

The Swim Pacer Unit

Project Proposal

Mark Alikpala, George Garcia, Miao Lu

TA: Alex Suchko

2/8/2012

This proposal covers an introduction, design overview, parts/costs, test plans, and schedule of the Swim Pacer Unit idea by Coach Howard

Introduction

The Swim Pacer Unit proposed by Coach Howard Schein is a swimmer's training tool. Swimmers usually are unaware of how fast they are moving while swimming. We want to be able to create a tool that can provide visual representation of a set pace which will help the swimmers swim at various speeds preprogramed by their coach.

Objectives

We will design and build a visual indicator for swimmers through the use of LED sequential lights. A controller with a digital interface will be designed to adjust the speed of the lights moving along the length of the pool. Pace profiles can be preprogramed into the control device. Swimmers can follow these lights to help them swim at speeds that are set at predetermined settings. This device can also be operated on deck by the coach while an athlete is swimming. The pace can be set from the deck as the swimmer begins each length. Different profiles can be preprogramed and can be varied by the coach. The pace ranges from 8 to 30 seconds per length in 0.5 second intervals.

Benefits

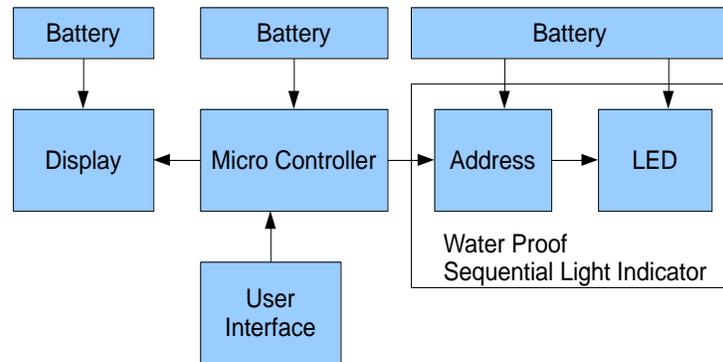
- It can help improve the performance of swimmers
- The swimmer and the coach can now see how fast the swimmer is compared to the pace
- Allows the swimmer to chase a visual cue

Features

- Programmable Pace Profiles and Pace controls
- Profiles can be saved and modified
- User friendly control interface and visual display
- Safe and reliable
- Works with all standard pools
- Waterproof LED sequential light indicator
- LCD monitor display

Design

Block Diagram



Block Descriptions

Microcontroller – This is the brain of the Swim Pacer Unit. This will receive user commands in the form of analog input coming from the User Interface block. The Microcontroller will be able to save current settings and profile information then output data to the Monitor Display. The Microcontroller also stores different swimmer pace settings and profiles as programs. Depending on the program called for using the User Interface, the Microcontroller controls the signals it sends to the Sequential Light Indicator. The Microcontroller also contains Profile information – set of user-defined customizable instructions that determine the output to the Sequential Light Indicator.

Water Proof Sequential Light Indicator – This strip of LED will run across the pool and will be visible to the swimmer. Each LED on this strip has a unique address that is accessed by the Microcontroller. The frequency of each light turning on depends on the settings.

Display Monitor – This display shows the current settings that the sequential light indicator will be running. It will display current speed/pace and current profile being used. Input will also be displayed.

User Interface – This is the analog control that allows the user to give commands to the Microcontroller. Buttons will be available to customize profiles and change the current pace.

Performance Requirements

- User input reflects on the monitor display 100% of the time.
- Display monitor should be able to display 1 of at least 3 programmed profiles and about 44 speed settings (minimum of 8 to a maximum of 30 sec/length in 0.5 second intervals)
- LED Sequential Lights should be visible to the swimmer and the pace of each sequential light should have a margin of error of at most 0.2 seconds.

Feature Requirements:

Controller-to-Monitor Requirements (CTM)

CTM_1: A "Welcome Screen" should be displayed when the unit is turned on. The users should be given the option on this page to continue using the device.

CTM_2: There should be a "Main Menu" page where the user could select three different profiles and a manual pace feature. The controller should help the users navigate this page.

CTM_3: The "manual pace" page should display the set pace (in seconds) for a length of the pool. The default time is 16 seconds. It should have a minimum of 8 seconds and a maximum of 30 seconds. The user should be able to adjust the pace by 0.5 second intervals. The user should be able to activate the sequential light circuit or go back to the main menu from this page.

