Wireless Level

Project Proposal

Stephone Shieh, Thurston Lee, Po-Yu Kung

TA: Justine Fortier

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1.0 Introduction

1.1Statement of Purpose

There exists an urgent need on the market for a low-cost, low-power-consumption, accurate, and wireless level. The current levels available to people in need today only fulfill some of the requirements, causing people trouble and making them inefficient when performing their jobs. The device that we propose to create will be inexpensive, but also provides a handheld receiver that will allow the user to monitor the level from distance away. We choose to focus on implementing a device that will improve work quality for workers.

1.2 Objectives

1.2.1 Goals

- Develop a device that accurately measures the tri-axis tilt level
- Implement a handheld device that will allow distant monitor of the level
- Device should be suitable for common working environments while providing long battery life.
- Device should be low cost, compact an, can be easily attached to any surface.

1.2.2 Functions

- Wireless communication between handheld receiver and level module.
- LCD display panel will display the tilt angles of the mounted surface

1.2.3 Benefits

- Low cost and low energy consumption in comparison to the only product on the market that provides similar features.
- Displays the tilt angle in 3 dimensions.
- User friendly.

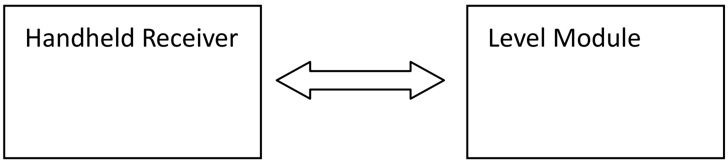
1.2.4 Features

- The device will allow up to 100 meters for monitor
- Batter lifetime up to half a year.
- The level module is waterproof and will able to sustain temperature from -10 to 50 degrees Celsius.
- Real time synchronization between receiver and level.

