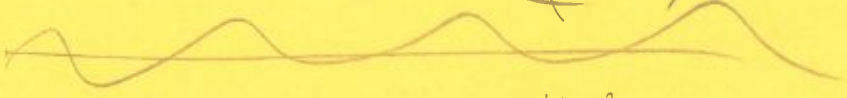
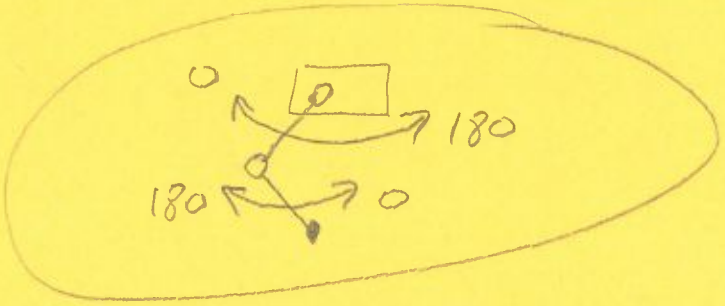
BOTH L & R



	HIP	KNEE
	0	0
	180	0
	0	180
	180	180
	90	90

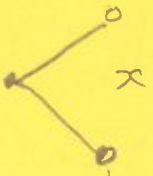


0 0

90 90

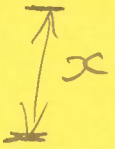
180 180

5/10



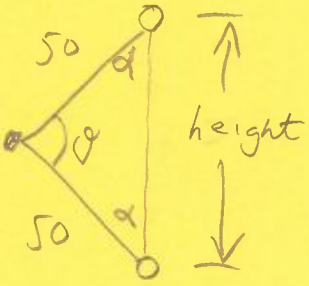
45/90

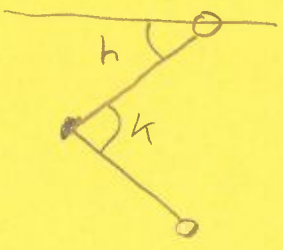
90/180



?

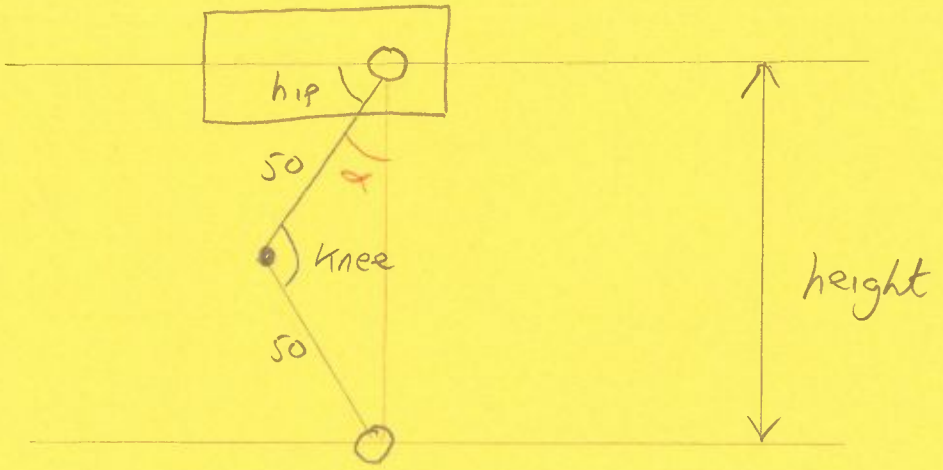
hip angle h

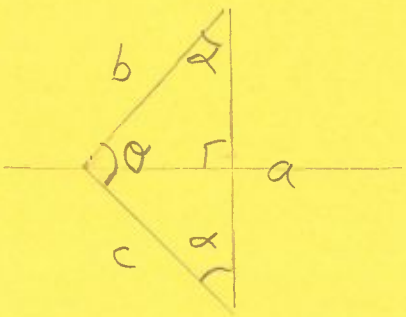




knee angle k

I





$$\theta = \cos^{-1}\left[(b^2 + c^2 - a^2)/2bc\right]$$

$$\alpha = \frac{180 - \theta}{2} = 90 - \frac{\theta}{2}$$

(II)

$$\text{knee} = \cos^{-1}\left[\left(50^2 + 50^2 - \text{height}^2\right) / 2 \times 50 \times 50\right]$$

