Raspberry Pi GPIO Library (in C)

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LOC
Library: 919
Example Files: 397
Device Abstraction Example Files: 170
Total: 1486
19 Total Public Functions
6 Private Functions
12 Files

Contents

About

This document is to be distributed with the RPi_GPIO library written by Bill Vandenberk, 2013. The library is designed to be an easy to use and understand interface for interacting with the general purpose input/output (GPIO) pins on the Raspberry Pi board. The library is modeled on stdio. The functions carry a similar format to those in the stdio library, see API usage for more information.

There are several files included with this library. You should have the following:

```
Report.pdf
Pin_Label.pdf
Device_Wiring.pdf
README.md
source/
        GPIO.c
        Rpi_GPIO.h
        Makefile
        examples/
                example0.c
                example1.c
                example2.c
                example3.c
                example4.c
                example5.c
        device_examples/
                led_abs_eg.c
                phr_abs_eg.c
                tws_abs_eg.c
```

Compiling the Library

Compiling the library is easy. Simply enter the source directory and type 'make'. This will build the library libRPi_GPIO.so.

NOTE: If you have a revision 1 Raspberry Pi, you need to uncomment the #define Rpi_board_rev_1 before compiling. This will make the library adopt the older pin numbers.

Installing the Library

Installing the library is just as easy as compiling it. From the source directory type 'make install' you may be prompted for a password for this step.

NOTE: If you have to recompile the library, you should do the install step again.

Compiling With the Library

Sticking with the idea of things being easy here. Once you compile and install the library, all you need to do is #include <RPi_GPIO.h> and link with -lRPi_GPIO.

Running the Example Code

To run the example code, first read through the code and try to understand it. In each file there is a line in the comment header that allows you to compile the program. Once compiled run the executable (with sudo) and watch the magic unfold. If you really want the magic to unfold, you should connect the specified devices to you Raspberry Pi first.

Terms

There are a few definitions you should know before using the library.
Pin – 1. a physical pin on the raspberry pi board. 1. a software representation of a physical pin.
Logic Type – active high or active low. Active high means 3.3v on a pin is true, active low means 0v on a pin is true.
Direction – pins can be defined as strictly input, strictly output or input and output. The direction of the pin specifies whether you plan on using it as an input or an output, or maybe both.
Read – to read from a pin is to get the logic level on the pin (input pins).
Write – to write to a pin is to apply a logic level on the pin (output pins).
Export – exporting a pin means to make its interface available for us to use.
Unexport – unexporting a pin means to make its interface not available for use.

API Usage

Once included, your program has access to all of these functions
RPi_init

```
/* int RPi_init ()

      This function will disable any active pins. It is meant to be run at the
      beginning of each program that uses this library

      Parameters: none
      Returns: 0 on success
*/
```

Pin ADT functions
RPi_popen

```
/* PIN * RPi_popen(int number, enum RPi_logicType logic, enum RPi_direction direc)

      This function will create a pin struct and export a pin, setting its
direction and logic type

      Parameters: int number - an integer in the range 0-16 representing a pin on
the pinmap, enum RPi_logicType logic - logic type to apply to this pin, enum
RPi_direction direc - intended direction of pin
      Returns: PIN, the pin struct
*/
```

RPi_pread

```
/* int RPi_pread(PIN * p, bool * in)

      This function will read the value of a pin that has been created

      Parameters: PIN p - the pin to be read, bool * in - the location to store
the read value
      Returns: 0 on success
*/
```

RPi_pwrite
```
/* int RPi_pwrite(PIN * p, bool value)

      This function will write a value to a pin that has been created

      Parameters: PIN p - the pin to be written to, bool value - the value to put
on the pin
      Returns: 0 on success
*/
```

RPi_pdirection
```
/* int RPi_pdirection(PIN * p, enum RPi_direction dire)

      This function will change the direction of a pin that has already been
created

      Parameters: PIN p - the pin that is to be changed, enum RPi_direction - the
new direction of the pin
      Returns: 0 on success
*/
```

RPi_pclose
```
/* int RPi_pclose(PIN * p)

      This function destroys a pin struct and disables the given pin

      Parameters: PIN p - the pin to be destroyed
      Returns: 0 on success
*/
```

