Avances PCE: Robot To

Camilo Valencia

01. Robot To

Estado del arte y predecesores

02. El problema

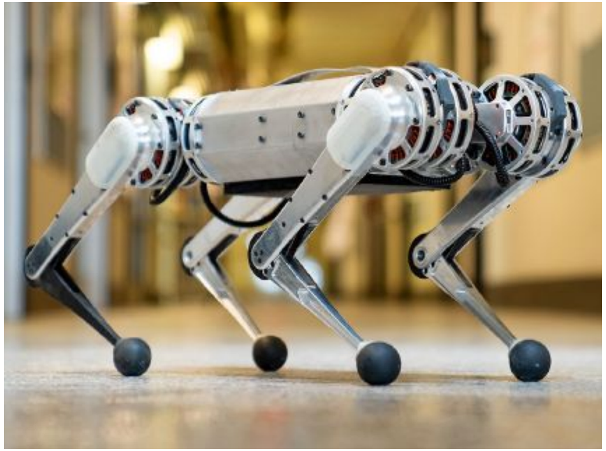
Control de miembro anterior en robot cuadúpedo

03. Avances

Paquetes existentes

Configuración del driver Mini Cheetah

Robot To



[1]

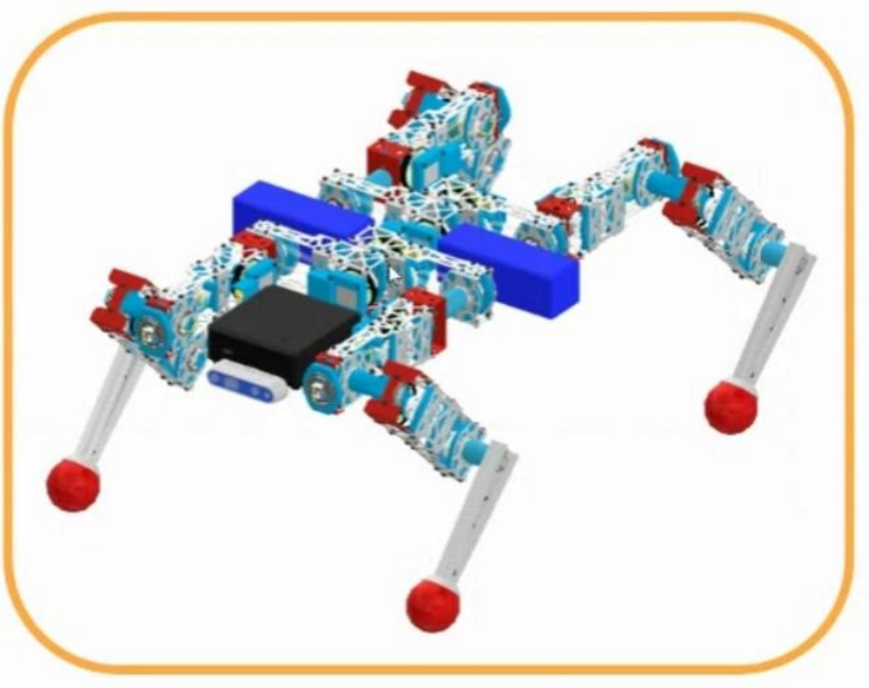
Mini Cheetah. MIT. Primer cuadrúpedo “académico” en realizar un salto mortal