$$= \cos^{-1}\left[\left(5000 - \text{height}^2\right) / 5000\right]$$

$$= \cos^{-1}\left[\frac{5000 - \text{height}^2}{5000}\right]$$

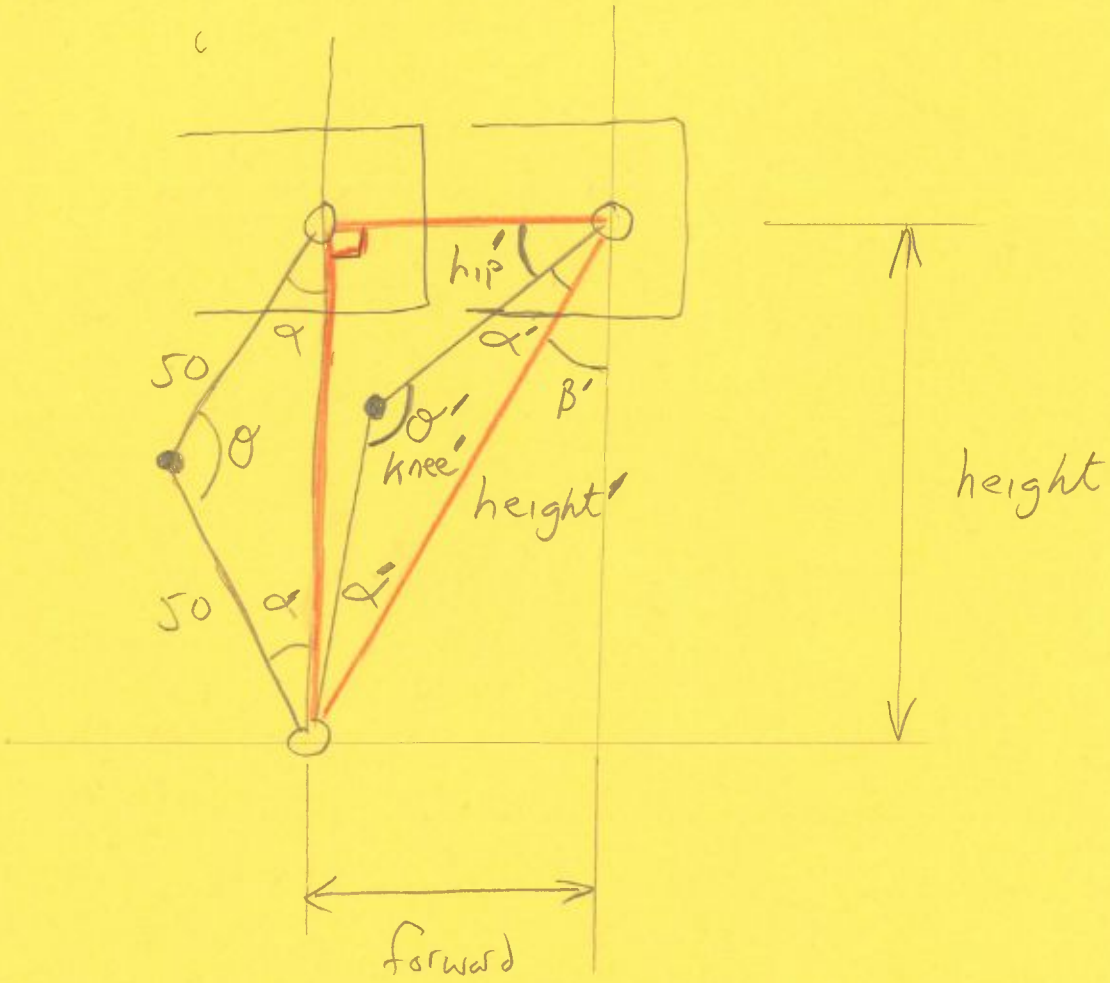
$$= \cos^{-1}\left[1 - \frac{\text{height}^2}{5000}\right]$$

