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| MIXED  REALITY  ROBOTICS | Motors and Joints |

There are 14 motors located all over the Pleo. These motors give the robot the ability to walk, wag its tail and crane its neck. All of these motors have force feedback sensors, so they are able to detect the environment surrounding the Pleo.

All of the motors already exist in the Pleo and the robot comes pre-programmed with some natural movements that the Pleo does on its own in a natural environment. However, because the motors move wires in the robot in response to instructions from processors, it is also possible to program more complex and unique movements that utilize these motors.

Pleo’s motors allow the robot to generate purposeful actions which often relay emotion. These movements can be in response to touch or a stimulus. Alternatively, Pleos can be programmed to do movements without any trigger.



**Head**

This motor is at neutral position, when the Pleo is looking straight ahead. Otherwise, the robot can look 90 degrees up and 90 degrees down.

**Neck (Horizontal)**

The neutral position is straight forward. The neck can, also, move 65 degrees left and right.

**Tail (Vertical)**

Neutral position is straight back. Otherwise, the tail can move 90 degrees up and 90 degrees down.

**Tail (Horizontal)**

Neutral position is straight back. Otherwise the tail can move 90 left and 90 degrees right.

**Neck (Vertical)**

This motor is at neutral position, when the Pleo is looking straight ahead. The neck can, also, move 75 degrees up or down.



**Elbows (2)**

Straight is the neutral position for this motor. The elbow motor can only move 30 degrees forward from the neutral state.

**Shoulders (2)**

Straight is the neutral position for this motor. It can also move 55 degrees forward from the neutral and state and 20 degrees backwards.



**Knee (2)**

The neutral state for this motor is straight down. The motor can also rotate 50 degrees backwards from the neutral state.

**Torso**

The neutral position is straight forward. The motor can move 35 degrees left and right.

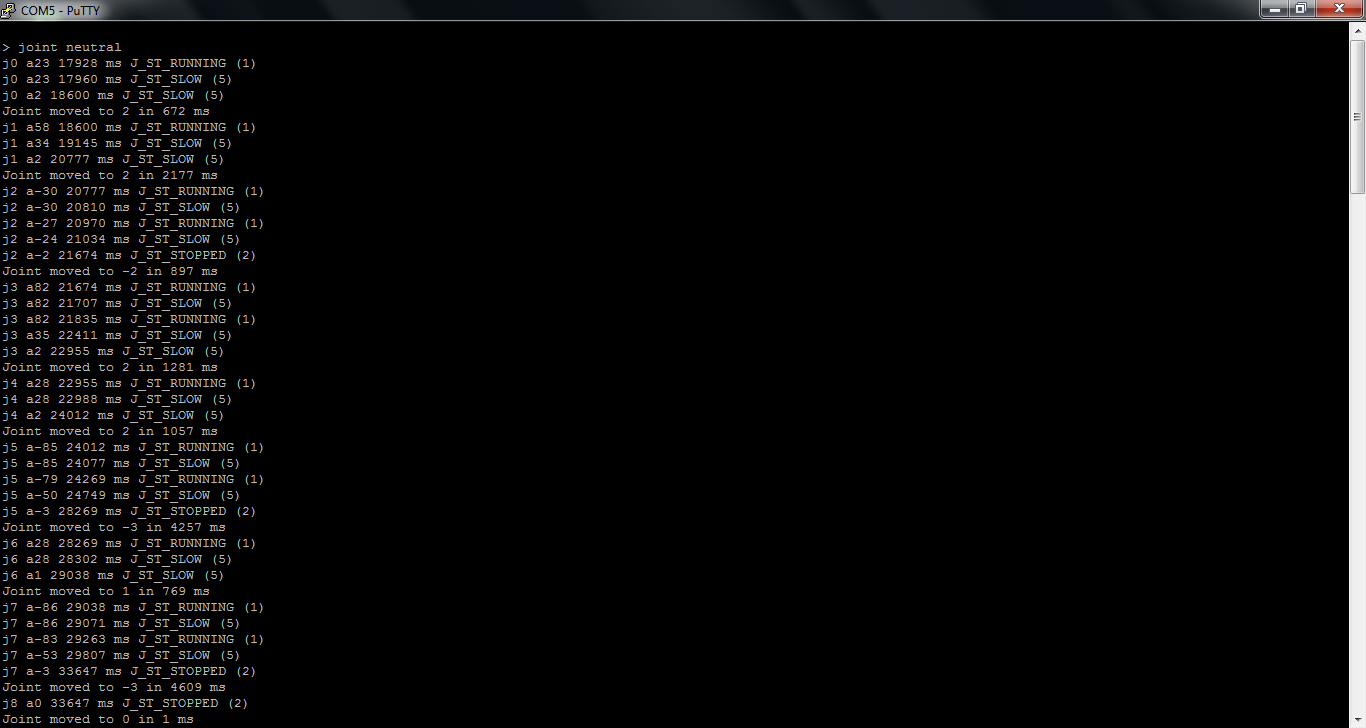
**Hips (2)**

The neutral state for this motor type is straight down. The motor can, alos, move 45 degrees forwards and backwards.

