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 **LinkSprite**

A Fun Introduction to Electronics and Software Programming



SCRAATCH!

A Complete Kit for Students of all ages to Learn about the "Internet of Things"

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Introduction

This user guide contains a fun introductory course for the **LinkSprite Scratch Linker Kit**. It presents some simple Scratch based projects designed to familiarise the user with Scratch programming. It also includes a more advanced “Internet of Things” project which is based on the Python programming language. **Scratch** is a visual programming system developed in the U.S. at M.I.T. and is intended as an entry level environment for younger students into programming. It is however, still a fairly powerful programming language and capable of quite complex tasks. All of the projects in this guide will only use the components provided in the kit, (shown in the image over page).

Each project in this guide builds on the one before it. The difficulty level increases with each project. At the end of this guide you will have created a functional Scratch game and an Infrared Theremin , (an electronic musical instrument), using various hardware sensors and actuators running on the pcDuino single board computer contained within the kit. You will also have created a Linux daemon written in Python which sends an email message to your address when the game is completed. This guide and other resources, (such as scratch projects, source code and videos), are available online at the following links:

<http://learning.linksprite.com.au/scratch-linker-kit/documents/guide.pdf>

<http://learning.linksprite.com.au/scratch-linker-kit/>



List of Contents



1 x pcDuino3 Single Board Computer.



1 x Base Shield for Linker Kit.



1 x Acrylic Clear Enclosure for pcDuino3 Single Board Computer.



1 x HDMI Video Cable.



1 x CAT 5E Twisted Pair Network Cable.



1 x Micro-USB Cable.



1 x 4-Port USB Hub.



1 x USB Camera.



1 x Servo Motor.



4 x 20 cm Linker Cable.



3 x 10 mm LED Linker Modules, (Blue, Yellow and Red).



1 x Momentary-ON Push Button Linker Module.



1 x Buzzer Linker Module.



1 x Joystick Linker Module.



1 x Linear Slide Potentiometer Linker Module.



1 x Temperature Sensor Linker Module.



1 x Touch Sensor Linker Module.



1 x Ambient Light Sensor Linker Module.



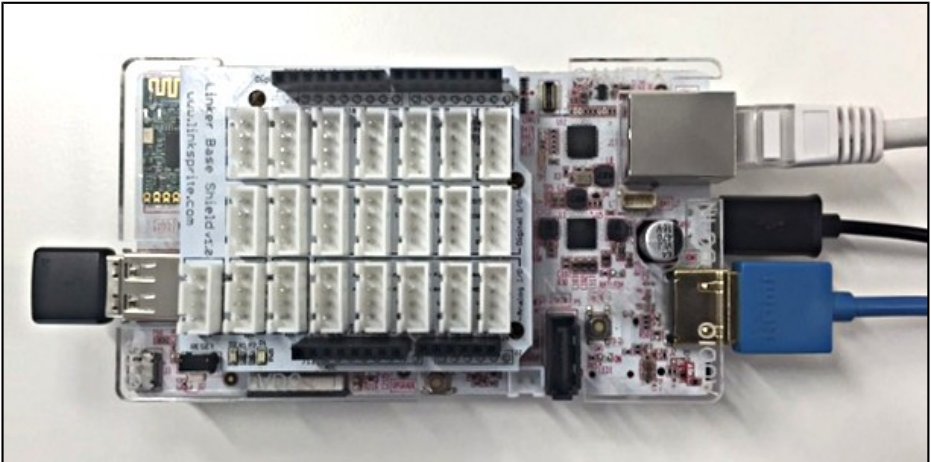
2 x Infra-red Distance Sensor Linker Module.

Before You Begin

What you need:

1. USB Wireless Keyboard/Mouse Combo
(or USB Keyboard and USB Mouse + USB Hub)
2. HDMI Screen, (or TV)
3. USB Power Supply
4. Network Port

The image below shows the Linker Base Shield plugged into the pcDuino motherboard from the Kit which forms the basis of all of the projects in this guide.



If you have a wireless Keyboard-Mouse combo then plug the wireless dongle into the USB port, otherwise you will need to connect a small USB hub first and then connect the mouse and keyboard to it. Plug the HDMI video cable into the HDMI port and plug a network cable into the network port. (WiFi is also available). Finally attach the Micro-USB power cable into the Micro-USB power port located under the PCB. (Take care to ensure it is correctly oriented and do not force it.)