$$\alpha = 90 - \frac{\text{knee}}{2}$$

$$\text{hip} = 90 - \alpha$$

$$= 90 - \left(90 - \frac{\text{knee}}{2}\right)$$

$$= + \frac{\text{knee}}{2}$$



$$height' = \sqrt{height^2 + forward^2}$$

$$knee' = \theta' = \cos^{-1}\left(1 - \frac{(height')^2}{5000}\right)$$

$$hip' = 90 - \alpha' - \beta'$$

RADIANS

$$\beta' = \tan^{-1}\left(\frac{forward}{height}\right)$$

$$\alpha' = \frac{180 - \theta'}{2}$$

$$= 90 - \frac{\theta'}{2}$$

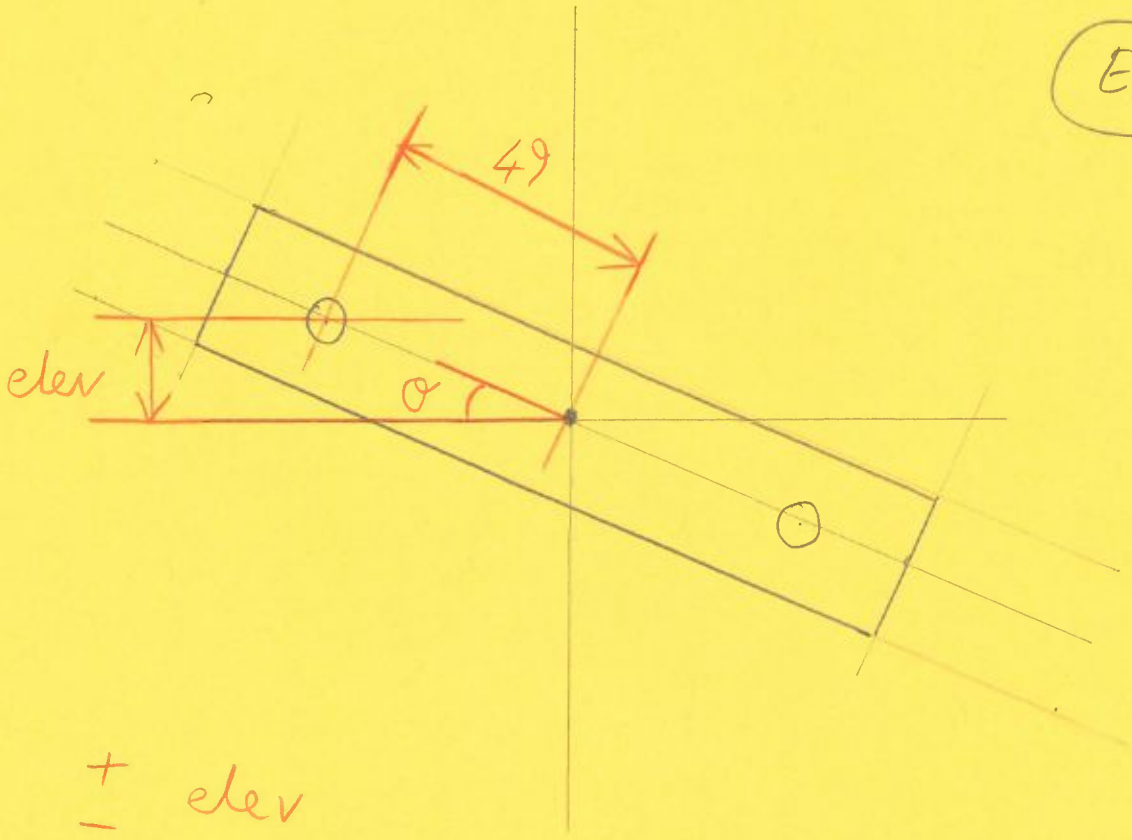
$$hip' = 90 - \alpha' - \beta'$$

$$= 90 - \left(90 - \frac{\theta'}{2}\right) - \tan^{-1}\left(\frac{\text{forward}}{\text{height}}\right)$$

$$hip' = \frac{knee'}{2} - \tan^{-1}\left(\frac{\text{forward}}{\text{height}}\right)$$