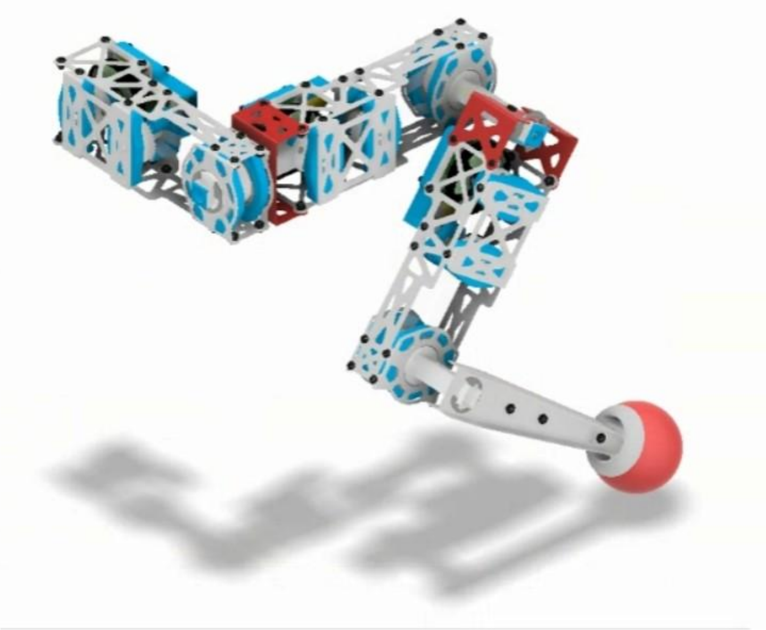
[2]

Solo 12. Open Source. Colaboración de múltiples grupos investigativos:
Max Planck Institute for Intelligent Systems (Alemania)
New York University, Tandon School of Engineering (E.E.U.U)
LAAS CNRS (Francia)

01

Robot To



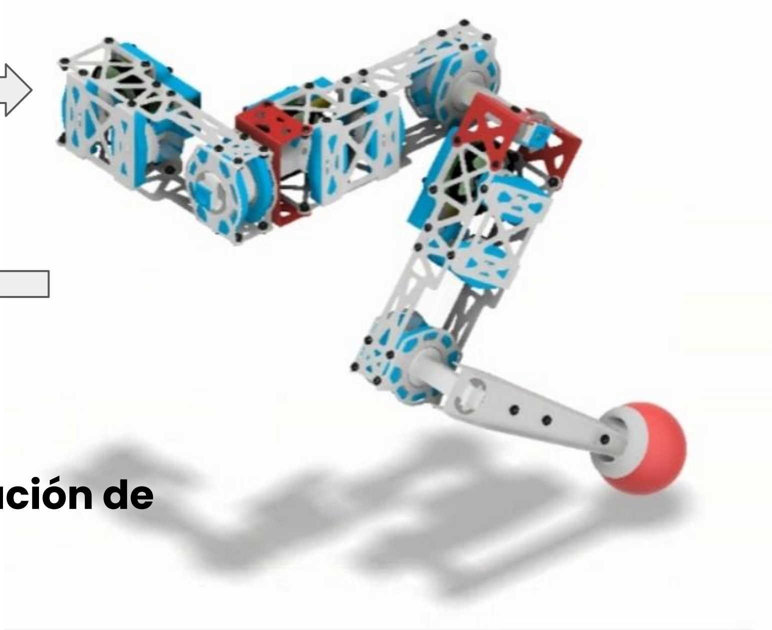


Créditos Modelo CAD: Juan Sebastian Santacoloma Barrera

El Problema

Actuación

?????????



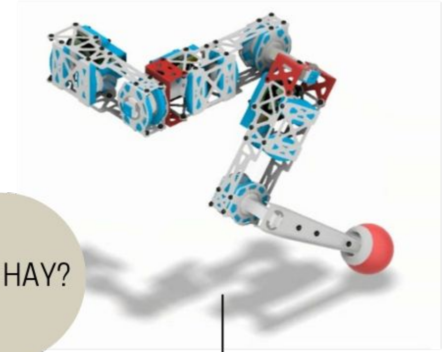
No hay retroalimentación de posición!

