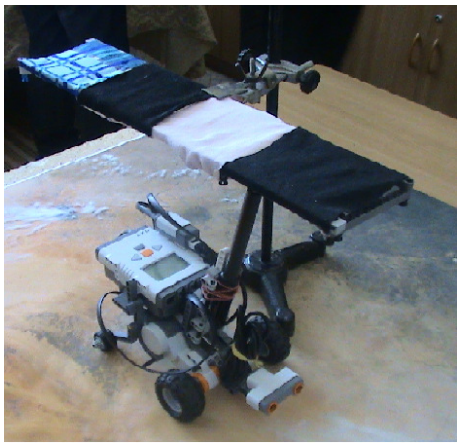

Figure 2 The canopy as we built

The Sunscreen Tester program operates under the premise that the best fabric will allow the lowest amount of UV light to pass through, consequently appearing to the robot as the "shadiest" spot. The first two blocks initialize the UV Min and Count Min variables that the program will be using to store the lowest UV reading and the motor's location at the lowest reading.

The robot will execute this measurement more times in order to sample 4 different fabrics, storing new minimum readings, and the location of these readings, as they occur.

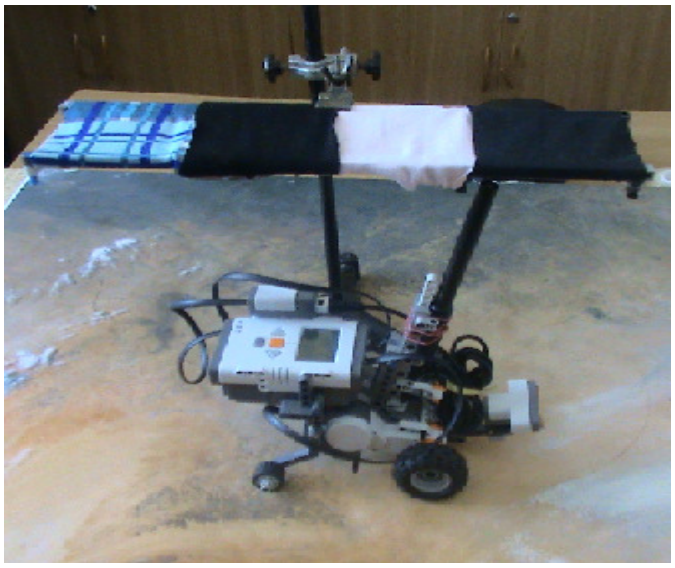

Figure 3 Our robot making the UV measurements

When the program exits the measurement loop, it closes the 18 UV Data.log file and then reads the value of the built-in rotation sensor on motor B. The program activates motors B and C to move the robot back to the location of the lowest UV reading or the "shadiest" spot.