Download all of the Scratch projects and other source code using the following instructions:

Open a web browser by double-clicking on the "**Chromium**" desktop icon, (see icon below). Check that you are connected to the internet by navigating to a website, (eg Google).

Open a terminal window by double-clicking on the "**LXTerminal**" desktop icon, (see icon below), and then type the following commands into the terminal window, pressing the ENTER key after each.



Chromium and LXTerminal Desktop Icons

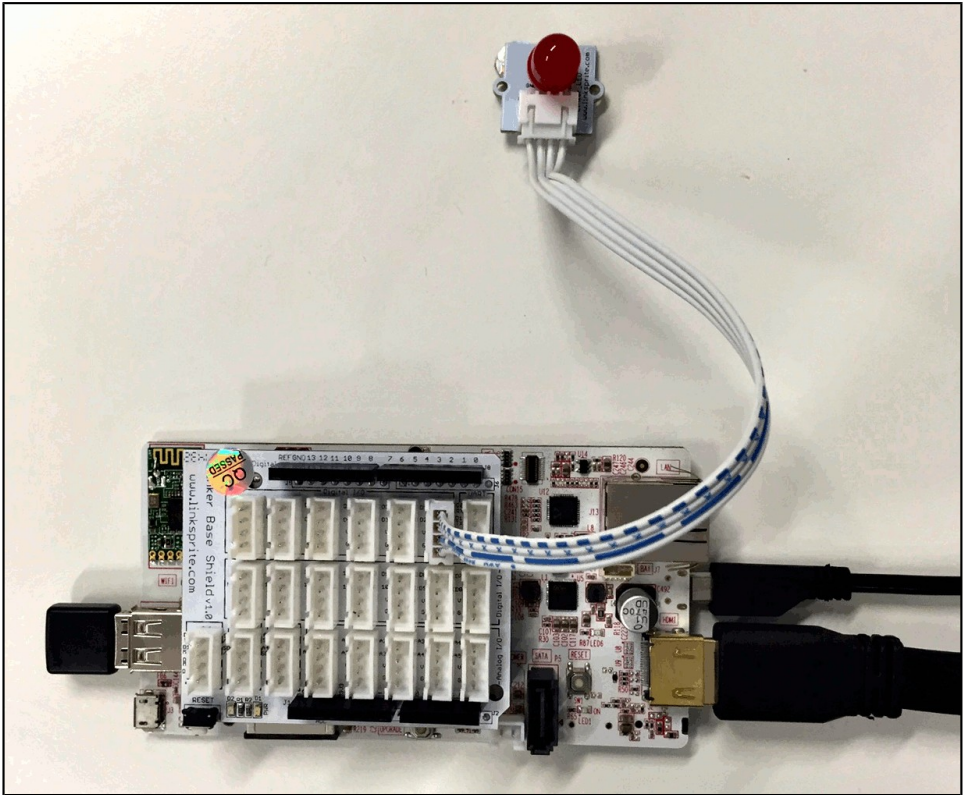
Important Note:

The commands are case sensitive and you must take care to include any spaces between the commands.

1. **sudo su**
2. **cd /home/ubuntu**
3. **wget -N 'http://learning.linksprite.com.au/scratch-linker-kit/install.sh'**
4. **chmod a+x /home/ubuntu/install.sh**
5. **/home/ubuntu/install.sh**

Project 1: "Blink an LED"

This project introduces the Scratch Linker Kit and creates two simple designs with it. Connect the LED, ("Light Emitting Diode") into the D1 Port of the Digital I/O of the Linker Base Shield as shown in the following image.