Créditos:
Modelo CAD: Juan Sebastian Santacoloma Barrera
Motor: https://build-its-inprogress.blogspot.com/2018/02/small-motor-controller-with-integrated.html

02

El Problema

Control de posición de un miembro anterior del robot To



MIEMBRO ANTERIOR

- ¿QUÉ HAY?
  - MOTORES, DRIVERS
  - CABLEADO
  - ESTRUCTURA
- PROBLEMA
  - **ES NECESARIO CERRAR EL LAZO DE CONTROL**
  - NO HAY UN CONTROLADOR DEFINIDO
  - ES NECESARIO CREAR UN MODELO DE IK PARA SIMULACIONES
- ¿QUÉ FALTA?
  - MODELO CINEMÁTICO INVERSO (IK)
  - REVISAR FIRMWARE DE LOS DRIVERS PARA COMPROBAR EL SENSOR DE EFECTO HALL
  - IMPLEMENTAR EL ALGORITMO DE CONTROL
- REQUISITOS
  - UTILIZAR LA PLATAFORMA EXISTENTE
  - EVITAR MOVIMIENTOS DAÑINOS
  - ALCANZAR LAS POSICIONES DESEADAS DE FORMA MANUAL

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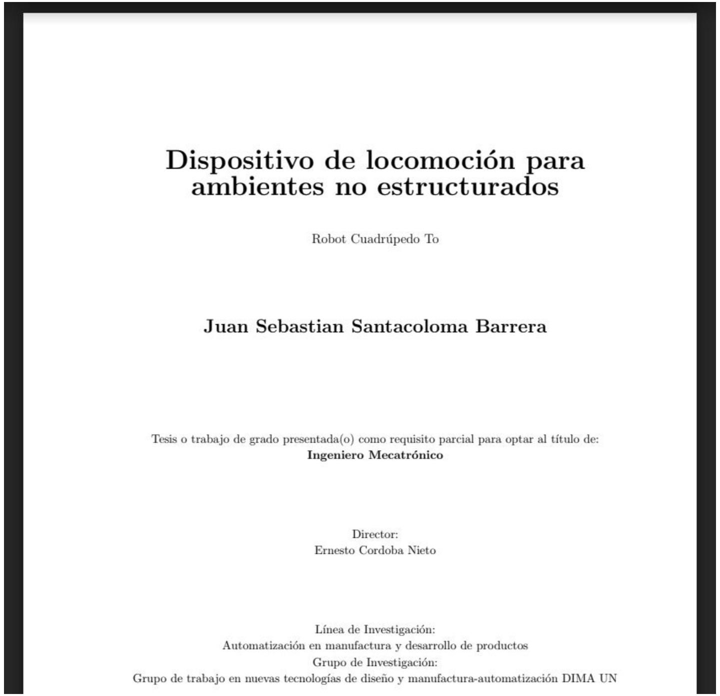
Automatización de Procesos de Manufactura

03

Avances

[4]