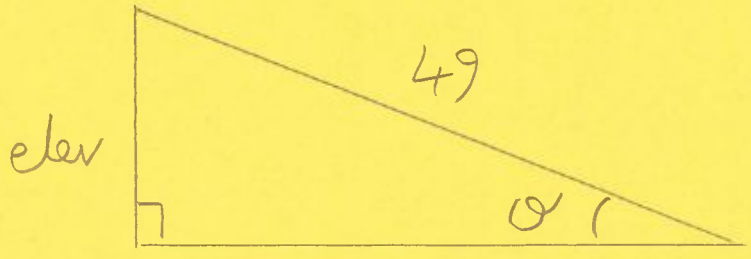
Automatically updated from #1

Elev



$\pm$ elev

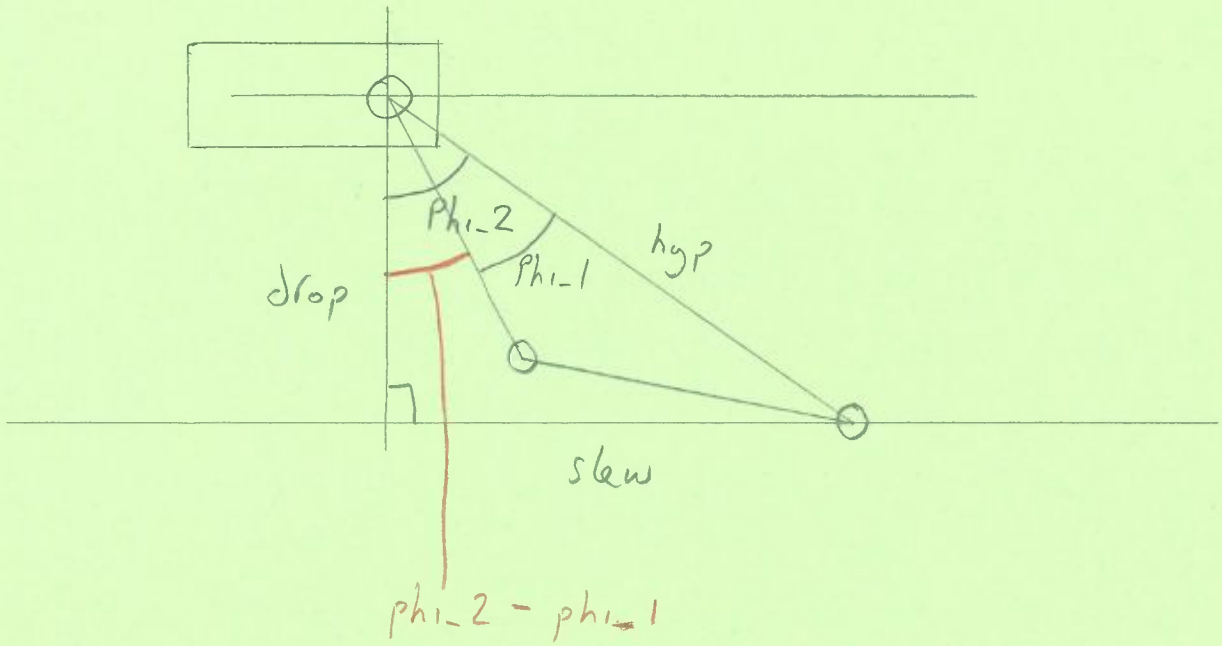
$\pm$ θ



$$\sin\theta = \frac{elev}{49}$$

$$\theta = \sin^{-1}\left(\frac{elev}{49}\right)$$

Inverse kinematics

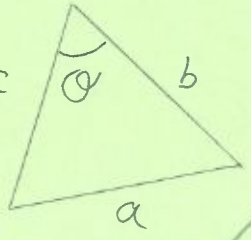


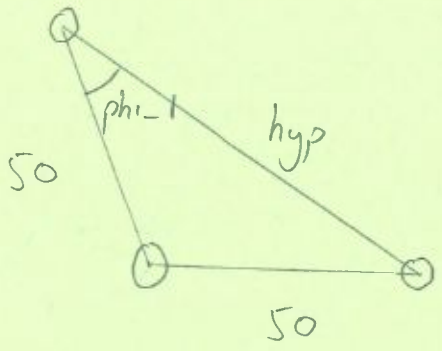
drop = height − required_height

$$hyp = \sqrt{skew^2 + drop^2}$$

Cosine Rule

$$\theta = \cos^{-1}\left[\frac{b^2 + c^2 - a^2}{2bc}\right]$$





$$phi\_1 = \cos^{-1}\left[\frac{hyp^2 + 50^2 - 50^2}{2 * hyp * 50}\right]$$

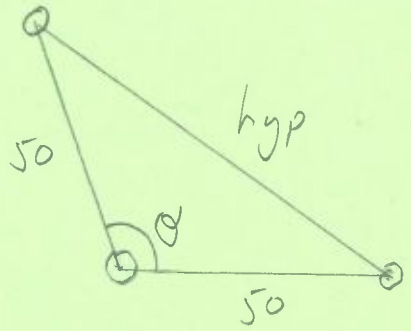
$$phi\_1 = \cos^{-1}\left[\frac{hyp^2}{100\ hyp}\right]$$

$$phy\_2 = \tan^{-1}\left[\frac{skew}{drop}\right]$$

$$hyp = 90 + (phi\_2 - phi\_1)$$

(C)