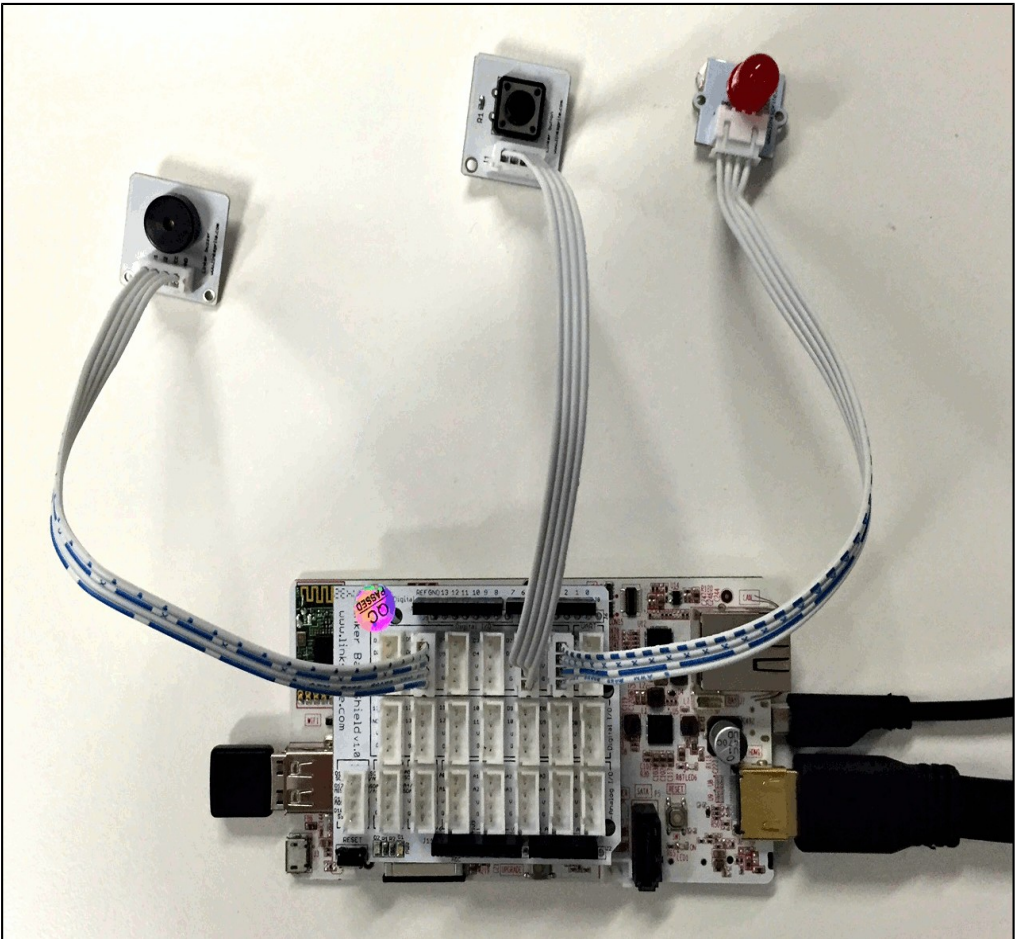
Open the Scratch development environment and open the "Project1" project file. This should contain a script for Sprite1 as shown in the following image. Test the script by clicking on the Green "Start" flag. The LED should blink once a second.



Stage

Project 2: “Start the Cat with a Button”

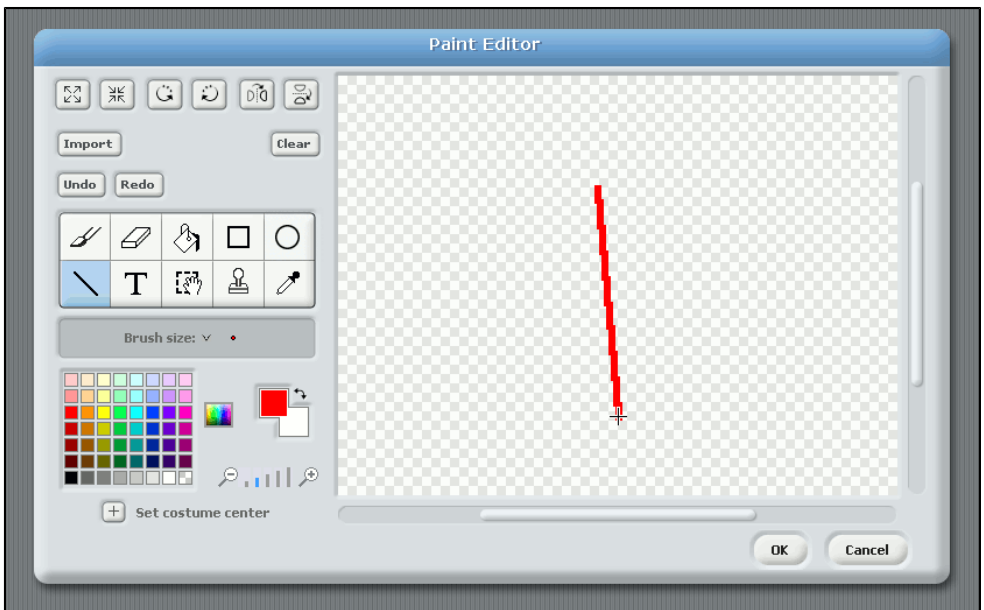
Open the “Project2” Scratch project file. Plug the Button and the Buzzer into the D2 and D5 Ports of the Digital I/O section on the Linker Base Shield as shown below.