Dispositivo de locomoción para ambientes no estructurados

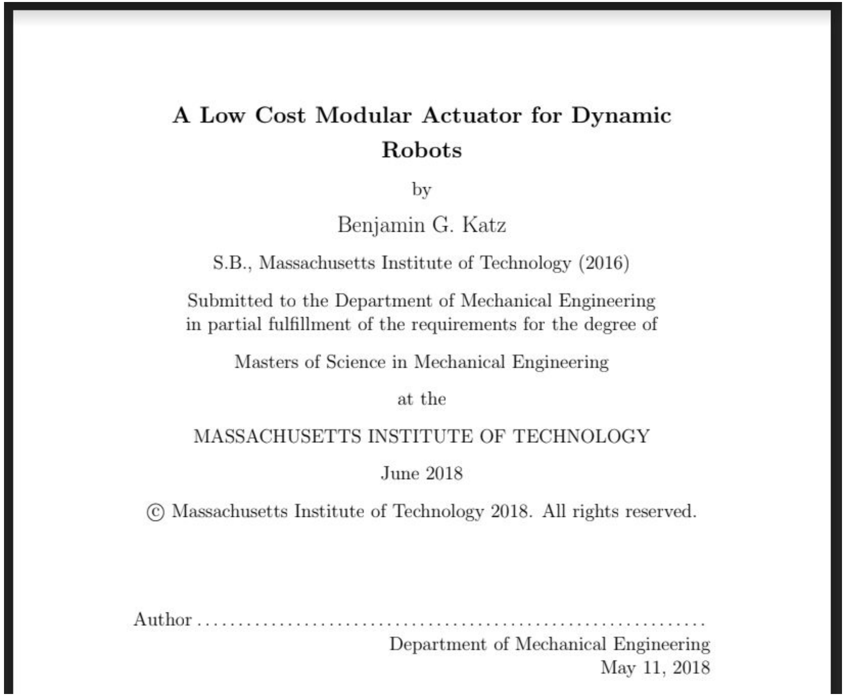
Robot Cuadrúpedo To

Juan Sebastian Santacoloma Barrera

Tesis o trabajo de grado presentada(o) como requisito parcial para optar al título de:
Ingeniero Mecatrónico

Director:
Ernesto Cordoba Nieto

Línea de Investigación:
Automatización en manufactura y desarrollo de productos
Grupo de Investigación:
Grupo de trabajo en nuevas tecnologías de diseño y manufactura-automatización DIMA UN



A Low Cost Modular Actuator for Dynamic Robots

by

Benjamin G. Katz

S.B., Massachusetts Institute of Technology (2016)

Submitted to the Department of Mechanical Engineering
in partial fulfillment of the requirements for the degree of

Masters of Science in Mechanical Engineering

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

June 2018

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Author ....
Department of Mechanical Engineering
May 11, 2018

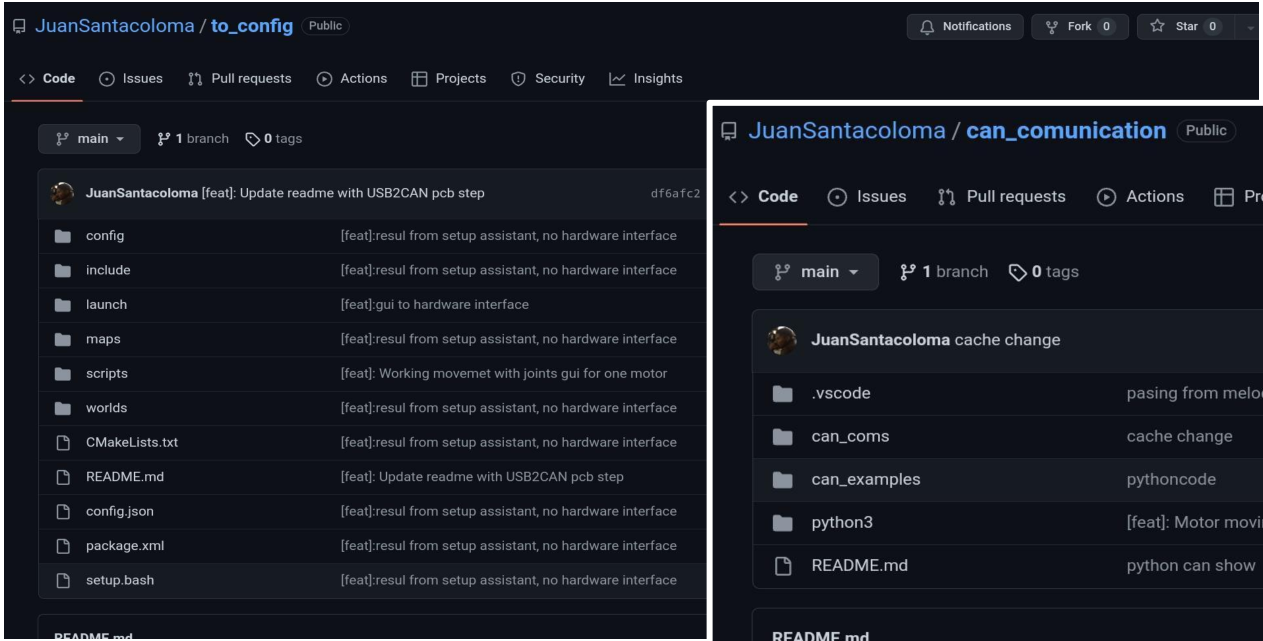
[3]

