100101: What Is Binary?

Subject Area(s) Number & operations, reasoning & proof, and science & technology

Associated Unit None

Associated Lesson None

Activity Title Binary Number System

Header

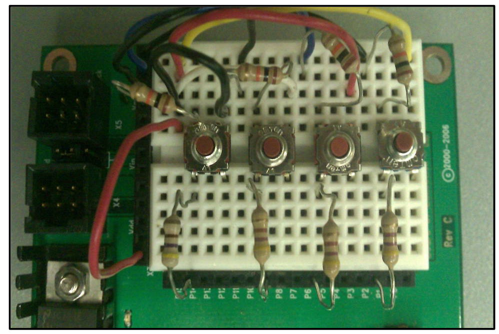

Image 1
ADA Description: students working on Pi activity
Caption: the students discussing how to calculate distance as robot travels along a circular path
Image file name: Pi_students.jpg

Grade Level 7 (6-8)

Activity Dependency None

Time Required Two 45-minute lessons

Group Size: 4

Expendable Cost /Group US$?

Summary Working as a team, students discover the basic concepts of binary numbers and their significance in digital electronic circuitry. Each team designs and builds a basic stamp model that will convert binary numbers into decimal. The binary number will be represented by four push buttons, where each push button represents a binary place value. This model will only convert up to decimal number 15. The result of the conversion will be displayed on the screen. Students testing their work will need to convert by hand and verify the result against the model. Hence, students learn how to convert decimal number to binary using the concept of place value.

Engineering Connection The binary numeral system is the foundation of digital electronic circuitry. Binary numeral system represents numbers using 1 and 0 and it is this system that makes modern day electronics possible. Digital electronics, which we all use and depend on daily, are rapidly growing and becoming more and more advance through research by engineers. Modern day cell phones now have more power than the early supercomputers which used to filled large rooms. However, no matter how far technology has advanced, all digital electronic system still have the foundation of using the binary number system. Many students as well as adults do not understand this concept and how it translates into daily electronics that they use everyday, such as using a microwave. This activity will help students understand this as well as understand binary logic in an engineering-team-effort way.

Engineering Category (3) relates math concept to engineering/the use of technology

Keywords build and design, binary number, binary logic

Educational Standards

NYS Math: 5.PS.3, 5.RP.1, 5.CM.9, 5.R.2, and 5.A.1 [1]

Pre-Requisite Knowledge

Familiarity with programming via BASIC STAMP and basic circuit knowledge

Learning Objectives

After this activity, students should be able to:

- Calculate, know, and understand the concept of the binary number system

Materials List

Each group needs:

- BASIC STAMP kit
- Breadboard
- Notepad and pen

Introduction / Motivation

The binary system is based on a base-2 number system, where numeric values are represented using two symbols, 0 and 1. Our number system that we all know is based on the base-10 number system. The base-2 number system is different in that there are only two possible numbers, 1 or 0, unlike 0-9 in the base 10 system.

Digital electronics operate using binary logic where devices are generally represented using two voltage levels (0V for “logic 0”/false and +5V for “logic 1”/true). These two levels correspond to the 0 and 1 used in the binary number system, with 0 being false and 1 being true.

The binary number system dates back to circa 5^{th}-2^{nd} centuries BC, an Indian scholar by the name of Pingala developed advanced mathematical concepts for describing prosody and this became the first known description of a binary numeral system [1].

Vocabulary / Definitions

Word	Definition

Procedure

Before the Activity

- Gather all required materials
- Make sure all BASIC STAMP kits have the necessary resistors and switches needed to complete the circuit
- Divide the class into groups of 4, (optional: assign roles to each person of the team – otherwise let the students choose)

With the Students

1. Discuss and go over the importance of binary numbers in the digital world.
2. Write on the board the following chart:

Bit number:	7	6	5	4	3	2	1	0
Power of 2:	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Decimal Value:								

3. Have them complete the decimal value. It should be as follows:

Bit number:	7	6	5	4	3	2	1	0
Power of 2:	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Decimal Value:	**128**	**64**	**32**	**16**	**8**	**4**	**2**	**1**

4.