LED Device Abstraction Functions

RPi_LED_open
```
/* LED * RPi_LED_open(int pin);

      This function opens a connection to an LED

      Parameters: int pin - the pin that the led is connected to
      Returns: LED *, the created LED
*/
```

RPi_LED_on
```
/* int RPi_LED_ON(LED * l);

      This function will turn an LED on

      Parameters: LED * l - the LED to turn on
      Returns: 0 on success
*/
```

RPi_LED_off
```
/* int RPi_LED_OFF(LED * l);

      This function turns an LED off

      Parameters: LED * l - the LED to turn off
      Returns: 0 on success
```

```
*/
```

RPi_LED_toggle

```
/* int RPi_LED_toggle(LED * l);

      This function will toggle the current state of an LED

      Parameters: LED * l - the LED to toggle
      Returns: 0 on success
*/
```

RPi_LED_close

```
/* int RPi_LED_close(LED * l);

      This function closes the connection to an LED

      Parameters: LED * l - the LED to close
      Returns: 0 on success
*/
```

3-Way-Switch Device Abstraction Functions

RPi_TWS_open

```
/* TWS * RPi_TWS_open(int pin1, int pin2);

      This function creates a three way switch

      Parameters: int pin1 - the first input pin (also connected to ground via a
resistor),
                        int pin2 - the second input pin (also connected to ground
via a resistor)
      Returns: a three-way-switch on success, NULL on failure
*/
```

RPi_TWS_readPosition

```
/* int RPi_TWS_readPosition(TWS * s, int * readto);

      This function reads the position of a 3-way-switch

      Parameters: TWS * s - the switch to get the position for,
                        int * readto - the int to read the position into
      Returns: 0 on success
*/
```

RPi_TWS_close

```
/* int RPi_TWS_close(TWS * s);

      This function will close a three way switch connection

      Parameters: TWS * s - the switch to close
      Returns: 0 on success
*/
```

Photoresistor Device Abstraction Functions

<u>RPi_PHR_open</u>

```
/* PHR * RPi_PHR_open(int pin);

      This function creates a photoresistor

      Parameters: int pin - the pin number that the photo resistor is hooked up to
      Returns: PHR *, the photoresistor
*/
```

<u>RPi_PHR_read</u>

```
/* int RPi_PHR_read(PHR * r, bool * readto);

      This function reads the photoresistor. False value means it is dark, true
value means it is bright

      Parameters: PHR * r - the resistor to read from, bool * readto - the boolean
to put the value into
      Returns: 0 on success
*/
```

<u>RPi_PHR_close</u>

```
/* int RPi_PHR_close(PHR * r);

      This function closes the connection to a photoresistor

      Parameters: PHR * r - the photoresistor you are no longer using
      Returns: 0 on success
*/
```

Error Handling Functions

RPi_errorno

```
/* int RPi_errorno()

      This function can be used to get the error number of the last funciton call
(if a function does not return 0, you can use this function to see what went
wrong.)

      Parameters: none.
      Returns: the last error number
*/
```

Possible Error Codes are 1-9 and unknown error (anything else).

RPi_errorstr

```
/* char * RPi_errorstr(int err)

      This function will return an english redable explanation of an errorno code.

      Parameters: int err - the error code as gotten from errorno()
      Returns" char *, a string containing information about the error
*/
```

Possible Error Strings are as follows.

Errorno	Error String
1	Unable to create PIN, memory not available.
2	Unable to interact with board, permissions are probably set up incorrectly.
3	Invalid pin number.
4	Recieved an argument that was NULL.
5	Attempt to write to an input only pin.
6	Attempt to read from a write only pin.
7	Unable to create LED, memory not available.
8	Unable to create three-way-switch, memory not available.
9	Unable to create photoresistor, memory not available.
?	Unknown Error.

Deliverables

There are several things this project needs to be a success.

1. No memory leaks.
2. Pin conrol works correctly.
3. Library follows state transition diagram (last in this document).
4. 6 well commented, simple example programs.
5. 3 device abstractions including at least an LED and a switch.
6. Example code for each device.
7. A working PIN ADT.
8. A library demo.

