techno -stuff Robotics

Pitch
Sensor

User Guide for the Audio Pitch Sensor.

What is a Pitch Sensor ?

The Audio Pitch Sensor is a sensor for the Lego® Mindstorms™ Robotic Invention System.
It detects the dominant frequency in an audio sound, and returns a number that is proportional to the frequency. Your program can use this information to control the behavior of your robot. This sensor responds best to pure tones, like from a flute.

What is Audio Pitch ?

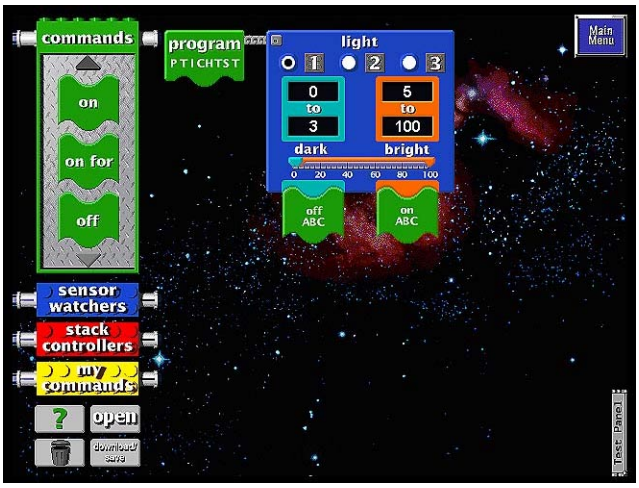
Sound is vibration of the air. This vibration travels as waves of pressure in the air. The strength, or amplitude of the wave is the volume or loudness of the sound. The rate or frequency of vibration is the pitch or tone of the sound. Most sounds are a combination of many frequencies, of differing strength. The pitch sensor can not sort out multiple frequencies, and will respond with an average value. The pitch sensor works best with "pure" tones, which have only one frequency. With pure tones, the value returned to the RCX is a function of the pitch. Pure tones are generated by wind instruments like a flute or recorder

Check your Batteries

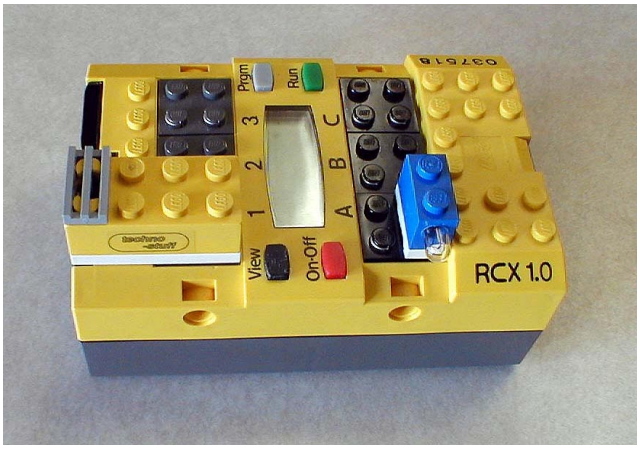
The Pitch sensor requires fresh batteries in your RCX. To check your batteries, go to the Lego Main Menu and select "getting started". Select "Set Up Options". Place the cursor on the green battery symbol. After a few seconds it will show the battery voltage. The voltage must be at least 8.0 for proper sensor operation..

Testing the Sensor

Remove all sensors from the RCX
Create and download the simple program shown below.



Mount the Pitch sensor, and a lamp, as show below.
If you do not have a lamp, use a motor as an indicator.



Run the program. In a quiet room, the lamp should be off. With your mouth close to the sensor, whistle or sing a note. The lamp (or motor) should turn on.

The sensor port is now programmed as a light sensor. It will stay that way until re-programmed. Turn off the RCX, then turn it back on, without running any program. Press the "View" button until the arrow points to the sound sensor. Now whistle or sing, and watch the display on the RCX. It will show the value being returned by the sensor.

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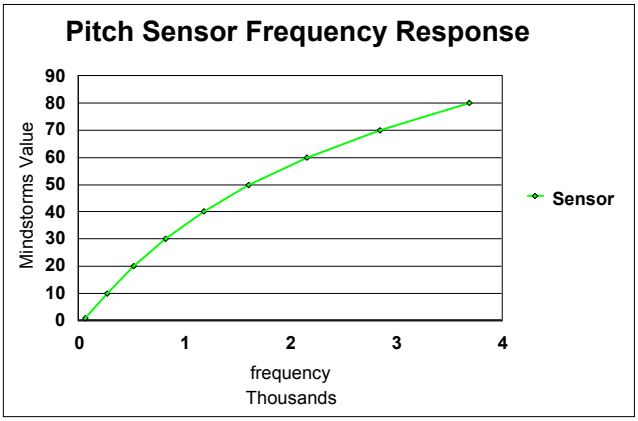
Sensor Output Values

The Pitch sensor must be programmed as a light sensor. It has a frequency response of 100 Hz to 4KHz.