Insert Figure 1.1 here, centered

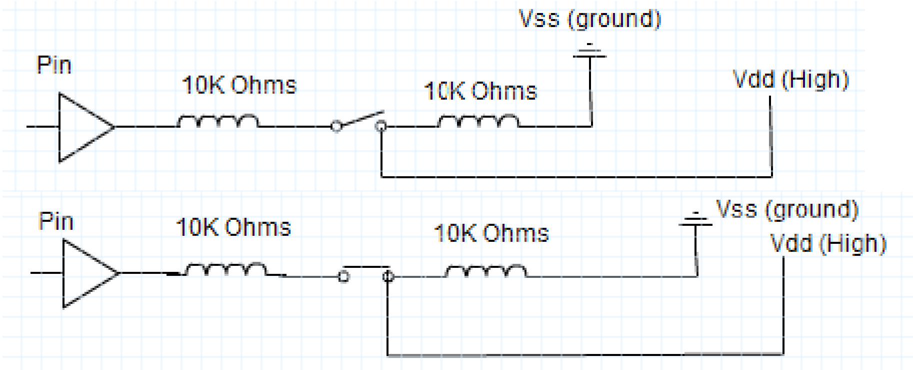

Figure 1.1
ADA Description: instruction on how to attach a marker/highlighter onto the robot's chassis
Caption: Figure 1.1: follow steps 1 through 4
Image file name: instruction.jpg
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Insert Figure 1.2 here, centered

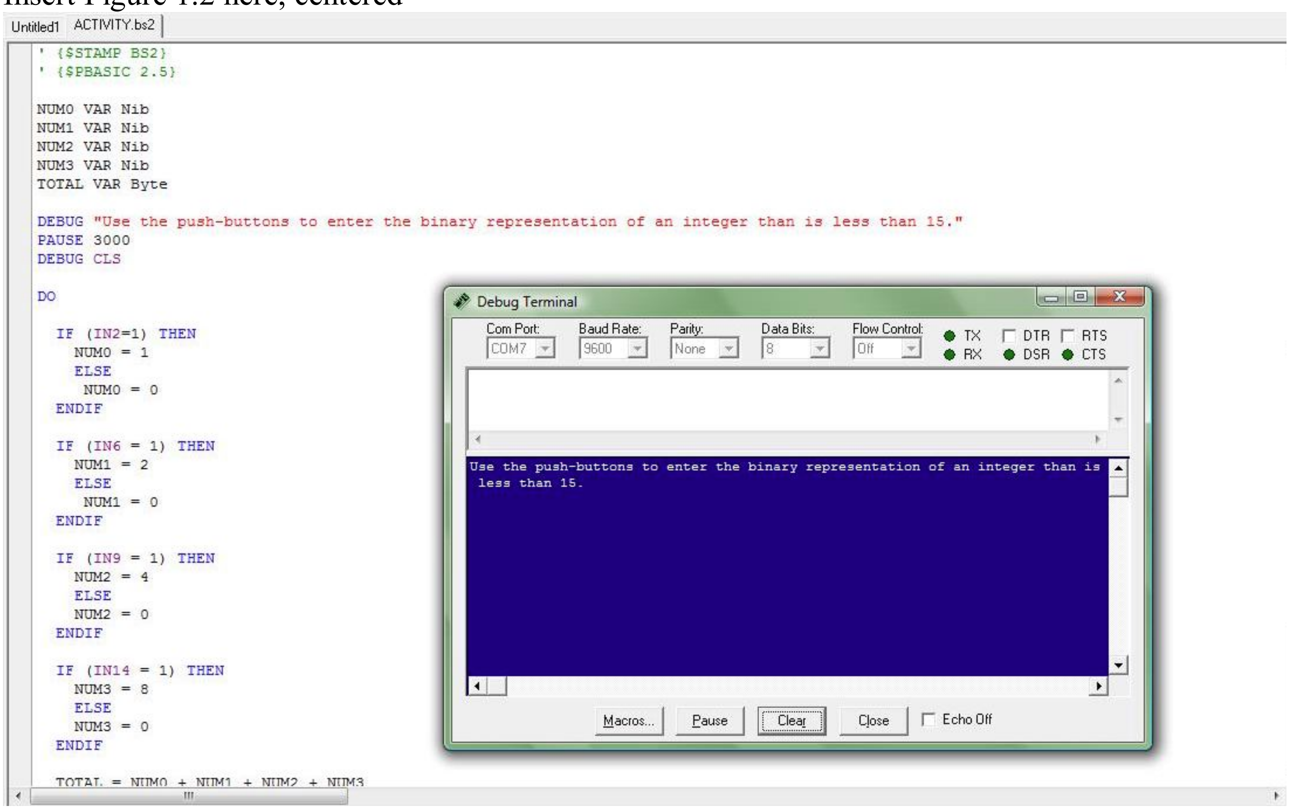

Figure 1.2
ADA Description: drag turn program
Caption: Figure 1.2: follow the instruction/values to program robot to do a drag turn
Image file name: dragTurn.jpg
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Insert Figure 1.3 here, centered