CTM_4: Any "Profile" should consist of up to 8 different times for pace lengths. Each pace for a length should be editable. The user should be able to activate the sequential light circuit or go back to the main menu from this page.

Controller-to-Lights Requirements (CTL)

CTL_1: When the unit is just turned on, no lights on the sequential light circuit should be on.

CTL_2: When a user presses "Back" from the "Manual Menu" or "Profile Menu" while the sequential light circuit is on, then the lights should turn off.

CTL_3: Selecting 'Run' from the 'Manual' menu or any 'Profile' menu would start the sequential light circuit.

CTL_4: Changing the pace length in manual mode will make the sequential light circuit move faster/slower only if the "Run" button is pressed again.

Sequential Light Circuits Requirement (SLC)

SLC_1: Only one light should be on at a time when the circuit is running

SLC_2: The lights should sequentially traverse across the pool

SLC_3: All LED's should have the capability to turn on.

Tolerance Requirements (TOL)

TOL_1: The pace set can only be off by 0.2 seconds.

TOL_2: The maximum time it takes the sequential light to travel across a length of the pool should be 30 seconds.

TOL_3: The minimum time it takes the sequential light to travel across the length of the pool should be 8 seconds.

Verification

Testing Procedures

Controller – to – Display tests

Purpose: The part of this test ensures that the communication between the controller and the monitor works as intended

Requirement	Test Steps	Expected Results
CTM_1	<p>Prerequisite: The Swim Pacer Unit must be turned off.</p> <ol style="list-style-type: none">1. Turn on the Swim Pacer Unit using the controller2. Observe the screen.3. Press the 'Continue' Button	<ol style="list-style-type: none">1. The display monitor should turn on.2. The screen should display a 'Welcome Screen'. There should be a 'Continue' option on the lower right of the screen.3. The display will go to a 'Main Menu' page
CTM_2	<p>Prerequisite: The Swim Pacer Display is turned on and is just accessed the "Main Menu"</p> <ol style="list-style-type: none">1. Observe the screen.2. Repeatedly press the down button.3. Repeatedly press the up button.4. Press OK.	<ol style="list-style-type: none">1. The display monitor should show the following options/selections: Manual Profile 1 Profile 2 Profile 3. "Manual" should be initially highlighted. A header on the top should say "Main Menu". There should be an 'OK' button on the lower right.2. One press of the down button will highlight the option below the current highlighted selection. Pressing the down button when the current selected option is the bottom-most (Profile 3 on this page) will not result in a change of the highlighted selection.3. One press of the up button will highlight the option above the current highlighted selection. Pressing the up button when the current selected option is the top-most (Manual on this page) will not result in a change of the highlighted selection.

		4. The display will enter the currently highlighted option.
CTM_3	<p>Prerequisite: The Swim Pacer Display is turned on and is on the "Manual Pace" page.</p> <ol style="list-style-type: none"> 1. Observe the screen. 2. Press the up button repeatedly. 3. Press the down button repeatedly. 4. Press the 'Run' button. 5. Press the 'Back' button 	<ol style="list-style-type: none"> 1. A text should indicate a pace for a length. When you just accessed the 'Manual Pace' page, the default time should display to 16 seconds. There should be a 'Run' button on the lower right and a 'Back button' on the lower left. 2. The pace time will increase by 0.5 seconds every time the up button is pressed. When the current pace time displayed is 30 seconds when the up button was pressed, then the pace time should still remain at 30 seconds. 3. The pace time will decrease by 0.5 seconds every time the down button is pressed. When the current pace time displayed is 8 seconds when the down button was pressed, then the pace time should still remain at 8 seconds. 4. An additional display should show "Running..." The 'Run' text is now replaced by 'Override' 5. The display will exit the "Manual Pace" page and will go back to the "Main Menu"
CTM_4	<p>Prerequisite: The swim pacer display is turned on and is on any 'Profile' menu.</p> <ol style="list-style-type: none"> 1. Observe the page. 2. Press the down button repeatedly. 3. Press the down up repeatedly. 4. Press the 'Select' button 5. Repeatedly press the up button. 6. Repeatedly press the down button. 7. Press the 'Deselect' Button 8. Press the 'Down' button repeatedly until you reach the 'Run' option 9. Press 'Select' 10. Press Back. 	<ol style="list-style-type: none"> 1. A header should indicate what specific profile was selected. There should be 8 total lengths to be displayed, (named Length 1 to Length 8) with "Length 1" initially highlighted. Right below Length 8 should be a 'Run' option. There should be a "Select" option on the lower right and a "Back" option on the lower left. 2. One press of the down button will highlight the option below the current highlighted selection. Pressing the down button when the current selected option is the bottom-most (Run on this case) will not result in a change of the

