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/**
 * @file pid.h
 * @brief A PID implementation
 * Copyright (C) 2017 Ethan Wells
 *
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 */

#ifndef CARL_PID_H_
#define CARL_PID_H_

#include "motors.h"
#include "sensors.h"

/**
 * The settings for step-based PID
 */
typedef struct PIDSettings {
    /**
     * p multiplier for the proportion of the error
     */
    float kP;

    /**
     * i multiplier for the compound of the error
     */
    float kI;

    /**
     * d multiplier for the change in error
     */
    float kD;

    /**
     * The ideal position, or goal value

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    */
    float target;

    /**
     * Maximum value to be assigned to the controlled system
     */
    int max;

    /**
     * Minimum value to be assigned to the controlled system
     */
    int min;

    /**
     * The maximum value the integral will be limited to (-1 for none)
     */
    int integrallimit;

    /**
     * The amount of distance from target to still be considered *at* the target
     */
    int tolerance;

    /**
     * How long the sensor must be near it's target, as defined by tolerance, to
     * be considered reached it's target
     */
    unsigned long precision;

    /**
     * The system the pid controls
     */
    Motor *root;

    /**
     * Whether or not the instance has remained at it's target, within the range
     * ***of tolerance, longer than precision
     */
    bool isTargetReached;

    /**
     * A sensor to use instead of root->sensor
     */
    Sensor *sensor;

    /**

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        * The output of millis() at the point in time which target within tolerance
        * was reached. 0 if not currently at target within tolerance
        */
    unsigned long _reached;

    /**
     * The last recorded time
     */
    unsigned long _time;

    /**
     * The integral
     */
    int _integral;

    /**
     * The error
     */
    int _error;

    /**
     * The derivative
     */
    float _derivative;
} PIDSettings;

/**
 * The default PID settings
 */
#define DEFAULT_PID_SETTINGS \
    .kP          = 1,          \
    .kI          = 0,          \
    .kD          = 0,          \
    .target      = 0,          \
    .max         = 127,        \
    .min         = -127,       \
    .integralLimit = 10,       \
    .tolerance    = 5,         \
    .precision    = 220,       \
    .sensor       = NULL

/**
 * Use the Settings to achieve the target, one step at a time
 *
 * @param settings a pointer to the settings to be used
 */

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void PID(PIDSettings *settings);  
  
#endif // CARL_PID_H_
```