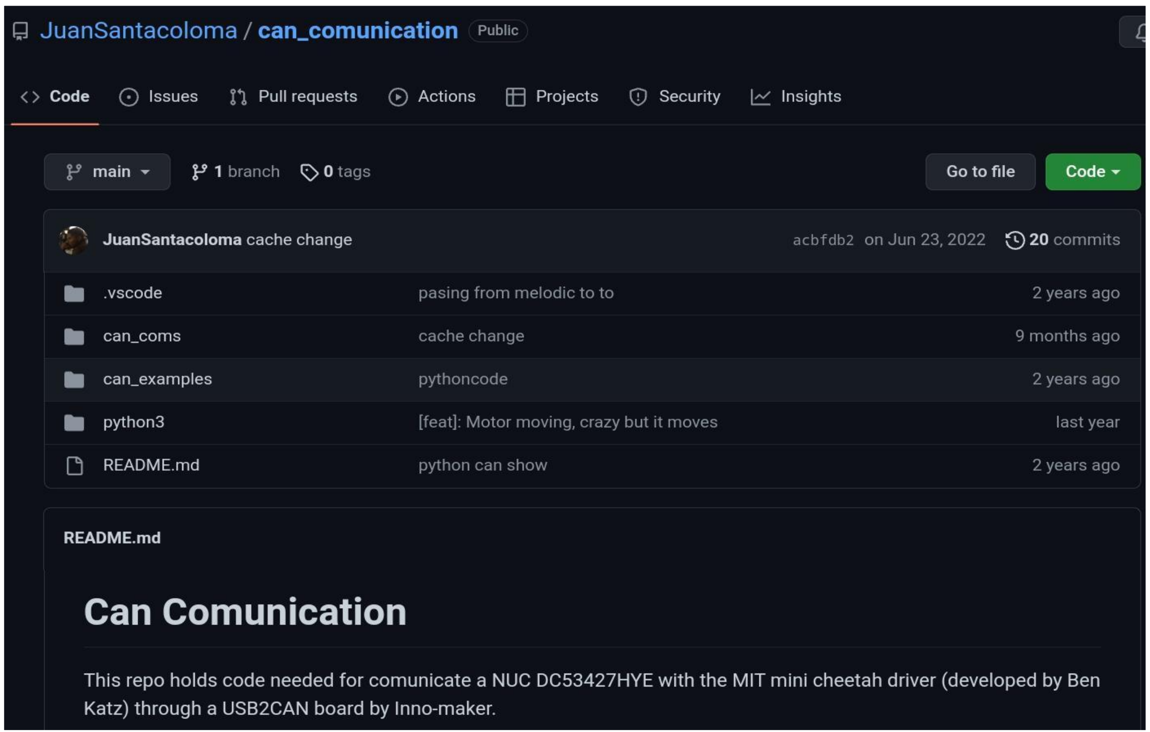
Entendimiento del robot To

Entendimiento de los drivers Mini cheetah empleados

03

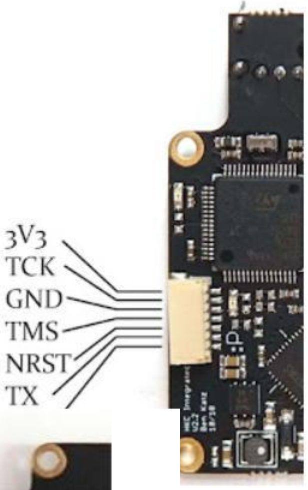
Paquetes existentes

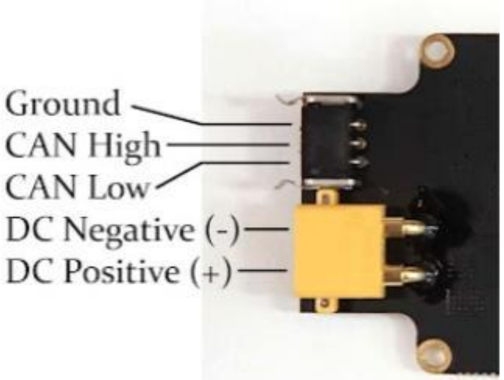




03

Drivers



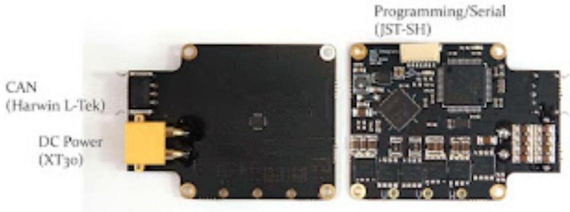


tation

Ben Katz
Motor Drive Documentation
6/29/2019
Last updated 4/15/2021

Connectors

The motor drive has two connectors which will be used during normal operation: An XT30 connector for power, and a Harwin Datamate L-Tek High-reliability connector for CAN bus communication. On the top side of the board, there is a JST-SH connector which contains the programming pins and a serial port which can be used for configuring the drive.



The part number for the CAN connector is M80-8420342. The mating connector is a M80-8990305. You can buy pre-crimped leads for the mating connector, which are part number M80-9110099.