These values will vary slightly between sensors. The output value may vary slightly as your battery voltage drops. Make your program respond to a range of values, as show in the test program.

Interference

The pitch sensor responds to what it hears. This is different than what you hear. The human brain does a good job of picking a fundamental tone out of noise and harmonics. (overtones). The pitch sensor is not so smart. For the pitch sensor to respond to a pitch, the tone must be pure, and it must be much louder than the background noise.

Response to a recorder

Many school music programs use a low cost wind instrument called a recorder. This is similar to a flute, and produces a pure tone. The Pitch sensor has been optimized for use with a recorder. Maximum distance is about six feet in a quiet room. (Less in a noisy room) Below are some typical RCX values generated by notes on a recorder.

RCX	Note	Description
40		All holes open
31		Thumb & top two holes closed.
25		Bottom 2 holes open.
20		All holes closed

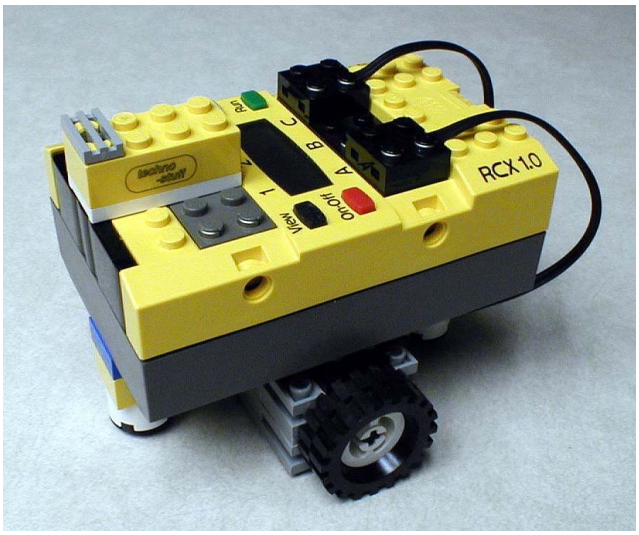
Technical Description

An electret microphone drives a high-gain amplifier. The amplifier is overdriven, so the output saturates, producing a square wave. The square wave feeds a charge pump with a bleeder resistor. This creates a voltage that is proportional to the frequency. The voltage controls the current through a transistor, which is connected across the RCX terminals.

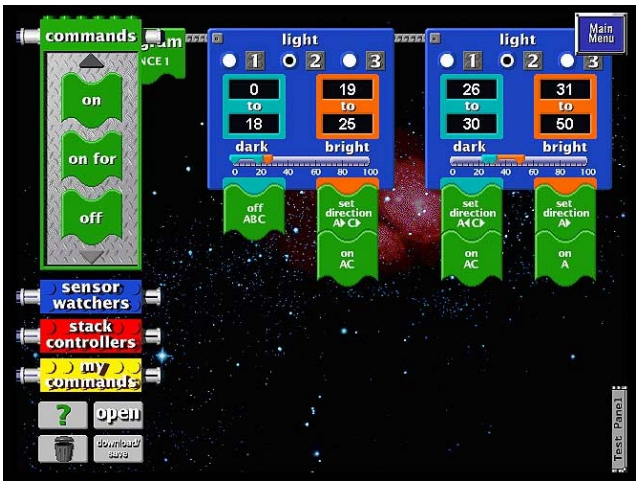
Any frequency component that is strong enough to drive the amplifier near saturation will affect the output. Musical tones that have strong harmonic content will produce values that are quite different from the fundamental tone.

Example: A robot that dances.

This robot will break-dance when you play music on a recorder or flute.



Start with the program shown below. The sensor watchers detect different notes played on the recorder. Behaviors are: go forward, spin, turn.



Try different value ranges in the sensor watchers. Try different motor actions. Add more sensor watchers to pick out individual notes.

Other projects

1. Create music by making your robot follow a path.
2. Make a robot that responds to your whistle.
3. Make a robot that goes toward someone who is talking. (Use a sound tunnel to make the sensor more sensitive in one direction)