**Terminal Command**: in order to control the movements of Pleo enter:

***help joint***

This command will give access to more ways of commanding the Pleo. For example, if **joint neutral** is entered into the terminal, the Pleo will move all of its joints to neutral position. The terminal will return the progress of each joint during the process of returning to neutral position.



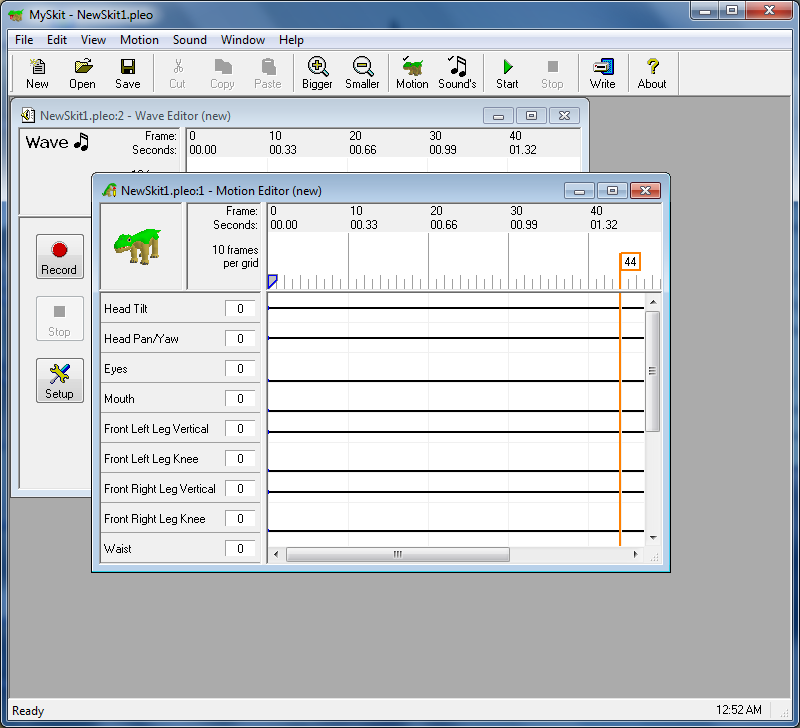
**Relevant Sensor**: SENSOR\_TILT  
This sensor detects the orientation of Pleo’s torso in three spaces and is triggered when the title sensor moves into a new position. The sensor can return these values…

TILT\_NONE = 0 (no orientation known)  
TILT\_ON\_FEET = 1 (feet are oriented downwards with respect to torso)  
TILT\_LEFT\_SIDE = 2 (on left side)  
TILT\_RIGHT\_SIDE = 3 (on right side)  
TILT\_ON\_NOSE = 4 (front of torso is pointed downwards)  
TILT\_ON\_TAIL = 5 (aft-end of torso is pointed upwards)  
TILT\_ON\_BACK = 6 (feet are pointed upwards with respect to torso)

**Relevant Sensor**: SENSOR\_SHAKE  
This sensor is used to detect if the Pleo is being shaken, like, for example, when it is being woken up. The value of this sensor can be between 0 and 255. The sensor triggers when the shake frequency goes from below 75 to above 150.

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Another easy way to control and create new movements for the Pleo is through a program called *MySkit*. This is very easy to use, and is basically a GUI that lets you set a routine of sound and movement for the Pleo. You then “compile” your skit and upload it to a SD card which you plug into the Pleo. When starting up, the Pleo first checks the SD card for any programs before it boots into normal routines.



Motions can be activated by connecting to Pleo via a terminal and typing the following command:

***motion play (Motion number)***

So, for example, the code for walk forward is 8330. To make Pleo walk forward, enter “**motion play 8330**” into the terminal and the robot will walk forward. For a list of all available motions, type the command “**motion show**”.