2.0 Block Design

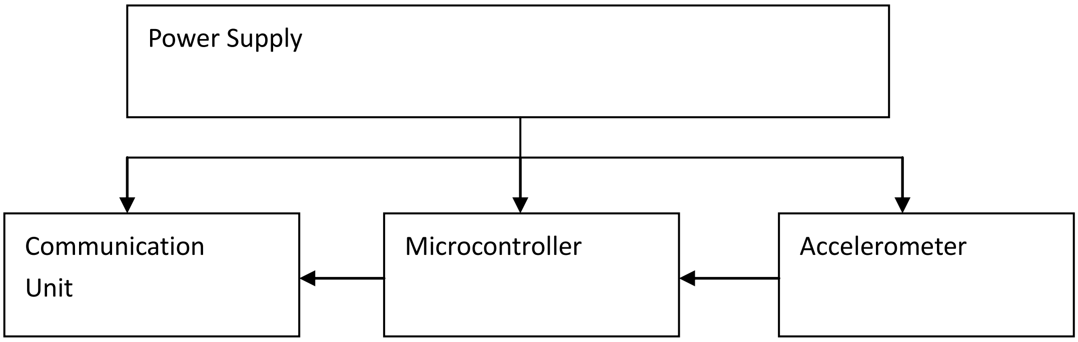
2.1 Block Diagram

Top View

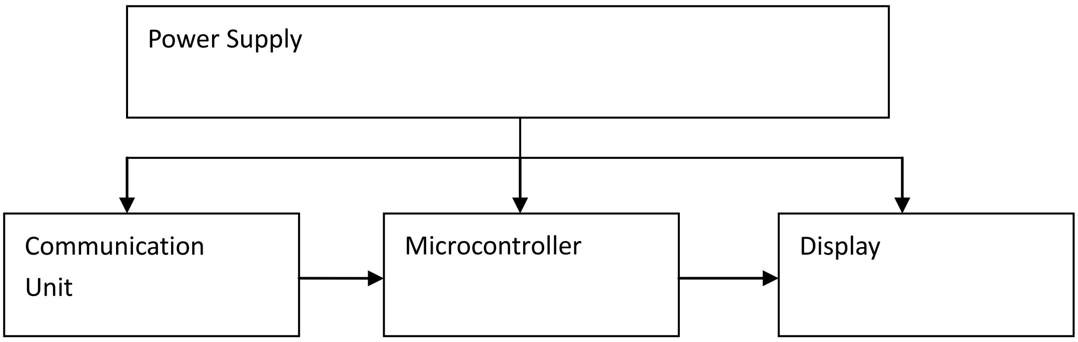


*connection between is wireless

Level Module



Handheld Receiver



2.2 Block Description

2.2.1 Level Module:

Overall Summary:

The Level module will be the measuring component of the system. It will determine the tilt level of the user's intended-to-balance surface, translate the analog data into digital and transmit it to the handheld receiver. It will consist of a MSP430, power supply, communications module, and an accelerometer.

Case Design:

The primary objective is to allow sustainability in tough environments while providing accurate data. The design will be based on a black acrylic box sealed by waterproof sealant. The case will hold all of the Level module as well as the power supply. The box will have dimensions of 5 centimeter by 5 centimeter by 5 centimeter. The case can be attached to any kind of surface.

Accelerometer:

The accelerometer used in the Level Module will be the DE-ACCM3D buffered 3D accelerometer. This device will measure its tilt level using static acceleration, gravity, and outputting voltage amplitudes. The outputted voltage amplitude will then be directed to the microcontroller for further process. The accelerometer will be powered by the power supply, which provides a constant 3V voltage to the device. The primary reason for choosing this particular accelerometer is that it is highly accurate tri-axis tilt sensing.

Microcontroller:

The microcontroller used in the Level Module will be the MSP430. This device is the primary control unit of the Level Module. MSP430 will be powered by the power source and its objective is to translate analog input from the accelerometer into digital outputs to the communication module. The primary reason for using this device is the low power consumption, low cost, and versatile customization.

Communication Unit:

The communication unit used in the Level Module will be the XBee ZB. The Xbee transceiver will recognize and wirelessly communicate with its counterpart located in the handheld receiver. This part of the Xbee will be responsible for transmitting the digital output of the MSP430 to its counterpart. The primary reason for utilizing the Xbee transceiver is due to its low frequency high data transfer capability, low cost, and low power consumption.

2.2.2 Handheld Receiver Module:

Overall Summary:

The main purpose of this module is to display the wirelessly transmitted measurements of the Level Module and display it on a LCD screen. It consists of a microcontroller, a communication unit, a power supply, a power switch, and a display unit. The LCD will display the tilt level in the x-axis, y-axis, and z-axis required. This module is connected wirelessly with the Level Module.

Communication Unit:

The communication unit used in the Receiver Module will be the XBee ZB. The XBee receiver will recognize and wirelessly communicate with its counterpart located in the Level Module. This part of the Xbee will be responsible for receiving the digital output from its counterpart and directed to the microcontroller in the Receiver Module. The primary reason for utilizing the Xbee transceiver is due to its low frequency high data transfer capability, low cost, and low power consumption.

Microcontroller:

The microcontroller used in the Receiver Module will also be the MSP430. This device is the primary control unit for the Receiver Module where it will be responsible for translating the digital output from the XBee into signals for the

LCD display.

Display:

The display used in the Receiver Module will be a LCD screen. The screen will take inputs from the microcontroller and display it on the screen for user. It will display the tilt angles of the x-axis, y-axis, and z-axis, and temperature on screen and will be simultaneously change in accordance to the current condition of the Level Module.

