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// "Another easier inverted pendulum balancing robot"
// You need only half a day to make it, if you have some Materials.
// (This sketch is ver.2.0.d for a digital output gyroscope.)
// No timer library is used in this version.
// But stability of robot is more improved than earlier version.
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#include <MsTimer2.h> //01 (This line is omitted in ver.2.0 and the later.)
//int i = 0; //02 (This line is omitted in this version.)
byte countS = 0;//03
//long zeroOmegaI = 0; //04 (This line is omitted in this version.)
int  recOmegaI[10];//05
int  omegaI = 0;//06
long thetaI = 0;//07
long sumPower = 0;//08
long sumSumP = 0;//09
const int kAngle = 50;//10
const int kOmega = 500;//11
const long kSpeed = 60;//12
const long kDistance = 20;//13
long  powerScale;//14
int  power;//15
long vE5 = 0;//16
long xE5 = 0;//17

#include <SPI.h> //DL1 (These 17 lines, DL1-DL17, are added in this version.)
int  ry;//DL2
long  R;//DL3
void L3GD20_write(byte reg,byte val)  { //DL4
  digitalWrite(10, LOW); //DL5
  SPI.transfer(reg); //DL6
  SPI.transfer(val); //DL7
  digitalWrite(10, HIGH); //DL8
} //DL9
byte L3GD20_read(byte reg)  { //DL10
  byte ret = 0;//DL11
  digitalWrite(10, LOW); //DL12
  SPI.transfer(reg | 0x80);//DL13
  ret =SPI.transfer(0); //DL14
  digitalWrite(10, HIGH); //DL15
  return ret;//DL16
} //DL17

void setup () { //18
  Serial .begin(115200); //19
  pinMode(4, OUTPUT); //20
  pinMode(5, OUTPUT); //20-a
  pinMode(6, OUTPUT); //21
  pinMode(7, OUTPUT);
  pinMode(8, OUTPUT);
  pinMode(9, OUTPUT);
  for (int i = 0 ; i < 10 ; i++ ) { recOmegaI[i] = 0; } //25 ("int" is added instead of line 2 omitted.)

  pinMode(10, OUTPUT); //DL18 (These 8 lines, DL18-DL25, are added in this version.)
  digitalWrite(10, HIGH); //DL19
  SPI.begin(); //DL20
  SPI.setBitOrder(MSBFIRST); //DL21
  SPI.setDataMode(SPI_MODE3); //DL22
  SPI.setClockDivider(SPI_CLOCK_DIV2); //DL23
  L3GD20_write(0x20, B11001111);//DL24
  L3GD20_write(0x23, B00000000);//DL25

  delay(300); //26
  // training(); // (This line is omitted in this version.)

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// MsTimer2::set(5, chkAndCtl); // (This line is omitted in ver.2.0 and the later.)
// MsTimer2::start(); // (This line is omitted in ver.2.0 and the later.)
} //30

void loop () { //31
  chkAndCtl();// NL1 (This line is added in ver.2.0 and the later.)
  if ( power > 0 ) { //32
    analogWrite( 6, power );
    digitalWrite( 4,HIGH );
    digitalWrite( 5,LOW ); //35
    analogWrite( 9, power );
    digitalWrite( 7,HIGH );
    digitalWrite( 8,LOW );
  }else {
    analogWrite( 6, - power ); //40
    digitalWrite( 4,LOW );
    digitalWrite( 5,HIGH );
    analogWrite( 9, - power );
    digitalWrite( 7,LOW );
    digitalWrite( 8,HIGH ); //45
  }
  // delayMicroseconds(3600); // NL2 (This is omitted in this version.)
}

//void training(){ //48 (These 7 lines, 48-54, are omitted in this version.)
// delay (1000);
// for ( i = 0 ; i < 500 ; i++ ){ //50
//   zeroOmegaI = zeroOmegaI + analogRead(A5);
// }
// zeroOmegaI = zeroOmegaI / i;
//} //54

void chkAndCtl() { //55
// omegaI = 0; // NL3 (These 6 lines, NL3-NL8, are omitted in this version.)
// for ( i = 0 ; i < 10 ; i++ ) { //NL4
//   omegaI = omegaI + analogRead(A5) - zeroOmegaI; //NL5
//   delayMicroseconds(10); //NL6
// } //NL7
// omegaI = omegaI / 10; //NL8

  R = 0; //DL26 (These 7 lines, DL26-DL32, are added in this version.)
  for (int i = 0 ; i < 45 ; i++ ) { //DL27 ("int" is added instead of line 2 omitted.)
    ry = ( L3GD20_read(0x2B) << 8 ) | L3GD20_read(0x2A) ); //DL28
    R = R + ry; //DL29
    delayMicroseconds(90); //DL30
  } //DL31
  omegaI = R * 0.00875 / 45; //DL32

  // omegaI = analogRead(A5) - zeroOmegaI; //56 (This line is omitted in ver.2.0 and the later.)
  if (abs( omegaI ) < 2 ) { omegaI = 0; } //57 (The lower bound is less than 2 in this version.)
  recOmegaI[0] = omegaI;
  thetaI = thetaI + omegaI;
  countS = 0; //60
  for (int i = 0 ; i < 10 ; i++ ) { // ("int" is added instead of line 2 omitted.)
    if (abs( recOmegaI[i] ) < 4 ) { countS++; } //62 (The lower bound is less than 4 in this version.)
  }
  if ( countS > 9 ) {
    thetaI = 0; //65
    vE5 = 0;
    xE5 = 0;
    sumPower = 0;
    sumSumP = 0;
  } //70
  for (int i = 9 ; i > 0 ; i-- ) { recOmegaI[ i ] = recOmegaI[ i-1 ]; } // ("int" is added instead of line 2 omitted.)

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powerScale = ( kAngle * thetaI / 100 ) + ( kOmega * omegaI / 100 ) + ( kSpeed * vE5 / 1000 ) + ( kDistance * xE5 / 1000 );/  
power =max (min ( 95 * powerScale / 100 , 255 ) , -255 );  
sumPower = sumPower + power;  
sumSumP = sumSumP + sumPower;//75  
// vE5 = ??? //76  
// xE5 = ??? //77  
} //78  
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```