The script for Sprite1 has been modified as shown below. Test the script by clicking on the Green "Start" flag. When the button is pressed, the Cat should move towards the Wall until it touches at which point the LED should turn on and the buzzer will sound.



This project includes a second Sprite created by using the Scratch Paint Editor which may be opened by clicking on the "Paint new sprite" button. The user can then draw a red straight line wall image for Sprite2 as shown below.



The script for Sprite 2 is shown over page.

Based on Scratch for pcDuino

File Edit Help

Sprite1
x: -230 y: 0 direction: 90

Scripts

when clicked

set pin 1 to OUTPUT mode

set pin 2 to INPUT mode

stop pwm 5

forever

set pin 1 to LOW level

go to x: -230 y: 0

wait until pin 2 level is HIGH ?

wait until pin 2 level is LOW ?

repeat until touching Sprite2 ?

move 4 steps

set pin 1 to HIGH level

set pwm 5 781 Hz 26 step

wait until pin 2 level is HIGH ?

wait until pin 2 level is LOW ?

stop pwm 5

Hardware

set pin 18 to INPUT mode

set pin 18 to LOW level

pin 3 level is HIGH ?

Voltage (mV) of pin A0

set pwm 5 781 Hz 1 step

stop pwm 5

Costumes

Sounds

Stage

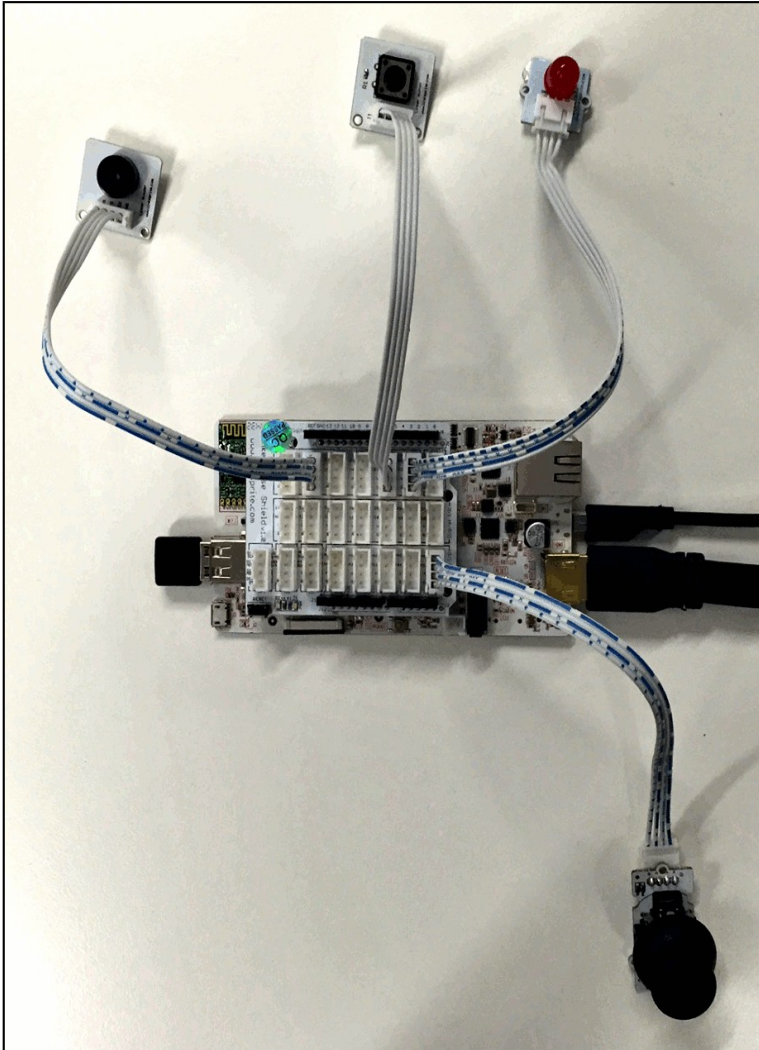
Sprite1

Sprite2

x: -1822 y: -826

Project 3: "Control the Cat with a Joystick"

This project extends the previous project by adding more Linker modules and functionality. The image below shows the additional Joystick module plugged into the A4 Port of the Analog I/O on the Linker Base Shield.



Open the "Project3" Scratch project file. This project modifies the script for Sprite2 as shown below.



