

Uyiosa Imarhiagbe, Zoltán Gere, Albert Offei

# Path follower(TM)

---

Helsinki Metropolia University of Applied Sciences

Bachelor of Engineering

Information Technology

24.04.2018

Author(s)	Uyiosa Imarhiagbe, Zoltán Gere, Albert Offei
Title	Path follower(TM)
Number of Pages	8 pages + 2 appendices
Date	April 24, 2018
Degree	Bachelor of Engineering
Degree Programme	Information Technology
Specialisation option	Smart Systems / Devices
Instructor(s)	Joseph Hotchkiss, Project Engineer Keijo Lämsikunnas, Senior Lecturer
<p>Project's aim is to develop an embedded software for Zumo robot control. This documentation covers the theoretical and practical principles required during development. Necessary mathematical, physical and electronic concepts also presented.</p>	
Keywords	Devices, Smart Systems, Embedded systems, Electronics

## Contents

### Abbreviation

1	Introduction	1
2	Background	1
2.1	Pulse Width Modulation	1
2.2	Infra red sensor	2
2.3	Cypress CY8 modeling kit	2
2.4	Zumo robot	2
2.4.1	Battery management	2
2.4.2	Motor control	3
2.4.3	Line detection sensors	3
3	Realization	3
3.1	The embedded software	3
3.1.1	Software mechanics	3
3.2	Timing	4
4	Conclusion	4
5	Latex formating helplet	4
5.1	Section	4
5.1.1	Subsection	6
5.1.2	Subsection with Math	6
5.2	Section with Source Code	7
5.3	Section with Table	7
	Bibliography	8
	Appendices	
	Appendix 1 Mathematics	
	Appendix 2 Physics	

## Abbreviation

AC	Alternating current
DC	Direct current
IR	Infrared
NiMH	Nickel-metal hydride
PID	Proportional, Integral, Derivate (control)
PWM	Pulse-width modulation

## 1 Introduction

Project's aim is to develop embedded software which controls the Zumo robot behavior, manage its hardware and perform given predefined tasks. No generic programming necessary, no ad-hoc behavior expected from the robot. Program change performed by reprogramming the firmware of the robot with a different program.

## 2 Background

This chapter gives insight and explanation to technical background.

### 2.1 Pulse Width Modulation

Pulse Width Modulation (PWM) is a modulation method used to encode information on a carrier signal. PWM is mainly used to empower electronic devices. As the modulated signal alternates between 0 and 1 the device gets an average power instead of continuous output. As a result the devices work in transition between OFF and ON states.

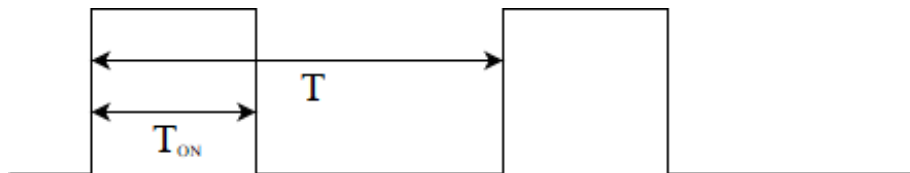


Figure 1: PWM cycle

Duty cycle means the length of ON state ( $T_{on}$  in figure) during a full cycle ( $T$  in figure). The cycle length or frequency can move on wide spectrum from 1 Hz (1 cycle / second) to 10-100 kHz. (See Appendix 2.)

In this project 1 cycle is exactly 2.56 ms long as 8 bit timer used. Therefore frequency

is approximately 390 Hz. 0 value means no movement, brakes are on during the whole cycle. [1]

## 2.2 Infra red sensor

Infrared light sensor operation.