Emotions that Pleo Motions evoke:

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| **Happy** | **Sad** | Tired |
| motion ID 8320 = com\_tail\_wag  motion ID 8321 = com\_tail\_wag\_v2  motion ID 8322 = com\_tilt\_back\_tickle\_la  motion ID 8323 = com\_tilt\_back\_tickle\_ll  motion ID 8324 = com\_tilt\_back\_tickle\_ra  motion ID 8325 = com\_tilt\_back\_tickle\_rl  motion ID 8343 = emo\_act\_happy\_v1  motion ID 8344 = emo\_act\_happy\_v2  motion ID 8407 = happy\_honk  motion ID 8354 = emo\_fidget\_happy\_v1  motion ID 8355 = emo\_fidget\_happy\_v2 | motion ID 8467 = soc\_abuse\_whimper  motion ID 8345 = emo\_act\_sad\_v1  motion ID 8346 = emo\_act\_sad\_v2  motion ID 8393 = fat\_nap\_fidget\_pain  motion ID 8394 = fat\_nap\_fidget\_sad  motion ID 8395 = fat\_nap\_fidget\_scared  motion ID 8264 = com\_disappointed\_v1  motion ID 8265 = com\_disappointed\_v2  motion ID 8266 = com\_fallen\_l\_breath\_v1  motion ID 8267 = com\_fallen\_l\_breath\_v2  motion ID 8268 = com\_fallen\_tilt\_l\_in  motion ID 8269 = com\_fallen\_tilt\_l\_loop\_v1  motion ID 8270 = com\_fallen\_tilt\_l\_loop\_v2  motion ID 8271 = com\_fallen\_tilt\_l\_sleep  motion ID 8272 = com\_fallen\_tilt\_r\_in  motion ID 8273 = com\_fallen\_tilt\_r\_loop\_v1  motion ID 8274 = com\_fallen\_tilt\_r\_loop\_v2  motion ID 8275 = com\_fallen\_tilt\_r\_sleep  motion ID 8356 = emo\_fidget\_pain\_v1  motion ID 8357 = emo\_fidget\_sad\_v1  motion ID 8358 = emo\_fidget\_scared\_v1  motion ID 8347 = emo\_act\_scared\_v1  motion ID 8348 = emo\_act\_scared\_v2 | motion ID 8482 = soc\_rest\_fidget\_v1  motion ID 8483 = soc\_rest\_fidget\_v2  motion ID 8484 = soc\_rest\_fidget\_v3  motion ID 8485 = soc\_rest\_fidget\_v4  motion ID 8486 = soc\_rest\_laydown  motion ID 8487 = soc\_rest\_listen  motion ID 8488 = soc\_rest\_pant  motion ID 8489 = soc\_rest\_pant\_v1  motion ID 8490 = soc\_rest\_pose\_v1  motion ID 8491 = soc\_rest\_rxn\_head  motion ID 8492 = soc\_rest\_rxn\_tail  motion ID 8493 = soc\_rest\_sniff  motion ID 8566 = yawn\_3  motion ID 8396 = fat\_nap\_fidget\_sniff  motion ID 8397 = fat\_nap\_fidget\_sound  motion ID 8398 = fat\_nap\_fidget\_v1  motion ID 8399 = fat\_nap\_fidget\_v2  motion ID 8400 = fat\_nap\_getup  motion ID 8401 = fat\_nap\_getup\_v2  motion ID 8402 = fat\_nap\_getup\_v3  motion ID 8403 = fat\_nap\_lay\_down  motion ID 8404 = fat\_sleep\_lay  motion ID 8405 = fat\_tired  motion ID 8406 = fat\_yawn |
| **Angry** | **Hungry** | Miscellaneous |
| motion ID 8337 = emo\_act\_angry\_v1  motion ID 8338 = emo\_act\_angry\_v2  motion ID 8350 = emo\_fidget\_angry\_v1  motion ID 8351 = emo\_fidget\_angry\_v2  motion ID 8462 = picked\_up\_shake  motion ID 8463 = picked\_up\_squirming  motion ID 8464 = singing\_howling  motion ID 8465 = soc\_abuse\_head\_chin  motion ID 8466 = soc\_abuse\_rxn  motion ID 8565 = upside\_down  motion ID 8388 = fat\_nap\_fidget\_angry  motion ID 8364 = exp\_object\_react\_growl | motion ID 8412 = hun\_baby\_bird\_feeding  motion ID 8413 = hun\_beg  motion ID 8414 = hun\_bite\_s  motion ID 8415 = hun\_chew\_drop  motion ID 8416 = hun\_chew\_drop\_stuck  motion ID 8417 = hun\_chew\_fast  motion ID 8418 = hun\_chew\_slow  motion ID 8419 = hun\_chew\_v1  motion ID 8420 = hun\_dropped\_sniff  motion ID 8421 = hun\_exit  motion