Cosine Rule again



$$Knee = Cos^{-1}\left[\frac{50^2 + 50^2 - hyp^2}{2 * 50 * 50}\right]$$

$$Knee = Cos^{-1}\left[\frac{5000 - hyp^2}{5000}\right]$$

$$Knee = Cos^{-1}\left[1 - \frac{hyp^2}{5000}\right]$$

one foot

3 ↑ 1

walk

2 4

two feet

↑ ↑

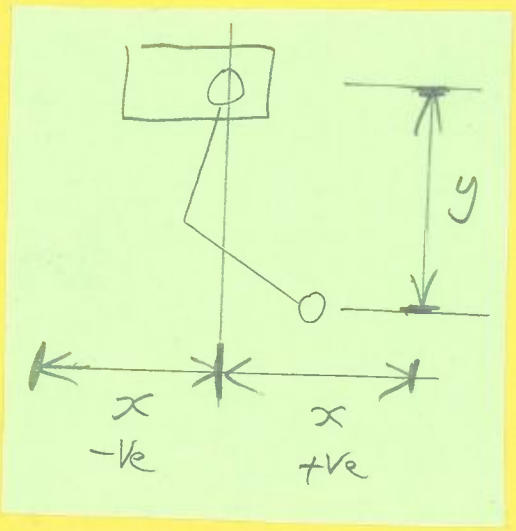
canter

three feet

trot

four feet

gallop



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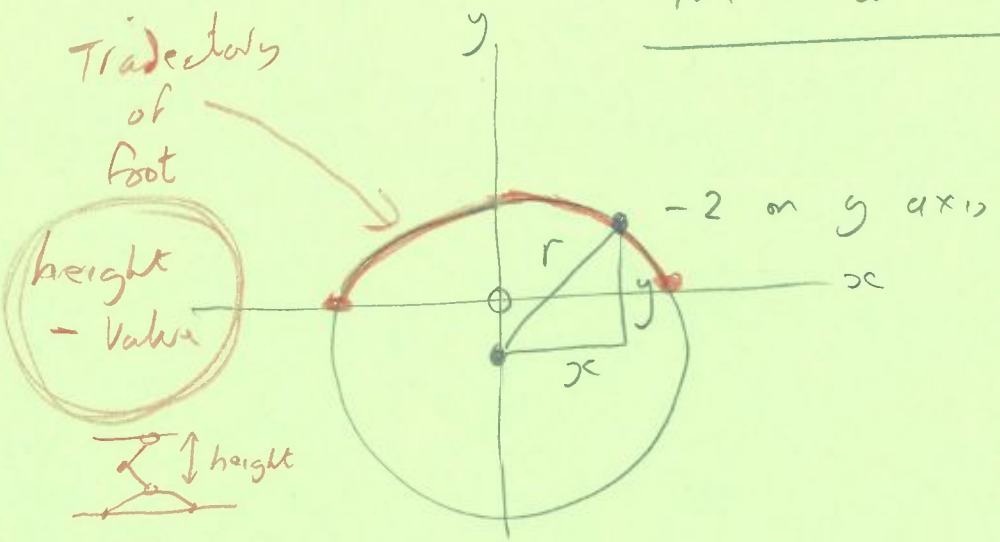
kinematics : set angle of servos →
: get to desired foot position

Inverse kinematics : set foot end coordinate →
: get angle servos require...

