Sensors

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Last Time

- JITPCB Peripherals
- Sensors

[Image: https://www.adafruit.com/products/245]
# Sensor Input Techniques

<table>
<thead>
<tr>
<th>Sensor Input Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DigitalIn</td>
<td>simple</td>
</tr>
<tr>
<td>DigitalOut</td>
<td>enable signal</td>
</tr>
<tr>
<td>AnalogIn</td>
<td>need to map values</td>
</tr>
<tr>
<td>UART</td>
<td>string parser</td>
</tr>
<tr>
<td>I2C</td>
<td>need address</td>
</tr>
<tr>
<td>SPI</td>
<td>number of bits</td>
</tr>
<tr>
<td>Sensor Input Techniques</td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
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</tr>
<tr>
<td><strong>Voltage</strong></td>
<td>any Analog value</td>
</tr>
<tr>
<td><strong>Event</strong></td>
<td>touch, IR, magnetic, hall effect</td>
</tr>
<tr>
<td><strong>Light</strong></td>
<td>LED, IR, pulse, camera</td>
</tr>
<tr>
<td><strong>Sound</strong></td>
<td>knock, mic</td>
</tr>
<tr>
<td><strong>Motion</strong></td>
<td>tilting, velocity, acceleration, flex, liquid flow</td>
</tr>
<tr>
<td><strong>Distance</strong></td>
<td>SONAR, LIDAR</td>
</tr>
<tr>
<td><strong>Weather</strong></td>
<td>temperature, humidity,</td>
</tr>
<tr>
<td><strong>Time</strong></td>
<td>real time, atomic time</td>
</tr>
<tr>
<td><strong>Magnetism</strong></td>
<td>magnetic contact, compass</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>load cell</td>
</tr>
<tr>
<td><strong>Pose</strong></td>
<td>GPS, encoder, altimeter</td>
</tr>
<tr>
<td><strong>UI</strong></td>
<td>mouse, game controller, wii, keyboard, keypad</td>
</tr>
</tbody>
</table>
measuring basic voltage
- variable resistor
- use map command for mapping values
- use multiplexor
- map domain to range
- can use constrain
use voltage divider
measure instantaneous event
- transmitter and receiver
- open collector receiver needs pull up resistor say 10k

https://www.adafruit.com/products/2167
Magnetic Contact Switch

- reed switch triggered when magnet is < 0.5” away

https://www.adafruit.com/products/375
Hall Effect Sensor

- measures magnet nearby
- high strength magnet works best
- wire vdd, gnd, digital out
- use 10k pull up resistor on out

https://www.adafruit.com/products/158
- breakout board below
- some microcontrollers have touch hardware built in
- wire to vdd, gnd, out

https://www.adafruit.com/products/1374
measuring aspects of light
- light dependent resistor
- analog in with 10k resistor to ground
- measure blood pulse through light
- need to sample analog signal and do DSP on it

https://www.adafruit.com/products/1093
- measure single line
- also line sensor with IR light bounced back

https://www.sparkfun.com/products/13582
- lots of different interfaces for cameras
- here’s one with TTL serial interface
- also ones with SPI interface

https://www.adafruit.com/products/397
- offloads processor

https://www.adafruit.com/products/1906
- longwave infrared light sensor
- 80x60 pixels
- SPI and I2C

https://www.sparkfun.com/products/13233
measuring aspects of sound waves
- BOB-08669 breakout board from sparkfun
- wire up aud, gnd, vcc
- just use analog in
- need to use sum of squares
■ measuring movement aspects
- piezo sensor
- analog value > threshold
- polarized – + goes to analog in
- 1 mega ohm is connected across terminals
- PIR sensor
- hookup out, gnd, 5v
- acts like switch
- Read acceleration as proportional to voltage value
- See Sparkfun accelerometer selection guide
- measure deflection of surface
- changes resistance with flex

https://www.adafruit.com/products/1070
Flow Sensor

- liquid flow meter
- count pulses using interrupt

https://www.adafruit.com/products/833
Distance

- measuring distance to object
- rough distance values
- ping sensor is one example
- ping and measure time back and convert to distance
- use pulseIn to measure pulse size
- no pinging
- continuous distance values
- use pulseIn to measure pulse size
- accurate distance values
- smaller range (1 to 2m) but
- use table to interpolate values to distance
- analog in and need to convert to length

https://www.adafruit.com/products/463
- measure distance to grid of points
- use spinning laser and camera
- I2C interface

https://www.sparkfun.com/products/14032
measuring weather attributes
- 1 mv per 0.1 deg c
- celcius = (value * 500L) / 1024 (max temp is 500)
Humidity

- I2C interface

https://www.adafruit.com/products/3251
- CLK / DAT for clocking out values

https://www.adafruit.com/products/1298
- I2C Interface
- barometric pressure changes with altitude

https://www.adafruit.com/products/1603
measuring angle / location either relative or absolute
Rotary Movement

- encoder
- two outputs and ground
- during high to low transition can detect direction of movement by looking at state of other pin
- encoders use steps per revolution (from say 16 to 1000)
- might be low to high instead in some cases
- multiple encoders require multiple state machines
- can do this using interrupt handler
- serial interface
- parse sentence
- popular one is USGlobalSatEM-406A
- tinygps in an arduino driver
- LY530AL output proportional to rotation rate
- also have ones that use I2C
- 3 axis one is ITG-3200
- hm55b compass module from parallax #29123
- wire gnd, 5v, en, dat, clk
- SPI interface (sw one in example)

\[
\text{calcAngle} = \frac{\text{atan2}(-y_{dat}, x_{dat})}{M_PI} \times 180
\]
- just like a switch
- digital input
- pull up resistor
- composite input device
wire the rows and columns from the keypad
rows are input with pull up resistor
cols are outputs
scan out data by writing 0 and reading rows
- parallax rfid reader
- hook up out to rx pin on
- set baud rate to 2400 baud (or whatever works)
- start character followed by 10 digit tag in ascii
- enable reader low
- check if have have enough characters
- two potentiometers

https://www.adafruit.com/products/245
Footswitch

- switch for the foot

https://www.adafruit.com/products/423
coins are assigned number of pulses

https://www.adafruit.com/products/787
keeping track of time
- much more accurate than microcontroller
- battery backup
- I2C interface

https://www.adafruit.com/products/264
- read atomic clock measurement from satellite
- enable signal and looks like serial interface

https://www.adafruit.com/products/746
measuring weight or force
- measure weight

https://www.sparkfun.com/products/13879

https://www.sparkfun.com/products/13330
Basic JIT PCB out today due next Tuesday
Actuators
References

- Arduino Cookbook, Michael Margolis
- 30 Arduino Projects for the Evil Genius, by Simon Monk