The script for Sprite1 has also been modified as shown over page. The changes include a new module to read the analogue voltages from the Joystick and convert these broadcast messages, "RIGHT", "LEFT", "UP" and "DOWN". Event handlers for each of these messages are created to set the direction of Sprite1, (the Cat).

Test the script by clicking on the Green "Start" flag. When the button is pressed, the Cat should now be able to be controlled by the Joystick. Try moving the Cat towards the Wall until it touches. The LED should turn on and the buzzer will sound. Pressing the Button will reset the game

Based on Scratch for pDuno

File Edit Help

Sprite1 x: 230 y: 0 direction: 90

Scripts

- when clicked
 - set pin 1 to OUTPUT mode
 - set pin 2 to INPUT mode
 - stop pwm 5
 - forever
 - set pin 1 to LOW level
 - go to x: 230 y: 0
 - wait until pin 2 level is HIGH?
 - wait until pin 2 level is LOW?
 - repeat until touching Sprite2?
 - move 4 steps
 - set pin 1 to HIGH level
 - set pwm 5 731 Hz 25° step
 - wait until pin 2 level is HIGH?
 - stop pwm 5
 - wait until pin 2 level is LOW?
 - wait until pin 2 level is HIGH?
 - wait until pin 2 level is LOW?

Costumes

Sounds

Control

- Make a variable
- Delete a variable
- JSX
- JSY
- set JSX to 0
- change JSX by 1
- show variable JSX
- hide variable JSX
- Make a list

Operators

Pen

Hardware

Course1-Lesson2-...

when I receive UP

point in direction 0

when I receive DOWN

point in direction 180

when I receive RIGHT

point in direction 90

when I receive LEFT

point in direction -90

when clicked

forever

- set JSX to Voltage (mV) of pin A4
- set JSY to Voltage (mV) of pin A5
- if JSX > 3000
 - broadcast RIGHT
- if JSX < 2000
 - broadcast LEFT
- if JSY > 3000
 - broadcast UP
- if JSY < 2000
 - broadcast DOWN
- wait 0.1 secs

Stage

Sprite1

Sprite2

Project 4: "Give the Cat a Mouse to Chase"