		<p>highlighted selection.</p> <p>3. One press of the up button will highlight the option above the current highlighted selection. Pressing the up button when the current selected option is the top-most (Length 1 on this page) will not result in a change of the highlighted selection.</p> <p>4. The highlighted option can now be edited. The 'Select' button turns into 'Deselect'.</p> <p>5. The pace time will increase by 0.5 seconds every time the up button is pressed. When the current pace time displayed is 30 seconds when the up button was pressed, then the pace time should still remain at 30 seconds.</p> <p>6. The pace time will decrease by 0.5 seconds every time the down button is pressed. When the current pace time displayed is 8 seconds when the down button was pressed, then the pace time should still remain at 8 seconds.</p> <p>7. The current highlighted option is now uneditable. The lower right option on the page now says 'Select'</p> <p>8. The 'Run' option is now highlighted.</p> <p>9. An additional display should show "Running..."</p> <p>9. The display return to the Main Menu</p>
--	--	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Controller-to-lights test

Purpose: The part of this test ensures that the communication between the controller and the sequential lights circuit

Requirement	Test Steps	Expected Test Results
CTL_1	1. Turn on the Swim Pacer Unit.	1. The display turns on. No lights on the sequential light circuits are turned on.
CTL_2	Prerequisite: User should be in "Manual Mode" or any of the three "Profiles". The sequential light circuit must be already running. 1. Press the "Back" button	1. The sequential light circuit should turn off.
CTL_3	Prerequisite: User should be in "Manual Mode" or any of the three "Profiles". The sequential light circuit should be off. 1. Press the 'Run' button if in Manual Mode or scroll down to the "Run" button in "Profile Mode" then press the "Select button.	1. The sequential light circuit should turn on.
CTL_4	Prerequisite. User should be in "Manual Mode". The sequential light circuit must be running. 1. Press the "Up" or "Down" button at least 5 times. 2. Observe the sequential light circuit 3. Press 'Override' and observe the sequential light circuit.	1. The time displayed for "Length Pace" changes. 2. The speed remains the same. 3. The speed decreased or decreased.

Sequential Lights Circuit Test

Purpose: The part of this test ensures that the sequential light circuit behaves within the sequential light circuit requirements

Requirements	Test Steps	Expected Test Results
SLC_1	<p>Prerequisite: User should be in "Manual Mode" or any of the three "Profiles". The sequential light circuit should be off.</p> <ol style="list-style-type: none">1. Press the 'Run' button if in Manual Mode or scroll down to the "Run" button in "Profile Mode" then press the "Select button.2. Observe the sequential light circuit	<ol style="list-style-type: none">1. The sequential light circuit should turn on.2. Only 1 light is on at a given point in time.
SLC_2	<p>Prerequisite: User should be in "Manual Mode" or any of the three "Profiles". The sequential light circuit should be off.</p> <ol style="list-style-type: none">1. Press the 'Run' button if in Manual Mode or scroll down to the "Run" button in "Profile Mode" then press the "Select button.2. Observe the sequential light circuit	<ol style="list-style-type: none">1. The sequential light circuit should turn on.2. The lights sequentially "traverse" from right to left or from left to right one by one.
SLC_3	<p>Prerequisite: User should be in "Manual Mode" or any of the three "Profiles". The sequential light circuit should be off.</p> <ol style="list-style-type: none">1. Press the 'Run' button if in Manual Mode or scroll down to the "Run" button in "Profile Mode" then press the "Select button.2. Observe the sequential light circuit	<ol style="list-style-type: none">1. The sequential light circuit should turn on.2. All lights should be able to turn on.