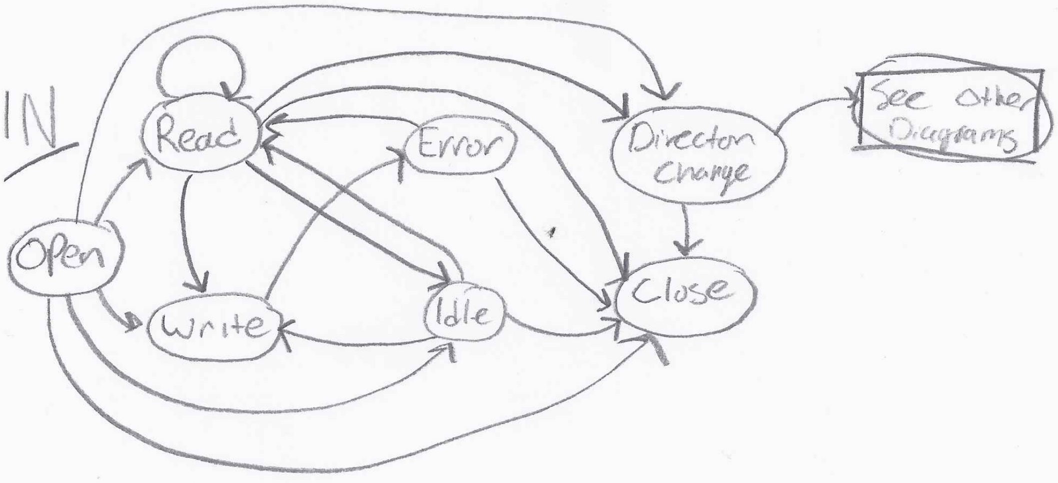
Below is proof that the library is working, has no memory leaks, and has 6 example programs. The project also contains the device abstraction examples and a state transition diagram (below)

MEMTEST RESULTS

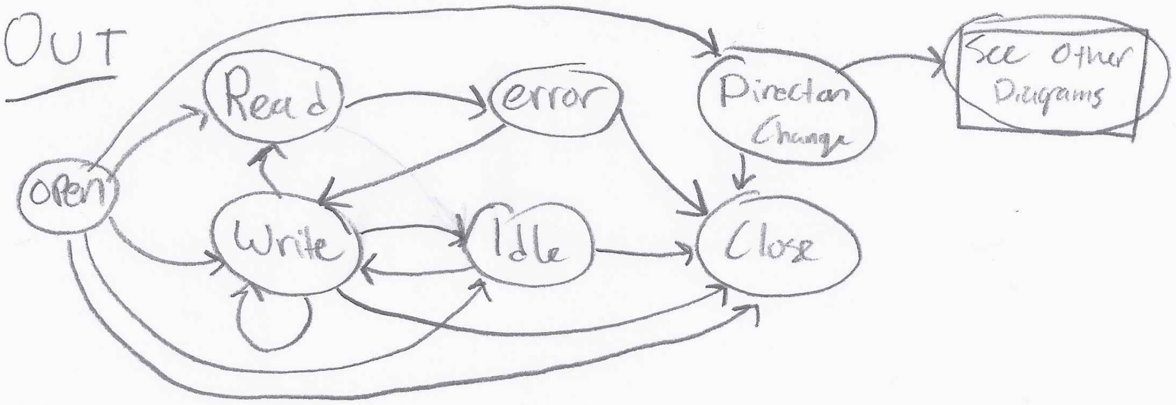
```
pi@raspberrypi ~/gpio/CIS4900/examples $ sudo valgrind ./example0
==2853== Command: ./example0
==2853== HEAP SUMMARY:
==2853==     in use at exit: 0 bytes in 0 blocks
==2853==   total heap usage: 50 allocs, 50 frees, 9,274 bytes allocated
==2853== All heap blocks were freed -- no leaks are possible
==2853== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 13 from 6)

pi@raspberrypi ~/gpio/CIS4900/examples $ sudo valgrind ./example1
==2857== Command: ./example1
==2857== HEAP SUMMARY:
==2857==     in use at exit: 0 bytes in 0 blocks
==2857==   total heap usage: 47 allocs, 47 frees, 8,877 bytes allocated
==2857== All heap blocks were freed -- no leaks are possible
==2857== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 13 from 6)

pi@raspberrypi ~/gpio/CIS4900/examples $ sudo valgrind ./example2
==2861== Command: ./example2
Press enter to toggle the LEDs
Press enter to terminate
==2861== HEAP SUMMARY:
==2861==     in use at exit: 0 bytes in 0 blocks
==2861==   total heap usage: 60 allocs, 60 frees, 11,226 bytes allocated
==2861== All heap blocks were freed -- no leaks are possible
==2861== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 13 from 6)

pi@raspberrypi ~/gpio/CIS4900/examples $ sudo valgrind ./example3
==2865== Command: ./example3
==2865== HEAP SUMMARY:
==2865==     in use at exit: 0 bytes in 0 blocks
==2865==   total heap usage: 137 allocs, 137 frees, 25,284 bytes allocated
==2865== All heap blocks were freed -- no leaks are possible
==2865== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 13 from 6)
```

```
pi@raspberrypi ~/gpio/CIS4900/examples $ sudo valgrind ./example4
==2869== Command: ./example4
==2869== HEAP SUMMARY:
==2869==     in use at exit: 0 bytes in 0 blocks
==2869==   total heap usage: 69 allocs, 69 frees, 12,790 bytes allocated
==2869== All heap blocks were freed -- no leaks are possible
==2869== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 13 from 6)

pi@raspberrypi ~/gpio/CIS4900/examples $ sudo valgrind ./example5
==2873== Command: ./example5
==2873== HEAP SUMMARY:
==2873==     in use at exit: 0 bytes in 0 blocks
==2873==   total heap usage: 68 allocs, 68 frees, 12,405 bytes allocated
==2873== All heap blocks were freed -- no leaks are possible
==2873== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 13 from 6)
```