< MY CODE > Python

1k Gr Walk



circle.py

Grid Cattle

$$r^2 = x^2 + y^2$$

$$y^2 = r^2 - x^2$$

$$y = \sqrt{r^2 - x^2}$$

drop offset -105 mm

$$y = \left[\sqrt{(r^2 - x^2)}\right] - 105$$

r = 60 mm

If $x = \pm 40$: $y = 60.3$ mm

$x = \pm 20$: $y = 48.4$

$x = \pm 10$: $y = 45.8$

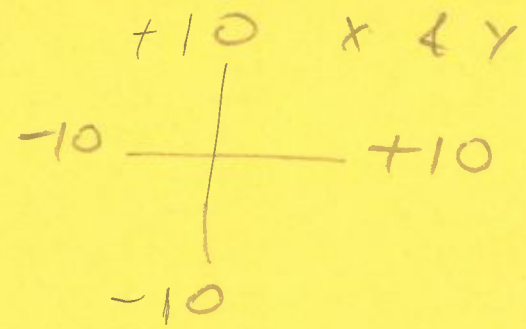
$x = 0$: $y = 45.0$

x -40 TO +40 mm

@ 1mm Intervals

X = Longitudinal
Y = Latitudinal

Gyro



Acc = ±10 G's X & Y

Gyro = Sudden Movement
IN REAL TIME
→ Great for Compliance
with Soft Rubber Legs

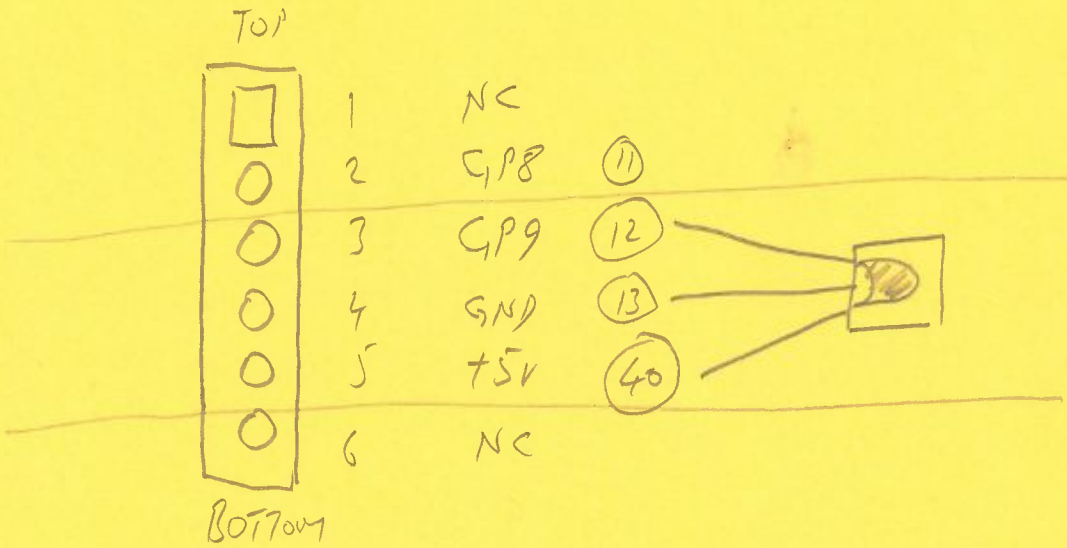
Mag = ?upside down?
COMPASS

So most of time only read (Acc)

