Cyber Theater Project – Video sync'd Robot Play

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Abstract

This project is focused to construct robotic artists in the Cyber Theater to perform various plays to educate the audience. We emphasized on educating the audience with entertainment, hence built theater characters with robots which are synchronized with a video played in the background. Both visual and motion attracts audience and conveys the message most efficiently.

In this project we worked on various robots, hacking it, to make it work with an Arduino or a sensor. We built Control Box to control the motion of the robots. Various computer programs are used to synchronize the video with the robot movements.

Acknowledgements

I thank Dr Marek A. Perkowski for giving me an opportunity to be a part of this dream project. I am very privileged to contribute for the theater.

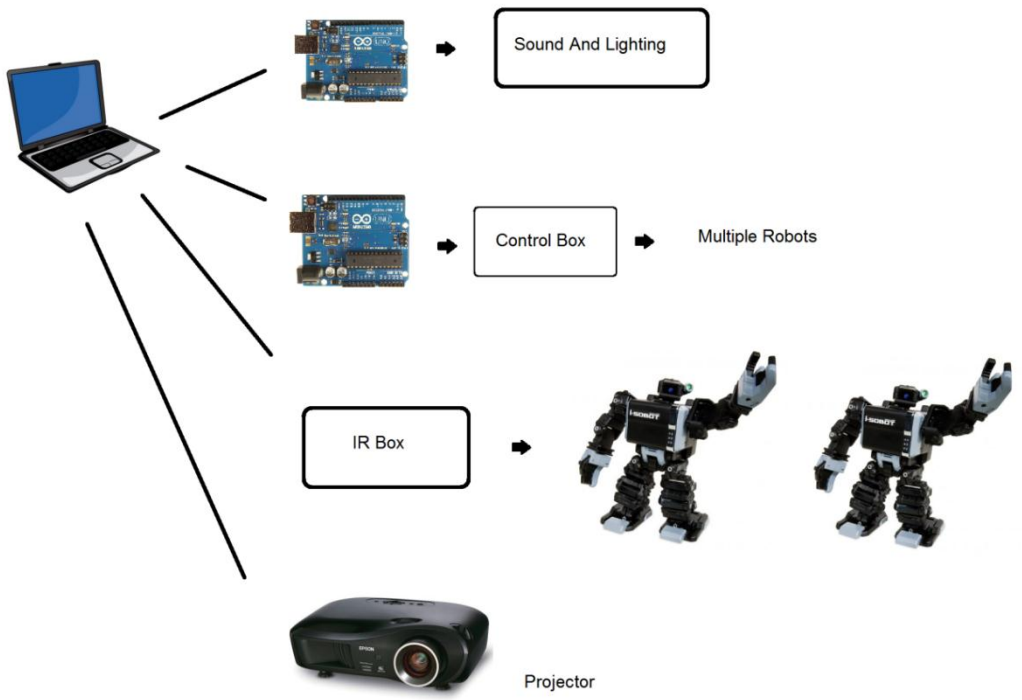
I would also like to thank Mathias Sunardi for helping and supporting me through the project. I appreciate his effort on the i-sobot robots and programing the software.

Implementation

Video synchronized robot Motion Theater uses numerous hardware and software. The hardware is used to control the robots and the software is used to synchronize the motion of the robots with the video. Below are the list of various hardware and software used in our project:

- Hardwares
    - Robots
    - Projector
    - Arduino
    - Control box
    - IR box

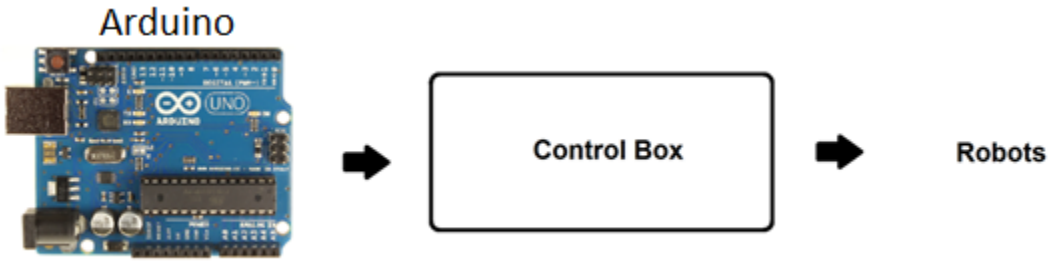
- Softwares
    - Python
    - C# (for Arduino)

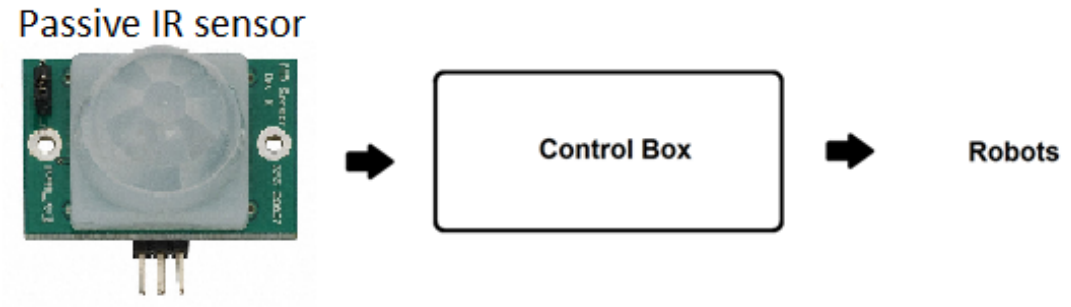


Hardware Implementation

Control Box:

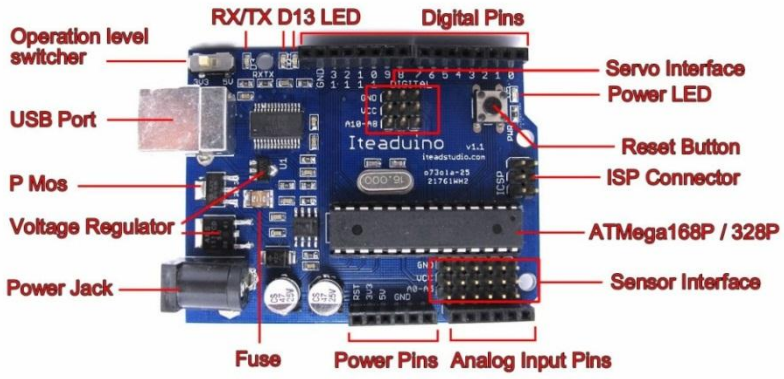
The control box is used to power the robots from the output of the Arduino. The Control Box is an electronic switch that is operated by Arduino to control the robots. The main advantage of the control box is to isolate the Adruino from the reverse bias voltages from the robots. In this project a regular power amplifier transistor is used because of low power requirements of the robots. For high current or voltage requirements, transistors TIP120/121/122 can be used in the control box.





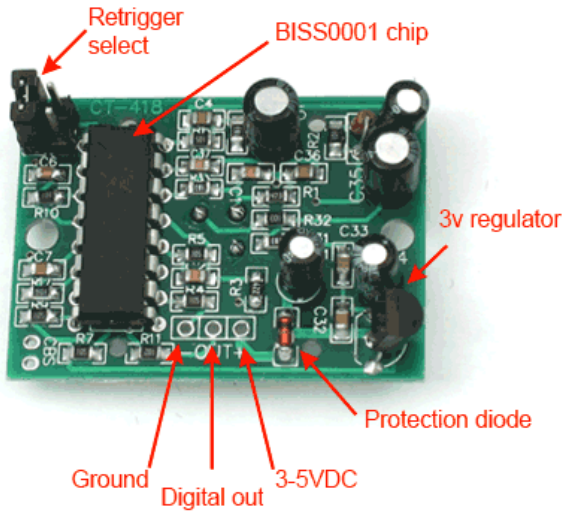
Pin Configuration of Arduino and PIR sensor:

Show below is the pin configuration of Arduino. The output/input pins of the Arduino to a robot are defined in the Arduino program.



Show below is the pin configuration of Passive Infrared sensor (PIR sensor). The sensor operates at 3-5 DCV power supply. The output (Digital out) of the PIR is logic high whenever motion is detected. The output of the sensor remains high for a time period (predefined by the PIR model), typically for 3-5 seconds.

The sensor can either be connected to the Arduino or to the control box directly. Please note that the Arduino must be powered ON if the sensor is connected to Arduino, to detect motion.

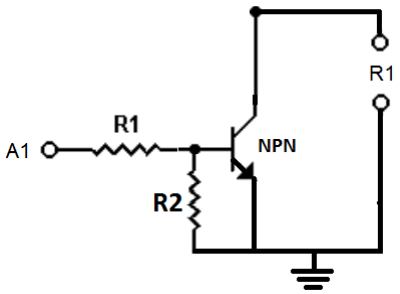


Schematics:

The NPN transistor is used to power the robots. The robot R1 is active whenever the input to the base is high. The base of the transistor is connected to Arduino with output pin in-series with a resistor, to control the current flow to base of the transistor. The resistor R2 is used to stabilize the output of the transistor (when using Arduino, R2 is not compulsory and can be avoided). The value of the resistors can be calculated by the formula:

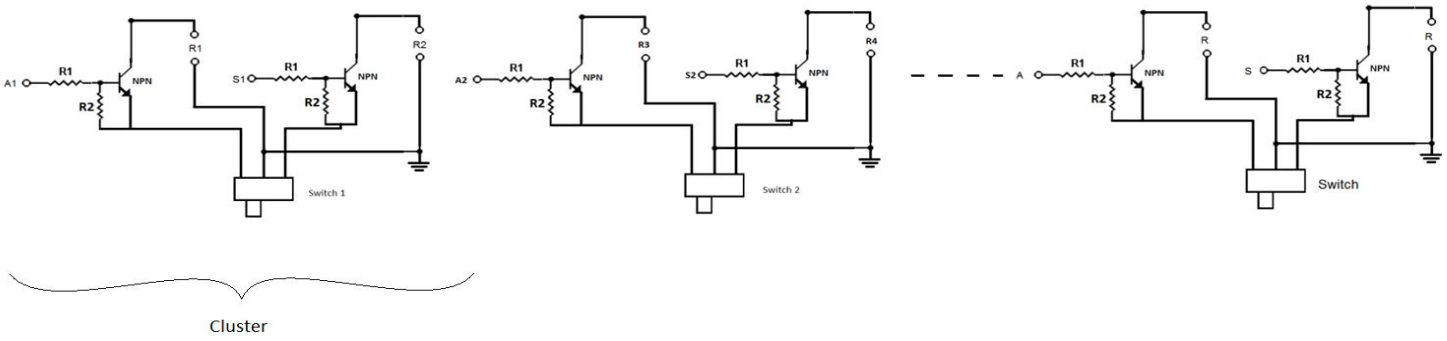
R1 = Supply Voltage / (Maximum Current Required / Minimum HFE x 1.3)
R2 = 10 x R1

Note: HFE = Forward Current Gain of the transistor, mentioned in the datasheet of the transistor.



Complete Control Box Schematic:

The control box has clusters of electronic switches connected which can be connected to Arduino or sensors. Each cluster consists of two independent electronic switches connected to Arduino and sensor, and operates in Arduino or sensor mode respectively. The mode of operation of the robot is selected by a mechanical switch as shown in the schematic. The robot work in Arduino mode or sensor mode independent of other robots connected to the control box. The clusters in the control box can be increased as required.

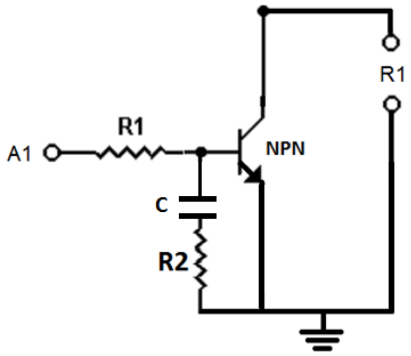


Note: A1, A2, A3, .. A are Arduino pin connections
R1, R2, R3, .. R are robot connections

Adding Delay to the Switch:

A delay can be introduced to the switching by the use of a capacitor between resistor R2 and base of the transistor. The value of the capacitor can be calculated by the formula:

T = R*C Where; T = time required for the circuit to be turned ON (delay)
R = value of the resistor R2
C = value of the capacitor



Robots

Bear Robot:

The bear robot turns ON when **Black** is connected to the ground and turns OFF when **Blue** is connected to the ground. Hence, to operate the bear robot with control box we use two clusters which operate according to the truth table shown below:

Bear Robot		A1/S1	
		0	1
A2/S2	0	OFF	ON
	1	OFF	**X**

Here, A1/S1 and A2/S2 are pins from Adruino/sensor to turn ON and OFF the robot respectively.

Witch Robot:

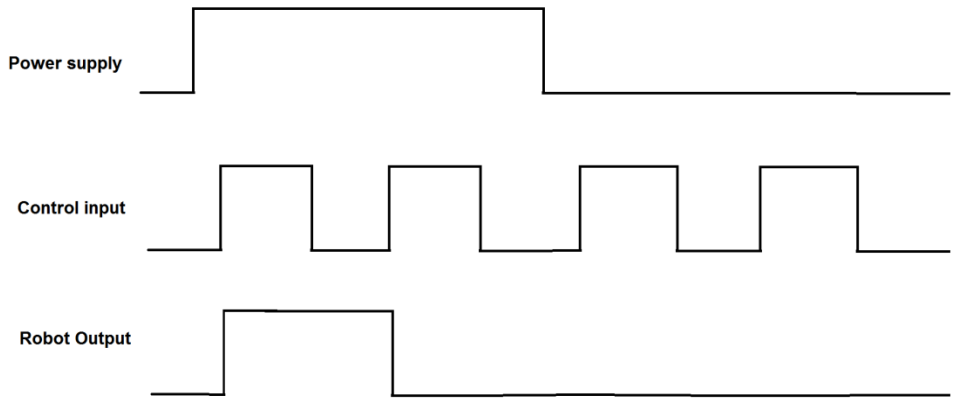
The witch robot turns ON when **Blue** wires are connected to power supply and when **Red** is connected to the ground. The robot turns OFF when power is turned OFF. Hence, to operate the witch robot with control box we use two clusters which operate according to the truth table shown below:

Witch Robot		A1/S1	
		0	1
A2/S2	0	OFF	ON
	1	OFF	OFF

Here, A1/S1 and A2/S2 are pins from Adruino/sensor to turn ON and OFF the robot respectively.

Halloween Robots:

The Halloween robot turns ON when both the **yellow** wires are connected to each other and turns OFF when they are connected again. Hence, to operate the Halloween robot with control box we use a single cluster which operates according to the timing diagram shown below:



Conclusion

In this project we created multiple robots which are synced with the video played in the Cyber Theater. The project emphasizes to teach, and entertain audience about Quantum computing. The robots are connected to sensors to start or end the play in the theater, making it more robust in structure. In future, this basic structure can be upgraded for multiple robots, and plays in the theater.