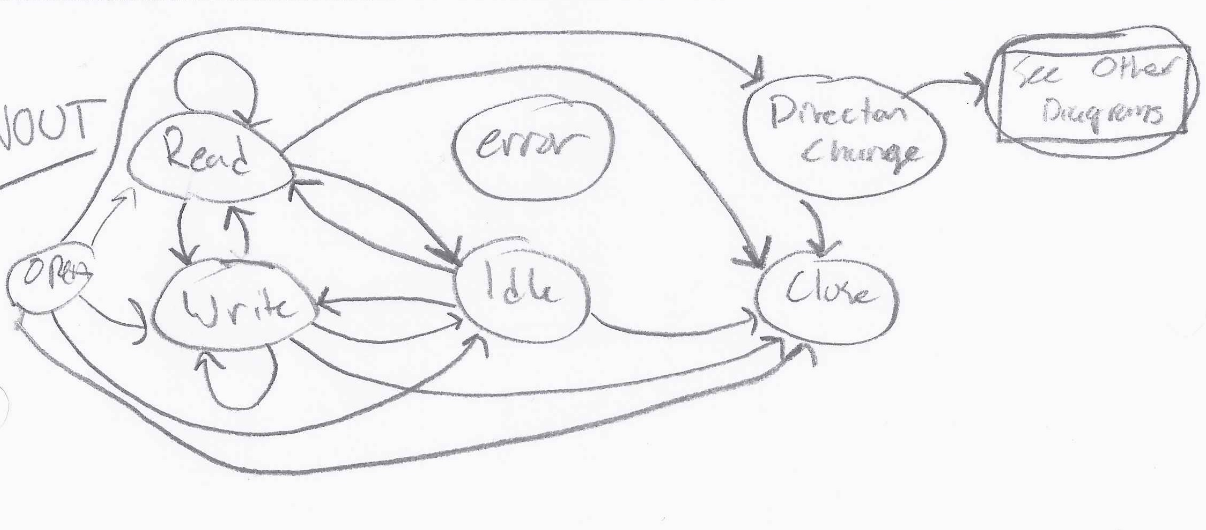
IN


Read
Error
Direction Change
See Other Diagrams
Open
Write
Idle
Close

OUT


Read
error
Direction Change
See Other Diagrams
Open
Write
Idle
Close

INOUT


Read
error
Direction Change
See Other Diagrams
Open
Write
Idle
Close