Tolerance Tests

Purpose: This test ensures that the sequential lights circuit behaves within the system tolerance requirements

Requirements	Test Steps	Expected Test Results
TOL_1	<p>Prerequisite: User should be in "Manual Mode" or any of the three "Profiles". The sequential light circuit should be off.</p> <ol style="list-style-type: none">1. Press the 'Run' button if in Manual Mode or scroll down to the "Run" button in "Profile Mode" then press the "Select button.2. Using a digital stopwatch, record the time it takes for the sequential lights to traverse across a length of a pool.3. Compare the time you measured with the time displayed on the screen.	<ol style="list-style-type: none">1. The sequential light circuit should turn on.2. The time is recorded in a digital stopwatch.3. The time should only be off by a maximum of 0.2 seconds.
TOL_2	<p>Prerequisite: The user is in 'Manual' mode. The pace time displayed is set to 30 seconds. The sequential light circuit is not yet running.</p> <ol style="list-style-type: none">1. Repeatedly press the up button.2. Press Run.3. Using a digital stopwatch, record the time it takes for the sequential lights to traverse across a length of a pool.	<ol style="list-style-type: none">1. The time displayed on the monitor should still be 30 seconds.2. The time sequential light circuit turns on.3. It should take 30 seconds for the sequential light circuit to traverse across a length of a pool
TOL_3	<p>Prerequisite: The user is in 'Manual' mode. The pace time displayed is set to 8 seconds. The sequential light circuit is not yet running.</p> <ol style="list-style-type: none">1. Repeatedly press the down button.2. Press Run.3. Using a digital stopwatch, record the time it takes for the sequential lights to traverse across a length of a pool.	<ol style="list-style-type: none">1. The time displayed on the monitor should still be 8 seconds.2. The time sequential light circuit turns on.3. It should take 8 seconds for the sequential light circuit to traverse across a length of a pool

Cost and Schedule

Labor

Name	Rate	Hours	Total	Total x 2.5
George Garcia	\$60/hour	240	\$ 14,400	\$ 36,000
Mark Alikpala	\$22/hour	240	5,280	13,200
Miao Lu	\$35/hour	240	8,400	21,000
			Grand Total	\$ 70,200

Parts

Part	Quantity	Unit Cost	Total
Color LCD 128x128 Nokia Knock-Off	1	\$ 14.95	\$ 14.95
Clear Vinyl tubing 1" ID 100'	1	68.63	68.63
Microcontroller (PIC 18F4550)	1	4.59	4.59
MSP430	10	1.52	15.20
Wearable Keypad	1	12.95	12.95
Wires	1	30.01	30.01
LEDs	100	0.15	15.00
Resistors, Capacitors, diodes, inductors		15.00	15.00
IC's		20.00	20.00
Miscellaneous components		10.00	10.00
		Grand Total	\$206.33

Schedule

Week	George Garcia	Miao Lu	Mark Alikpala
1/23	Research programmable controller parts	Research interface sequential light control circuit parts	Research monitor display parts and high level design of sequential light circuit
1/30	Proposal: Design	Proposal: Introduction	Proposal: Verification & Requirements
2/6	Research programmable controller implementation	Research interface and sequential light control implementation	Research monitor display implementation
2/13	Complete block diagram, description, contents and simulations	Complete schematics, flow charts and calculations	Complete requirements & verification and tolerance & analysis
2/20 – DESIGN REVIEW	Update block diagram, description, contents and simulations with	Update schematics, flow charts and calculations with	Update requirements & verification and tolerance & analysis

	regards to design review critique	regards to design review critique	with regards to design review critique
2/27	-Prototype circuit implementation -Buy circuit parts	Circuit interface implementation	Create prototype of sequential light circuit through a protoboard
3/5	Program the controller	Interface controller with sequential light display	Interface controller with the monitor
3/12	Test interface and monitor display	Test every light turns on	Test light traverses at the set pace
3/19 – SPRING BREAK	Spring Break	Spring Break	Spring Break
3/26 – MOCK UP DEMOS	Add/Program “profile” feature to the swim pacer unit	Research on possible additional features for product enhancement	Test the product with Coach Howard Schein
4/2	Modify program profile feature’s efficiency	Test and implement the feasibility of the features for enhancement with Mark	Test and implement the feasibility of the features for enhancement with Lu
4/9	Test that each controller button works appropriately	Test that each light in the circuit works appropriately	Test that the monitor shows the appropriate displays
4/16	Troubleshoot any bugs regarding microcontroller	Troubleshoot any bugs regarding sequential light circuit	Troubleshoot any bugs regarding monitor display
4/23 – DEMOS	Construct final paper (Design portion)	Construct final paper (introduction, cost and misc)	Construct Test and Verification
4/30 – FINALS PAPER DUE	Proofread Lu and Mark’s portion of the Final Paper. Work with Lu and Mark in combining the Final Paper together.	Proofread George and Mark’s portion of the Final Paper. Work with George and Mark in combining the Final Paper together.	Proofread George and Lu’s portion of the Final Paper. Work with George and Lu in combining the Final Paper together.