## 2.3 Cypress CY8 modeling kit

Cypress CY8CKIT is an Arm Cortex M3 based inexpensive prototyping kit. It includes a programmer and debugger modul, making development easier. It is programmed through USB connection. Output terminal is provided on UART port emulated over the USB connection. Software development and device firmware write performed with PSoC Creator IDE software provided by Cypress, the kits manufacturer.[2]

## 2.4 Zumo robot

The Pololu Zumo is a small size (less than 10cm) tracked base robot platform. The motors and controller are replaceable allowing customized builds. It includes a steel plate, mounted at the front to protect electronics and to provide capability to push objects. Power source is 4 pieces of AA battery.[3]

### 2.4.1 Battery management

Donec et sapien ac leo condimentum vulputate id et tellus. Maecenas hendrerit malesuada interdum. Aenean dignissim sem faucibus elit congue faucibus id non risus. Morbi at dui non tortor pellentesque consequat non eget urna. Cras in sapien dui, a tincidunt

velit.

#### 2.4.2 Motor control

#### 2.4.3 Line detection sensors

### 3 Realization

#### 3.1 The embedded software

Flow charts

##### 3.1.1 Software mechanics

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aliquam aliquam aliquam purus, in ornare nulla imperdiet molestie. Nam tempus erat eu dui rhoncus et vestibulum mi elementum. Ut porttitor elit sit amet justo dignissim sit amet sagittis massa egestas. Mauris sed dolor eget dui fermentum sodales ut eu nibh.

Quisque augue est, elementum ac porttitor non, porttitor ac orci. Donec hendrerit, ligula ac luctus egestas, sem dolor pretium nunc, sed vehicula magna diam a massa. Donec mattis, arcu et tempor mattis, risus tortor ultrices metus, nec sodales sem dolor eu elit. Nullam egestas enim at odio pellentesque bibendum.

Donec et sapien ac leo condimentum vulputate id et tellus. Maecenas hendrerit malesuada interdum. Aenean dignissim sem faucibus elit congue faucibus id non risus. Morbi at dui non tortor pellentesque consequat non eget urna. Cras in sapien dui, a tincidunt

velit.

### 3.2 Timing

Gantt charts

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aliquam aliquam aliquam purus, in ornare nulla imperdiet molestie. Nam tempus erat eu dui rhoncus et vestibulum mi elementum. Ut porttitor elit sit amet justo dignissim sit amet sagittis massa egestas. Mauris sed dolor eget dui fermentum sodales ut eu nibh.

## 4 Conclusion

This chapter gives insight to technical background

## 5 Latex formating helplet

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aliquam aliquam aliquam purus, in ornare nulla imperdiet molestie. Nam tempus erat eu dui rhoncus et vestibulum mi elementum. Ut porttitor elit sit amet justo dignissim sit amet sagittis massa egestas. Mauris sed dolor eget dui fermentum sodales ut eu nibh.

### 5.1 Section

Here is an example how to add biblio entry [4] using the “cite” [5, section 4.2]. Note that a paragraph is added by forcing a new line.



And let also try the figure (see figure 2 on the following page) and internal reference (with label and ref or vref). The reference can be done to any label, for example why not to appendix 1 or to appendix 2? To note,  $\LaTeX$  will place the figure to the best place (except with forcing). Let them float till the final of final edit... then force them to not break a paragraph.

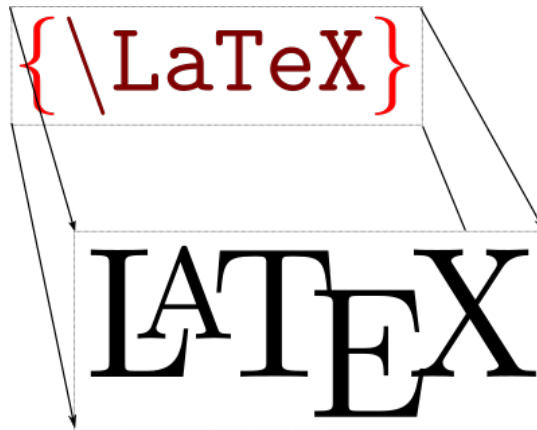


Figure 2:  $\LaTeX$  cover image (Copied from wikibooks.org (2012) [6]).