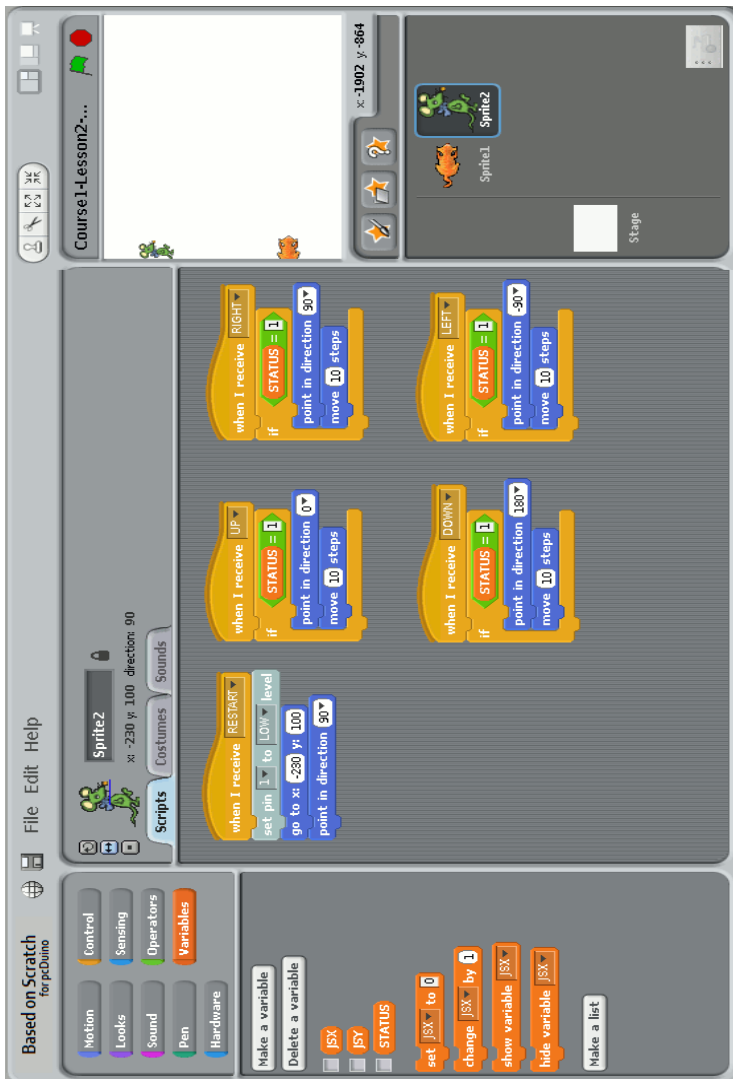
Open the "Project4" Scratch project file. In this project, Sprite2 has been deleted and replaced with a mouse sprite which has some limited behaviour. This may be done by clicking on the "Choose new sprite from file" button and then selecting the mouse sprite as shown below. Once the mouse is selected it can be resized to the same dimensions as the cat sprite using the "Shrink sprite" button.



This project modifies the script for Sprite 1 as shown in the following image. It adds a new "Restart" event handler which "cleans" up the code structure in order to facilitate later code changes in Project 5. The "Restart" event handler utilises a new "STATUS" global variable to store the current restart state.

[illegible]

The script for Sprite2 has also been modified as shown in the following image. Test the script by clicking on the Green "Start" flag. When the button is pressed, the Cat should now be able to be controlled by the Joystick. Move the Cat towards the Mouse until it touches at which point the LED should turn on and the buzzer will sound. Pressing the Button will reset the game.



Project 5: "A Smarter Mouse"

Open the "Project5" Scratch project file. This project modifies the script for Sprite 1 as shown on the following page. It includes a new global "Enabled" variable which is set in a separate event handler when Sprite1 touches Sprite2. In addition, a new Timer module has been added to indicate the number of seconds passed since the game commenced. All initialisation is now done in separate event handlers triggered by the "RESTART" message.

Based on Scratch for Arduino

File Edit Help

Sprite1

x: 230 y: 100 direction: 90

Costumes Sounds

Control

Sensing

Looks

Operators

Sound

Pen

Hardware

Variables

Course1Lesson3-Project1-Cat-Mouse

9

New sprite:
? * ☆

Sprite1

Sprite2

Stage

when clicked

set INITIALISED to 0

set ENABLED to 0

set TIMER to 0

stop pin 5

set pin 2 to OUTPUT mode

set pin 2 to INPUT mode

set pin 1 to LOW level

go to x: 230 y: 100

point in direction 90

set INITIALISED to 1

when clicked

wait until INITIALISED = 1

forever

broadcast

restart

wait until ENABLED = 1

repeat until ENABLED = 0

move 4 steps

if touching Sprite2?

set pin 2 to HIGH level

set pin 1 to 785 Hz 25 step

wait until pin 2 level is HIGH?

wait until pin 2 level is LOW?

when clicked

forever

set JSX to Voltage (mV) of pin J4

set JSY to Voltage (mV) of pin J5

if JSX > 8000

broadcast RIGHT

if JSY < 2000

broadcast LEFT

if JSX < 2000

if JSY > 8000

broadcast UP

if JSY < 2000

broadcast DOWN

wait 0.1 secs

when I receive RESIDOR

stop pin 5

set pin 1 to LOW level

go to x: 230 y: 100

point in direction 90

wait until pin 2 level is HIGH?