IR

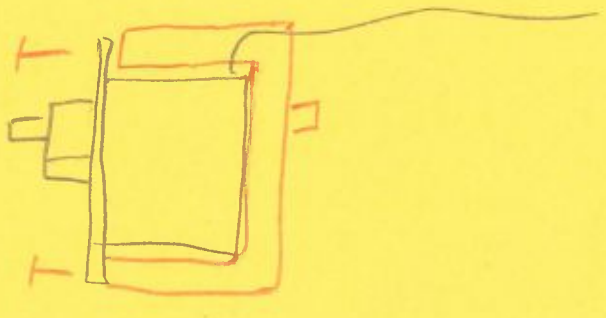
V38238

2.5V – 5.5V



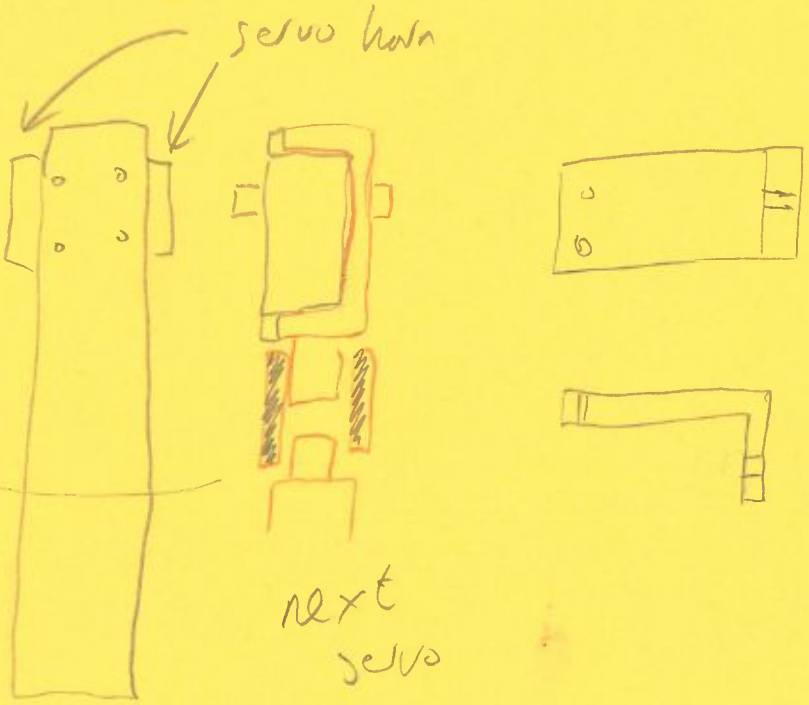
The PiHUT Sensor

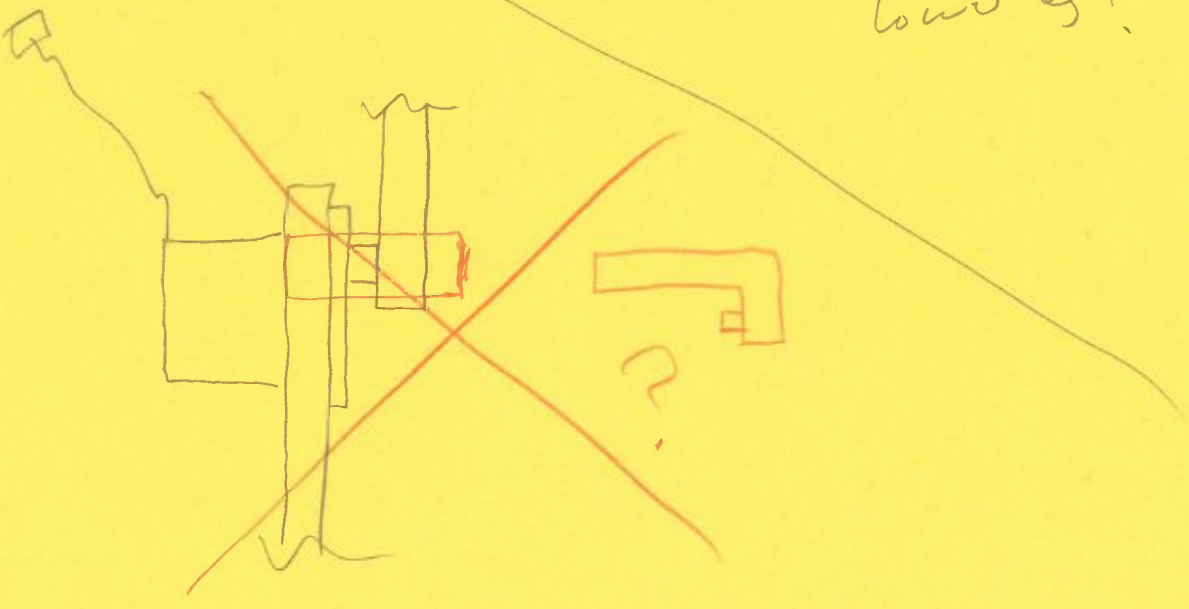
Robot Servo Cam MG90S :