Let's also try a long quote: From the Universal Declaration of Human Rights:

- (1) Everyone has the right to education. Education shall be free, at least in the elementary and fundamental stages. Elementary education shall be compulsory. Technical and professional education shall be made generally available and higher education shall be equally accessible to all on the basis of merit.
- (2) Education shall be directed to the full development of the human personality and to the strengthening of respect for human rights and fundamental freedoms. It shall promote understanding, tolerance and friendship among all nations, racial or religious groups, and shall further the activities of the United Nations for the maintenance of peace.
- (3) Parents have a prior right to choose the kind of education that shall be given to their children. [7, article 26]

*Quisque augue* est, **elementum ac porttitor** non, porttitor ac orci. Donec hendrerit, ligula ac luctus egestas, sem dolor pretium nunc, sed vehicula magna diam a massa. Donec mattis, arcu et tempor mattis, risus tortor ultrices metus, nec sodales sem dolor eu elit.

- **A small hack** with list
- is to force the vertical space
- before and after the list

Nullam egestas enim at odio pellentesque bibendum.

### 5.1.1 Subsection

Donec et sapien ac leo condimentum vulputate id et tellus. Maecenas hendrerit malesuada interdum. Aenean dignissim sem faucibus elit congue faucibus id non risus. Morbi at dui non tortor pellentesque consequat non eget urna. Cras in sapien dui, a tincidunt velit.

### 5.1.2 Subsection with Math

Donec et sapien ac leo condimentum vulputate id et tellus. Maecenas hendrerit malesuada interdum. Aenean dignissim sem faucibus elit congue faucibus id non risus. Morbi at dui non tortor pellentesque consequat non eget urna. Cras in sapien dui, a tincidunt velit.

Ionivahvuus lasketaan kaavalla.

$$I = \frac{1}{2} \cdot \sum z_i^2 c_i \quad (1)$$

$$z_i = \text{ionin varausluku} \quad (2)$$

$$c_i = \text{ionin konsentraatio} \quad (3)$$

Aktiivisuuskertoimen  $\gamma_{\pm}$  lasketaan kaavalla.

$$\log \gamma_{\pm} = - |z_+ \cdot z_-| A \cdot I^{\frac{1}{2}} \quad (4)$$

$$A = 0,509 \text{ (lämpötilassa } 25^{\circ}\text{C)} \quad (5)$$

$$I = \text{ionivahvuus} \quad (6)$$

$$z = \text{ionien varaus} \quad (7)$$

## 5.2 Section with Source Code

Donec et sapien ac leo condimentum vulputate id et tellus. Maecenas hendrerit malesuada interdum. Aenean dignissim sem faucibus elit congue faucibus id non risus. Morbi at dui non tortor pellentesque consequat non eget urna. Cras in sapien dui, a tincidunt velit.

```

1
2 <?php
3 $userName = $_POST["usern"];
4 //maybe not?
5 if ($userName){
6     ?>
7     <h2>Hello <?php echo $userName; ?>!/h2>
8     <p>your message got received.</p>
9     <?php
10 }
11 ?>
```

Listing 1: Descriptive Caption Text

As see in listing 1: Donec et sapien ac leo condimentum vulputate id et tellus. Maecenas hendrerit malesuada interdum. Aenean dignissim sem faucibus elit congue faucibus id non risus. Morbi at dui non tortor pellentesque consequat non eget urna. Cras in sapien dui, a tincidunt velit.

## 5.3 Section with Table

Donec et sapien ac leo condimentum vulputate id et tellus. Maecenas hendrerit malesuada interdum. Aenean dignissim sem faucibus elit congue faucibus id non risus. Morbi at dui non tortor pellentesque consequat non eget urna. Cras in sapien dui, a tincidunt velit.

Table 1: Some data

Test 1	test 1234 test
Some more data comes here	with more values and if the text is very long it will disappear out of the box unless you force the column size :(

As presented in table 1: Donec et sapien ac leo condimentum vulputate id et tellus. Mae-

cenas hendrerit malesuada interdum. Aenean dignissim sem faucibus elit congue faucibus id non risus. Morbi at dui non tortor pellentesque consequat non eget urna. Cras in sapien dui, a tincidunt velit.