wait until pin 2 level is LOW?

set ENABLED to 1

when I receive RESIDOR

wait until ENABLED = 1

wait until touching Sprite2

set ENABLED to 0

when I receive RESIDOR

wait until ENABLED = 1

wait until pin 2 level is HIGH?

set ENABLED to 0

when I receive RESIDOR

wait until ENABLED = 1

set TIMER to 0

repeat until ENABLED = 0

wait 1 secs

change TIMER by 1

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The script for Sprite2 has also been modified as shown on the following page. Sprite 2 now has a new random walk functionality added to make its behaviour more unpredictable, (and thus harder to catch). Test the script by clicking on the Green "Start" flag. When the button is pressed, control the Cat with the Joystick and move towards the Mouse. The Mouse is a little smarter now and will run away. When they touch, the LED should turn on and the buzzer will sound. Pressing the Button will reset the game.

Based on Scratch for pCDuino

Notion

Looks

Sound

Pen

Hardware

Control

Sensing

Operators

Variables

Make a variable

Delete a variable

ENABLED

INITIALISED

JSX

JSY

☒ TIMER

set ENABLED to 0

change ENABLED by 1

show variable ENABLED

hide variable ENABLED

Make a list

Scripts

Costumes

Sounds

Sprite2

x: 230 y: 100 direction: 90

when clicked

go to x: 230 y: 100

point in direction 50

when I receive RESTART

wait until ENABLED = 1

repeat until ENABLED = 0

if on edges bounce

wait until not touching edge

wait 0.1 secs

when I receive RESTART

go to x: 230 y: 100

point in direction 50

wait until ENABLED = 1

repeat until ENABLED = 0

move 4 steps

when I receive RESTART

wait until ENABLED = 1

repeat until ENABLED = 0

wait 0.5 secs

point in direction pick random 1 to 3 * 90

when I receive UP

if ENABLED = 1

point in direction 0

when I receive DOWN

if ENABLED = 1

point in direction 180

when I receive RIGHT

if ENABLED = 1

point in direction 90

when I receive LEFT

if ENABLED = 1

point in direction 270

Course1-Lesson3-Project1-Cat-Mouse

9

Sprite1

Sprite2

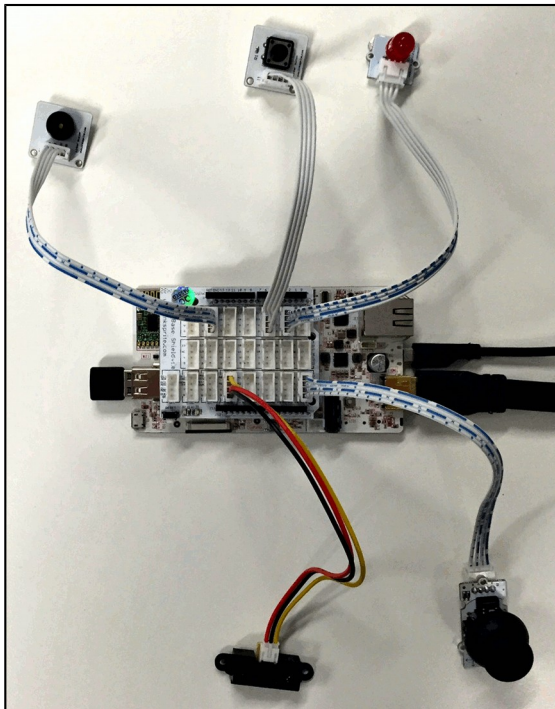
New sprite:

Stage

x: 990 y: 325

Project 6: “Add an Infrared Theremin”

Every Cat and Mouse game needs an Infrared Theremin, (or perhaps that's just me). A theremin is an electronic musical instrument controlled by the proximity of your hand. This project extends the previous project by adding an Infrared Distance sensor Linker module to create a theremin which can be played whilst you chase the mouse. The image below shows the additional Infrared Distance sensor module plugged into the A0 Port of the Analog I/O section on the Linker Base Shield.



Open the “Project6” Scratch project file. This project modifies the script for Sprite1 as shown over page.