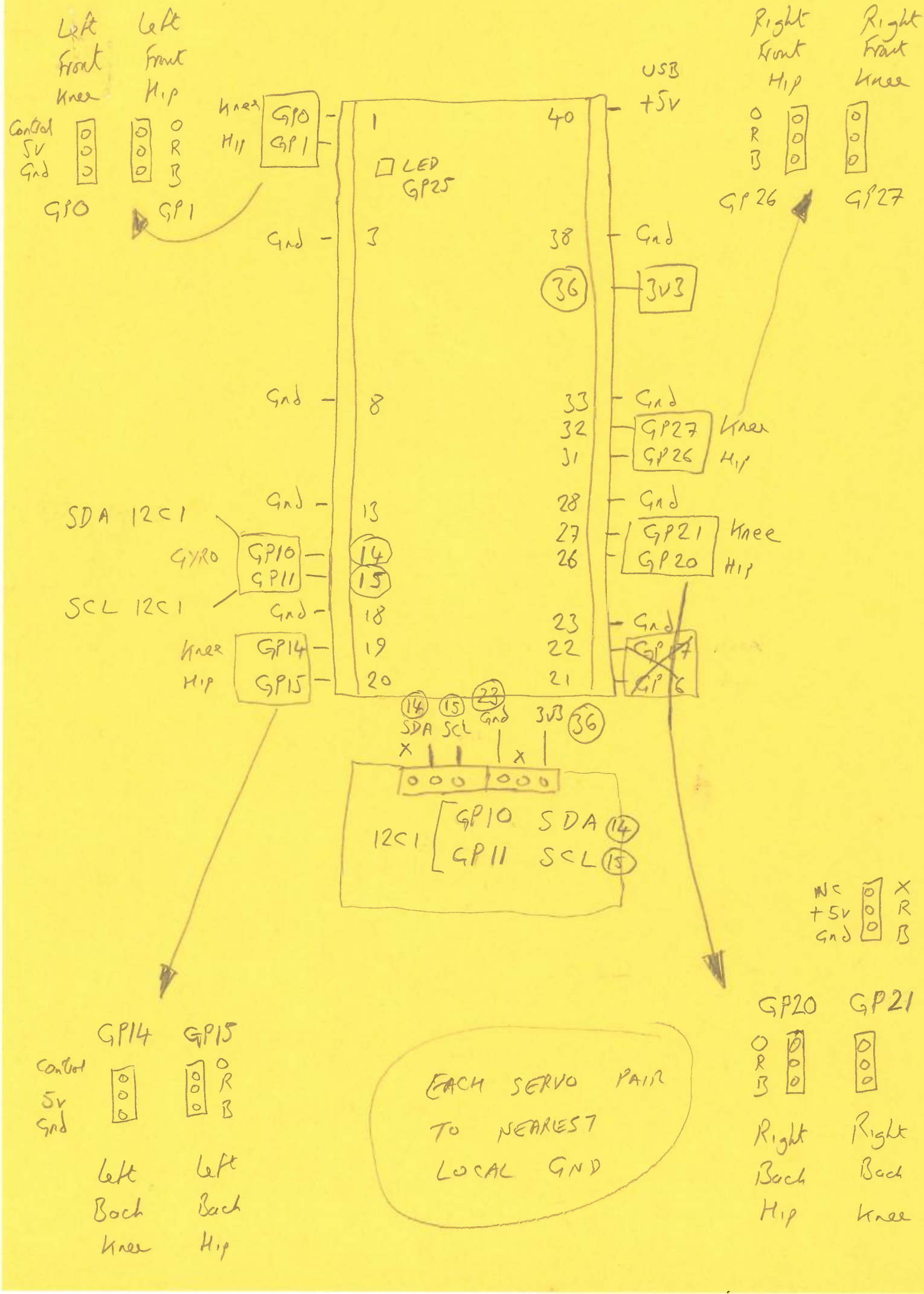


Overlapping Servo

Upper leg






Left Front Knee
Left Front Hip
Control
5V
Gnd
O
R
B
GP0
GP1
Right Front Hip
Right Front Knee
GP26
GP27
USB
+5V
Knee
Hip
GP0
GP1
LED
GP25
Gnd
3V3
SDA I2C1
GYRO
SCL I2C1
GP10
GP11
GP14
GP15
GP21
GP20
GP27
GP26
Knee
Hip
SDA
SCL
X
I2C1
GP10 SDA
GP11 SCL
NC
+5V
Gnd
GP14
GP15
GP20
GP21
Control
5V
Gnd
Left Back Knee
Left Back Hip
Right Back Hip
Right Back Knee
EACH SERVO PAIR TO NEAREST LOCAL GND

FL_knee FL_hip

FRONT

FR_hip FR_knee

GP0 knee

GP1 Hip

knee GP27

Hip GP26

LEFT

RIGHT

GP14 knee

GP15 Hip

knee GP ~~17~~ 21

Hip GP ~~16~~ 20

BL_knee BL_hip

BACK

BR_hip BR_knee

Gyro

I2C1

GP10 SDA

GP11 SCL