Table 2: Another table with tabularx

Test 1	test 1234 test
Some more data comes here	with more values and if the text is very long it will disappear out of the box unless you force the table size :(

As presented in table 2: Donec et sapien ac leo condimentum vulputate id et tellus. Maecenas hendrerit malesuada interdum. Aenean dignissim sem faucibus elit congue faucibus id non risus. Morbi at dui non tortor pellentesque consequat non eget urna. Cras in sapien dui, a tincidunt velit.

## Bibliography

- 1 Pulse Width Modulation; 2018.
- 2 Corp CS. CY8CKIT-059 PSoC® 5LP Prototyping Kit With Onboard Programmer and Debugger;. Available from:  
<http://www.cypress.com/documentation/development-kitsboards/cy8ckit-059-psoc-5lp-prototyping-kit-onboard-programmer-and> [cited April 24, 2018].
- 3 Pololu. Zumo robots and accessories;. Available from:  
<https://www.pololu.com/category/129/zumo-robots-and-accessories> [cited April 24, 2018].
- 4 Kopka, Helmut. Guide to  $\LaTeX$ . Boston: Addison-Wesley; 2004.
- 5 Tobias Oetiker, Hubert Partl, Irene Hyna, Elisabeth Schlegl. The Not So Short Introduction to  $\LaTeX$ 2 $\epsilon$ ;.
- 6  $\LaTeX$ ; 2012.
- 7 international community UN. The Universal Declaration of Human Rights. 1948;Available from: <http://www.un.org/en/documents/udhr>.

## 1 Mathematics

Note that every appendix will be a chapter.

Sorry for the ugly hack on how to count the total pages per appendix.

Of course with section and subsection.

### 1.1 Appendix Section

And you can cite [5] stuff, it will go into the main bibliography.

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aliquam aliquam aliquam purus, in ornare nulla imperdiet molestie. Nam tempus erat eu dui rhoncus et vestibulum mi elementum. Ut porttitor elit sit amet justo dignissim sit amet sagittis massa egestas. Mauris sed dolor eget dui fermentum sodales ut eu nibh.

#### 1.1.1 With a Subsection

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aliquam aliquam aliquam purus, in ornare nulla imperdiet molestie. Nam tempus erat eu dui rhoncus et vestibulum mi elementum. Ut porttitor elit sit amet justo dignissim sit amet sagittis massa egestas. Mauris sed dolor eget dui fermentum sodales ut eu nibh.

Quisque augue est, elementum ac porttitor non, porttitor ac orci. Donec hendrerit, ligula

ac luctus egestas, sem dolor pretium nunc, sed vehicula magna diam a massa. Donec mattis, arcu et tempor mattis, risus tortor ultrices metus, nec sodales sem dolor eu elit. Nullam egestas enim at odio pellentesque bibendum.

Donec et sapien ac leo condimentum vulputate id et tellus. Maecenas hendrerit malesuada interdum. Aenean dignissim sem faucibus elit congue faucibus id non risus. Morbi at dui non tortor pellentesque consequat non eget urna. Cras in sapien dui, a tincidunt velit.

## 2 Physics

### 2.1 Frequency

Frequency means for periodical functions (e.g. signals) the number of periods completed in 1 second. Unit of frequency is Hertz (Hz). For example 1 period in 1 second is 1 Hz. 10 period in 1 second is 10 Hz.

### 2.2 Kinematics

### 2.3 Electricity

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aliquam aliquam aliquam purus, in ornare nulla imperdiet molestie. Nam tempus erat eu dui rhoncus et vestibulum mi elementum. Ut porttitor elit sit amet justo dignissim sit amet sagittis massa egestas. Mauris sed dolor eget dui fermentum sodales ut eu nibh.

### 2.4 Infrared light

Infrared light (IR) is 700nm to 1mm section of light spectrum. The wavelength of IR is longer than that visible by human eye. This invisibility gives IR light wide range of purpose.