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

#pragma once

#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;

/**
 * The output of millis() at the point in time which target within tolerance

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        * 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
    */
    void PID(PIDSettings *settings);

```