The pinouts of the CAN and XT30 connectors are shown in the image below. The XT30 pinout is standard and should match the markings molded into any mating XT30 connector.

Drivers

Ben Katz / Mbed 2 deprecated MotorModuleExample

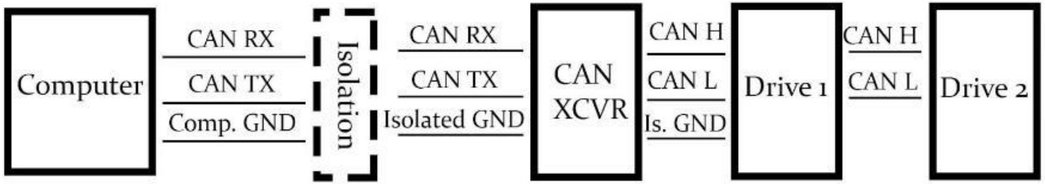
MotorModule CAN example

Dependencies: mbed

Home | History | Graph | API Documentation | Wiki | Pull Requests

main.cpp

Committer:	benkatz
Date:	2019-08-08
Revision:	4:0ce97b9fde37
Parent:	3:f0d054d896f9



File content as of revision 4:0ce97b9fde37:

```
#define CAN_ID 0x0

#include "mbed.h"
#include "math_ops.h"
#include "MotorModule.h"


Serial      pc(PA_2, PA_3);                  // Serial port to the computer
CAN         can(PB_8, PB_9, 1000000);        // CAN Rx pin name, CAN Tx pin name
```