ID 8422 = hun\_expecting  motion ID 8423 = hun\_fidget\_scratch\_left  motion ID 8424 = hun\_graze\_big\_bites  motion ID 8425 = hun\_graze\_drink  motion ID 8426 = hun\_graze\_ripping  motion ID 8427 = hun\_graze\_stand  motion ID 8428 = hun\_graze\_v1  motion ID 8429 = hun\_graze\_v2  motion ID 8430 = hun\_graze\_v3  motion ID 8431 = hun\_happy\_graze  motion ID 8432 = hun\_happy\_honk  motion ID 8433 = hun\_hatch\_bird  motion ID 8434 = hun\_hatch\_bird\_whimper  motion ID 8435 = hun\_hatch\_cry\_down  motion ID 8436 = hun\_hatch\_cry\_inward  motion ID 8437 = hun\_hatch\_cry\_up  motion ID 8438 = hun\_hatch\_tantrum\_A  motion ID 8439 = hun\_hatch\_tantrum\_B  motion ID 8440 = hun\_lip\_smack  motion ID 8441 = hun\_moo  motion ID 8442 = hun\_paw\_ground\_l  motion ID 8443 = hun\_paw\_ground\_r  motion ID 8444 = hun\_rxn\_back  motion ID 8445 = hun\_rxn\_chin  motion ID 8446 = hun\_rxn\_head  motion ID 8447 = hun\_rxn\_la  motion ID 8448 = hun\_rxn\_ra  motion ID 8449 = hun\_search  motion ID 8450 = hun\_sniff\_l  motion ID 8451 = hun\_sniff\_r  motion ID 8452 = hun\_sniff\_s  motion ID 8453 = hun\_sniff\_stand\_ground  motion ID 8454 = hun\_sniff\_walk\_air  motion ID 8455 = hun\_stand  motion ID 8456 = hun\_stand\_chewing\_cud  motion ID 8457 = hun\_stand\_looking  motion ID 8458 = hun\_stand\_sniff\_ground  motion ID 8459 = hun\_tantrum\_for\_food  motion ID 8460 = hun\_tummy\_rumble  motion ID 8461 = hungry\_cry | motion ID 8349 = emo\_fidget\_affect\_v1  motion ID 8352 = emo\_fidget\_bored\_v1  motion ID 8353 = emo\_fidget\_curious\_v1  motion ID 8359 = exp\_in  motion ID 8360 = exp\_object\_gone  motion ID 8361 = exp\_object\_react\_bark  motion ID 8362 = exp\_object\_react\_bite  motion ID 8363 = exp\_object\_react\_curious  motion ID 8339 = emo\_act\_bored\_v1  motion ID 8340 = emo\_act\_bored\_v2  motion ID 8341 = emo\_act\_curious\_v1  motion ID 8342 = emo\_act\_curious\_v2  motion ID 8408 = hatch\_coax\_walk1  motion ID 8409 = hatch\_coax\_walk2  motion ID 8410 = hatch\_reward  motion ID 8411 = hiccup  motion ID 8276 = com\_fidget\_cough  motion ID 8277 = com\_fidget\_sneeze  motion ID 8278 = com\_hatch\_twitchy\_stand  motion ID 8279 = com\_head\_held\_v1  motion ID 8280 = com\_hello\_bark\_lg  motion ID 8281 = com\_hello\_bark\_sm  motion ID 8282 = com\_hello\_howl  motion ID 8283 = com\_hello\_playfight  motion ID 8284 = com\_holding\_fidget\_l\_v1  motion ID 8285 = com\_holding\_fidget\_l\_v2  motion ID 8290 = com\_holding\_l  motion ID 8291 = com\_holding\_pre\_l  motion ID 8292 = com\_holding\_r  motion ID 8293 = com\_light\_off\_v1  motion ID 8294 = com\_light\_on\_v1  motion ID 8295 = com\_listen\_s  motion ID 8296 = com\_obj\_detect\_l  motion ID 8297 = com\_obj\_detect\_r  motion ID 8298 = com\_obj\_detect\_s  motion ID 8299 = com\_puke  motion ID 8300 = com\_rxn\_buck  motion ID 8301 = com\_rxn\_buttup  motion ID 8302 = com\_rxn\_dizzy  motion ID 8303 = com\_rxn\_howl  motion ID 8304 = com\_rxn\_lite\_off  motion ID 8305 = com\_rxn\_lite\_on  motion ID 8306 = com\_rxn\_tickle  motion ID 8307 = com\_shat  motion ID 8308 = com\_sit  motion ID 8309 = com\_sneeze\_v1  motion ID 8314 = com\_sniff\_neutral\_l\_v2  motion ID 8318 = com\_tail\_held\_v1  motion ID 8319 = com\_tail\_held\_v2  (and many more… ) |