Bi-wheel Robot Control
An application of PIC18F4431 MCU

MICROCONTROLLERS FOR MECHATRONICS
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Introduction

The Bi-wheel Robot

Control Algorithm Design

Conclusion

Demonstration
Introduction

• Objective
  o Design an autonomous balancing and remote controllable bi-wheel robot (like a Segway).

• PIC18 microcontroller and other devices.
The Bi-wheel Robot

• Hardware for the application
Control Algorithm Design

- Flowchart

Main Program

Setup → Analog to Digital Sensing → Control Input Variables → PID and PWM Signalling

Delay

Interrupt Routine

Bluetooth Signal → Modify Control Variables
Control Signal Flow

- Error Signal
- Gyro Signal
- Differential Input

- PI controller
- Derivative Controller
- Direction

- Signal
- Add Signal
- Subtract Signal
- Saturation Detection
- PWM

- Saturation Detection
- PWM
Control Algorithm Design (cont.)

• IMU

- 3 axis accelerometer + 2 axis gyro
- Accelerometer sensitivity : 300mv/g 1.5V 0 g bias
- Gyro sensitivity
- $9.1\text{mv} \cdot \frac{1}{s}$, 1.35V 0 bias
Control Algorithm Design (cont.)

- Pic 18 ADC: 10 bits.
- Vref- = GND, Vref+ = 3.3 mv -> 3.222 mv/ count of resolution.
- Accelerometer 0 bias ~ 465 counts, 1g ~ 93 counts.
- Gyro 0 bias ~ 435 counts.
- Gyro data integration and gravity tilt are used in a complementary filter arrangement to approximate the tilt angle of the robot.
Control Algorithm Design (cont.)

ADC DATA

- calibrate_sensors (calibrate the sensors offset)
- Zero bias(acc+gyro) 1g count

ADC + Zero bias(acc+gyro)+1g count

- sensor_count (converts ADC to physical values)
- Acc(g), gyro(deg/s)

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- Angle_filtered (return the filtered pitch)
- Filtered pitch angle(deg)
Control Algorithm Design (cont.)

- GUI and Bluetooth communication
GUI (PC)
- A USB Bluetooth tangle
- Add remote Bluetooth and paring
• **Bi-wheel robot**
  - Connect RX pin of Bluetooth model to TX pin of the MUC (Pin 26), TX pin of Bluetooth module to RX pin of MCU (Pin 25);
  - Read control commands form Pin RX \((\text{getsUSART}())\), send to TX \((\text{putsUSART}())\)
  - Set high priority interrupt for command receiving event
Conclusion

• An application with PIC18 MCU, gyro sensor, servo motors, and Bluetooth module, by PI control.
• The bi-wheel robot is able to balance itself autonomously.
• Problems:
  o Hobby servo motor -- no speed control
  o 16K program memory for PIC18F4431-I/P
Future work

• Use DC motor instead.
  • Position control, velocity control, PWM

• An MCU with larger memory size.
(Demonstration)

Thank You!