Drivers

```
COM7 - Tera Term VT
File  Edit  Setup  Control  Window  Help

HobbyKing Cheetah

Debug Info:
Firmware Version: 1.9
ADC1 Offset: 1937    ADC2 Offset: 1943
Position Sensor Electrical Offset:   0.0000
Output Zero Position:  0.0000
CAN ID:  1


Commands:
m - Motor Mode
c - Calibrate Encoder
s - Setup
e - Display Encoder
z - Set Zero Position
esc - Exit to Menu

FAULT
UDS_OCP
GDF
UULO
OTSD
UDS_HA
UDS_LA
UDS_HB
UDS_LB
UDS_HC
UDS_LC
```

```
COM7 - Tera Term VT
File  Edit  Setup  Control  Window  Help

Configuration Options

prefix parameter                          min    max     current value

b      Current Bandwidth (Hz)             100    2000    1000.0
i      CAN ID                             0      127     1
m      CAN Master ID                      0      127     0
l      Current Limit (A)                  0.0    40.0    40.0
f      FW Current Limit (A)               0.0    33.0    0.0
t      CAN Timeout (cycles)(0 = none)     0      100000  0

To change a value, type 'prefix''value''ENTER'
i.e. 'b1000''ENTER'
```

```
/// CAN Reply Packet Structure ///
/// 16 bit position, between -4*pi and 4*pi
/// 12 bit velocity, between -30 and + 30 rad/s
/// 12 bit current, between -40 and 40;
/// CAN Packet is 5 8-bit words
/// Formatted as follows.  For each quantity, bit 0 is LSB
/// 0: [position[15-8]]
/// 1: [position[7-0]]
/// 2: [velocity[11-4]]
/// 3: [velocity[3-0], current[11-8]]
/// 4: [current[7-0]]
void pack_reply(CANMessage *msg, float p, float v, float t){
    int p_int = float_to_uint(p, P_MIN, P_MAX, 16);
    int v_int = float_to_uint(v, V_MIN, V_MAX, 12);
    int t_int = float_to_uint(t, -T_MAX, T_MAX, 12);
    msg->data[0] = CAN_ID;
    msg->data[1] = p_int>>8;
    msg->data[2] = p_int&0xFF;
    msg->data[3] = v_int>>4;
    msg->data[4] = ((v_int&0xF)<<4) + (t_int>>8);
    msg->data[5] = t_int&0xFF;
    }

/// CAN Command Packet Structure ///
/// 16 bit position command, between -4*pi and 4*pi
/// 12 bit velocity command, between -30 and + 30 rad/s
/// 12 bit kp, between 0 and 500 N-m/rad
/// 12 bit kd, between 0 and 100 N-m*s/rad
/// 12 bit feed forward torque, between -18 and 18 N-m
/// CAN Packet is 8 8-bit words
/// Formatted as follows.  For each quantity, bit 0 is LSB
/// 0: [position[15-8]]
/// 1: [position[7-0]]
/// 2: [velocity[11-4]]
/// 3: [velocity[3-0], kp[11-8]]
/// 4: [kp[7-0]]
/// 5: [kd[11-4]]
/// 6: [kd[3-0], torque[11-8]]
/// 7: [torque[7-0]]
void unpack_cmd(CANMessage msg, ControllerStruct * controller){
        int p_int = (msg.data[0]<<8)|msg.data[1];
        int v_int = (msg.data[2]<<4)|(msg.data[3]>>4);
        int kp_int = ((msg.data[3]&0xF)<<8)|msg.data[4];
        int kd_int = (msg.data[5]<<4)|(msg.data[6]>>4);
        int t_int = ((msg.data[6]&0xF)<<8)|msg.data[7];

        controller->p_des = uint_to_float(p_int, P_MIN, P_MAX, 16);
        controller->v_des = uint_to_float(v_int, V_MIN, V_MAX, 12);
        controller->kp = uint_to_float(kp_int, KP_MIN, KP_MAX, 12);
        controller->kd = uint_to_float(kd_int, KD_MIN, KD_MAX, 12);
        controller->t_ff = uint_to_float(t_int, T_MIN, T_MAX, 12);
    //printf("Received   ");
```

Referencias

[1] J. Chu, “Mini cheetah is the first four-legged robot to do a backflip.” [Online] Disponible en: https://news.mit.edu/2019/mit-mini-cheetah-first-four-legged-robot-to-backflip-0304

[2] Grimminger, F., Meduri, A., Khadiv, M., Viereck, J., Wüthrich, M., Naveau, M., Berenz, V., Heim, S., Widmaier, F., Flayols, T., Fiene, J., Badri-Spröwitz, A., & Righetti, L. (2020). An Open Torque-Controlled Modular Robot Architecture for Legged Locomotion Research. IEEE Robotics and Automation Letters, 5(2), 3650–3657. https://doi.org/10.1109/LRA.2020.2976639

[3] B. G. Katz, “A low cost modular actuator for dynamic robots”, Thesis: S.M., Massachusetts Institute of Technology, Department of Mechanical Engineering, 2018. URI: http://hdl.handle.net/1721.1/118671.

[4] J. S. Santacoloma, ”Dispositivo de locomoción para ambientes no estructurados ”, B.sc Thesis, Universidad Nacional de Colombia, Bogotá, Colombia, 2022.

Gracias!