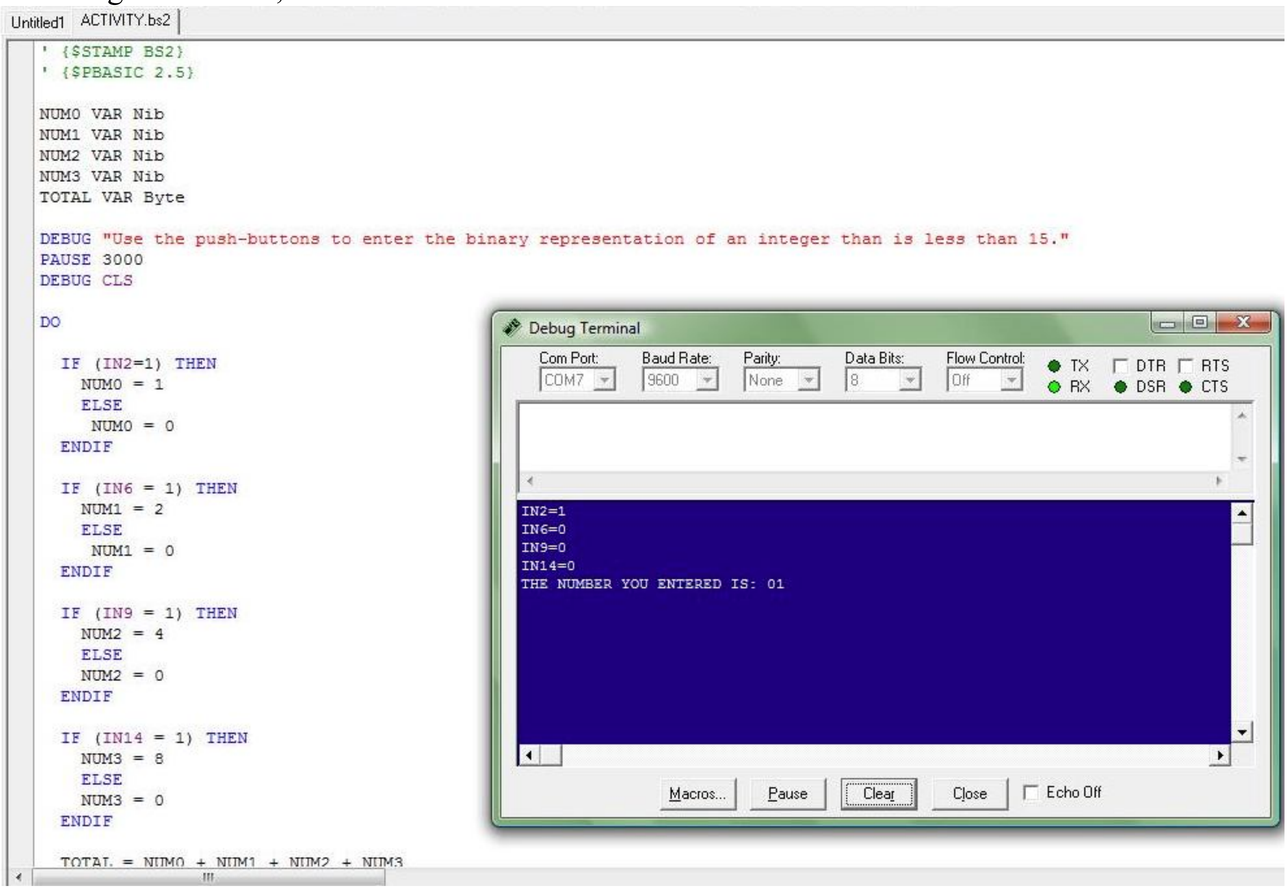

Figure 1.3 **ADA Description:** point turn program on NXT 2.0 software **Caption:** Figure 1.3: follow the instruction/values to program robot to do a point turn **Image file name:** pointTurn.jpg **Source/Rights:** Copyright © Carole Chen 2009