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The script for Sprite2 has also been modified as shown over page. Test the script by clicking on the Green "Start" flag. When the button is pressed, the Cat should now be able to be controlled by the Joystick. Move the Cat towards the Mouse until it touches at which point the LED should turn on and the buzzer will sound. While you're doing this take a break and "play" the Infrared Theremin by moving your hand up and down above the Infrared Distance sensor. Pressing the Button will reset the game.

```

move 10 steps
turn 15 degrees
turn 15 degrees
point in direction 90
point towards
go to x: 230 y: 100
go to
glide 1 secs to x: 230 y: 100
change x by 10
set x to 0
change y by 10
set y to 0
if on edge, bounce
x position
y position
direction

```

```

when green flag clicked
  go to x: 230 y: 100
  point in direction 90
  when I receive UP
    repeat until ENABLED
      if on edge, bounce
      wait 0.1 secs
      pick random 1 to 8 * 90
    when I receive DOWN
      go to x: 230 y: 100
      point in direction 90
      when I receive 180
        repeat until ENABLED
          if on edge, bounce
          wait 0.1 secs
          pick random 1 to 8 * 90
        move 4 steps
  
```

Project 7: "The Internet of Things"

We have now completed the hardware portion of this guide. The final project will focus on connecting our Cat and Mouse game to the internet. We will do this by using a Python "Daemon" to monitor the state of the General Purpose I/O pin connected to the D1 port of the Digital I/O section on the Linker Base Shield. This python daemon will then call a web service which will send an email message to a designated address. We will use Python for this, because the Scratch programming system operates within a sand-boxed environment which prevents it accessing the host file system or other devices.

Open a terminal window by double-clicking on the "LXTerminal" desktop icon. The rest of this project will be conducted using the terminal window. (**Important Note:** Keep the terminal window open for the remainder of this project.)

Confirm that you are connected to the internet and then type the following command into the terminal window to edit the python daemon script, (pressing the ENTER key afterwards).

nano /home/ubuntu/monitor.py

Modify the value for the "**EmailAddress**" parameter to your email address:

eg: EmailAddress = '**support@linksprite.com.au**'

Press **CTRL-O** to save.

Press **CTRL-X** to exit the editor.

Now the system is ready for testing. Open your previous Scratch project, ("Project6") and run it.

Type the following command into the terminal window to start the python daemon.

service monitor start

Press the Linker Button and catch the Mouse. You should receive an email message.

Type the following command into the terminal window to stop the python daemon.

service monitor stop

Congratulations you have now completed all of the LinkSprite Linker Kit Guide Projects.

Additional Linker Modules And Kits

In addition to the components available in this kit, LinkSprite also stock a wider range of Linker Modules and Kits. Some of these have been listed below. LinkSprite also have a wide range of Arduino shields that are compatible with the Linker Kit.

- ◆ *Vibration Sensor Linker Module*
- ◆ *LED Bar Linker Module*
- ◆ *Linker kit Base Shield for Beaglebone*
- ◆ *Linker kit Base Shield for Raspberry Pi with ADC Interface*
- ◆ *Serial Servo Linker Module*
- ◆ *Magnetic Switch Linker Module*
- ◆ *MOSFET Linker Module*
- ◆ *OLED Display Linker Module*
- ◆ *Oxygen Sensor Linker Module*
- ◆ *Path Tracking Sensor Linker Module*
- ◆ *Relay Linker Module*
- ◆ *Rotary Potentiometer Linker Module*
- ◆ *Real Time Clock Linker Module*
- ◆ *Sound Sensor Linker Module*
- ◆ *Tilt Sensor Linker Module*
- ◆ *4-Digit 7-Segment Display Linker Module*
- ◆ *5mm Blue LED Linker Module*
- ◆ *5mm Green LED Linker Module*
- ◆ *5mm Red LED Linker Module*
- ◆ *5mm Yellow LED Linker Module*
- ◆ *Double buttons Linker Module*
- ◆ *Flame Sensor Linker Module*
- ◆ *Hall Effect Sensor Linker Module*
- ◆ *High Power LED Linker Module*
- ◆ *Infrared Receiver Linker Module*
- ◆ *Wireless Remote Controlled Video Robot Kit*
- ◆ *Touch Screen "Build Your Own Tablet" Kit*

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