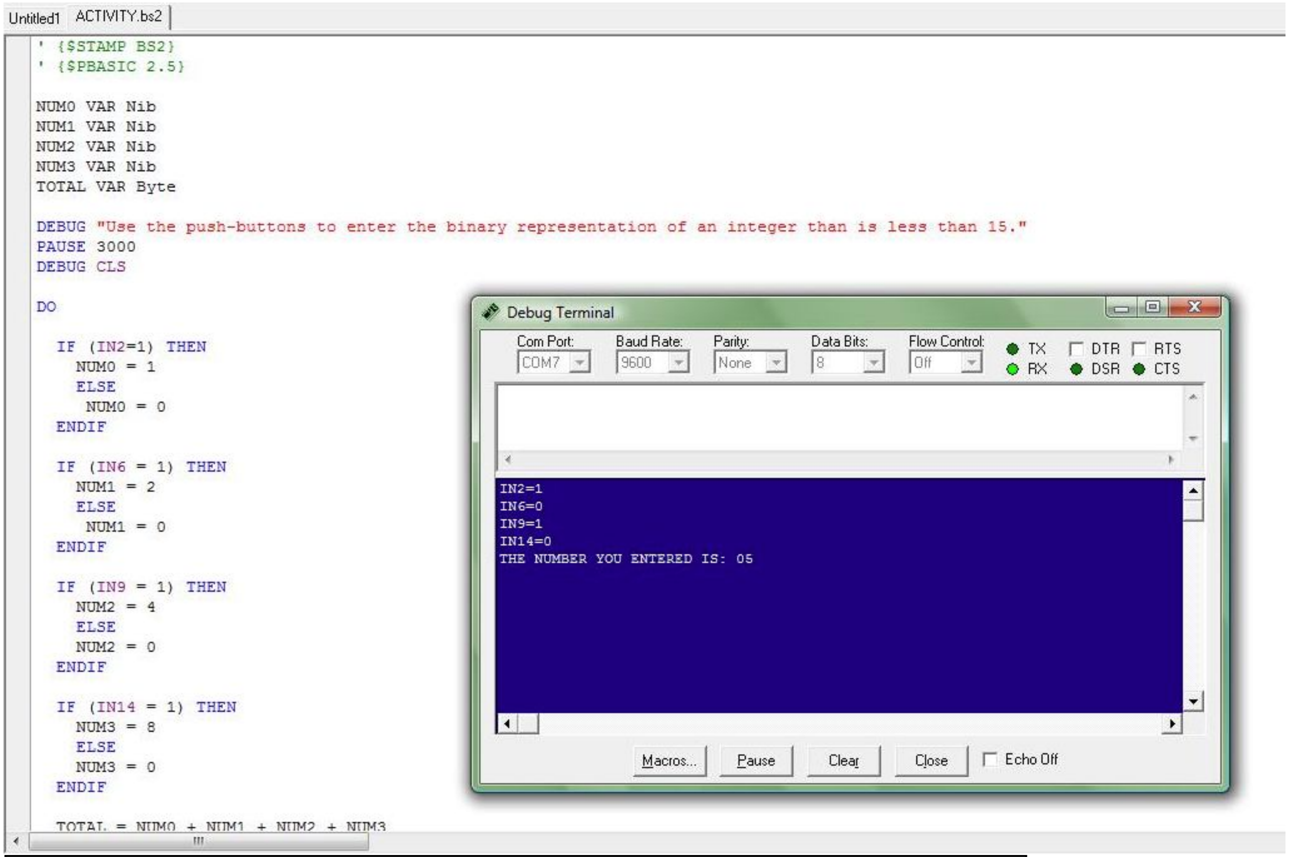

Figure 1.4
ADA Description: point turn program on NXT 2.0 software
Caption: Figure 1.3: follow the instruction/values to program robot to do a point turn
Image file name: pointTurn.jpg
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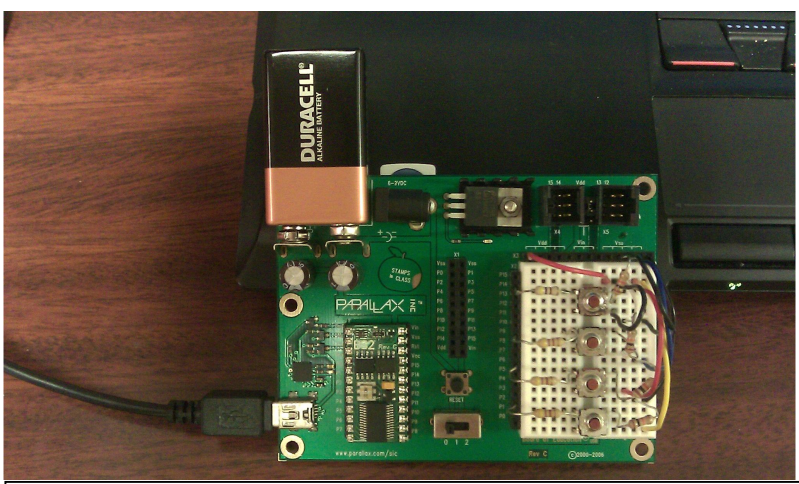

Figure 1.5
ADA Description: point turn program on NXT 2.0 software
Caption: Figure 1.3: follow the instruction/values to program robot to do a point turn
Image file name: pointTurn.jpg
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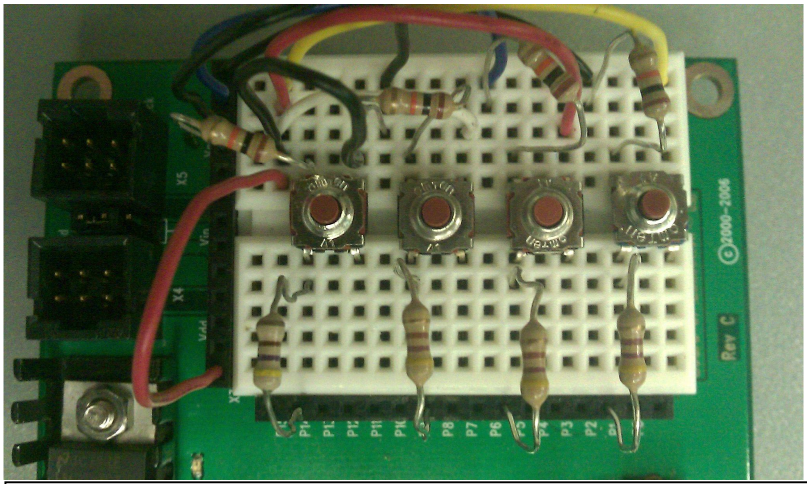

Figure 1.6
ADA Description: point turn program on NXT 2.0 software
Caption: Figure 1.3: follow the instruction/values to program robot to do a point turn
Image file name: pointTurn.jpg
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Attachment

- Pi_Pre_Activity_Worsheet.docx (available also in pdf)

Troubleshooting Tips

- If robot does not travel the point turn as programmed, make sure that the surface of the ground is completely flat and that the paper is taped securely on the ground (without bumps)
    - If that does not fix the problem, try programming the "pointTurn" using the help panel on the right side of the Mindstorms software
    - "Robot Educator" panel → "Common Palette" → "07. Point Turn" → "Programming Guide"
- If the robot does not travel the drag turn as programmed, try using a "curve turn" as shown in the "Robot Educator" panel under "Common Palette" also

Assessment

Pre-Activity Assessment

How accurate is your pi?

Take an average of three pi values obtained from the 3 different sized circles drawn by the students. Compare this average value of pi to the known pi – 3.14159…What does that say about the circles you drawn? Good or bad?

Activity Embedded Assessment

Different circles, same pi?

After explaining that all circles have the same value of pi and that pi is a constant, ask students to predict the pi value of the circles that the robot draws.

Post-Activity Assessment

How accurate is Robot's pi?

Take an average of two pi values obtained from the 2 different sized circles drawn by the robot. Compare this average value of pi to the known pi – 3.14159… How off was the value? What does that say about the circles the robot drawn? Good or bad?

Activity Scaling

- For upper grades, estimate the circumference of the robot's tires and based on this value and the number of rotations that the robot has traveled, the student can calculate a rough estimate of the circle's circumference. (This will only work if the robot is programmed for exactly 1 round).

References

[1] http://en.wikipedia.org/wiki/Binary_number

[2]

[3]

[4]

Redirect URL http://gk12.poly.edu/amps-cbri/

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