2.3 Performance Requirements

1. The accelerometer should accurately measure the tilt angle of the current platform within 2% error.
2. The overall efficiency of the power supply should be over 50% to ensure long battery lifetime. Typical AA batteries have a lifetime of 2100mA-h; therefore a 50% efficiency rate should guarantee a battery life of around 6 months to 1 year.
3.
4. The two modules should be able to communicate with each other within a 50 meter range based on the specifications of XBee.
5. The microcontroller in the Level Module should be able to take in 4 analog signal and output 1 digital output.
6. The microcontroller in the Receiver Module should be able to take in digital input and control the display unit.
7. Transmission between communication units should be seamless and accurate.

3.0 Verification

3.1 Testing Procedures

1. The accelerometer will be test by hand measuring the tilt angle and compare it with the voltage output of the accelerometer. The voltage output of the accelerometer will be transformed to 3 different angles according to the formula sheet of the accelerometer.
2. The microcontroller at the level module will be tested by giving a known set of input voltages and see if the digital output signal coming out of the microcontroller matches the signal we send in. We will check by doing the analog to digital transformation by hand.
3. The microcontroller at the handheld receiver will be tested by giving a known set of digital signal and see if the analog output signal coming out of the microcontroller matches the signal we send in. We will check by doing the digital to analog transformation by hand.
4. The communication unit for both the level module and the handheld receiver will be tested by feeding the level module communication unit a digital signal and see whether the receiver receives the digital signal without error.

3.2 Tolerance Analysis

The communication unit will be the most vital component of this design due to the specificity of the project. The XBees should be able to communicate through most types of common architecture materials and should be able to communicate at least up to 50 meters. The plan is to perform testing in various environments to ensure that the communication units will be effective in providing seamless long range data transmission for the user.

Two tests will be focused on in order to ensure functioning communication unit. The first test will be the distance test and the second test will be the interference test. Distance tests will be performed at 0 meters, 1 meter, 5 meters, 10 meters, 20 meters, and 50 meters. Data transmission between the two XBees will be monitored and recorded for examination purposes. The interference tests will be performed at different locations including Everit Lab, where mass electrical interference exists, basements, and the underground tunnels of Noyes lab. The purpose of the interference test is to ensure maximum data transmission between the XBees in all kinds of environment.

4.0 Cost and Schedule

4.1 Cost Analysis

4.1.1 Labor

Name	Hourly Rate	Total hour Invested	Total cost
Stephone Shieh	$35.00	150	$13,125
Thurston Lee	$35.00	150	$13,125
Po-Yu Kung	$35.00	150	$13,125
Total	$135.00	450	$39,375

4.1.2 Parts

Item	Quantity	Cost($)
MOSFET and gates	10	8.00
Resistor, Capacitor		5.00
LCD Display	1	15.00
MSP-EXP430G2	1	5.00
Accelerometer	1	35
Wireless Units	2	100
Total		168

4.1.3 Grand Total

Section	Total
Labor	39375.00
Parts	168.00
Total	39543.00

4.2 Schedule

Date:	Thurston Lee	Po-Yu Kung	Stephone Shieh
9/16~9/22	Find the components	Finalize proposal	Research components
9/23~9/29	Accelerometer testing	Ordering parts	Microcontroller design
9/30~10/6	Xbee design and testing	LCD design and testing	Microcontroller testing
10/7~10/13	Learn to program Xbee	Learn to use LCD	Learn to program msp430
10/14~10/20	Debug the wireless components when parts are put together	Debug the LCD display and accelerometer	Debug microcontroller when all parts are put together
10/21~10/27	Test level module	Test receiver module	Test the communication
10/28~11/3	Work on final report	Work on final report	Work on final report
11/4~11/10	Mock demo	Mock demo	Mock demo
11/11~11/17	Fix communication unit bugs	Fix display unit bugs	Fix microcontroller bugs
11/18~11/24	Presentation	Presentation	Presentation
11/25~12/1	Work on communication and accelerometer analysis	Work on economic and power consumption analysis	Work on microcontroller analysis
12/2~12/8	Demo + finalize paper	Demo + finalize paper	Demo + finalize paper
12/9~12/15	Turn in paper do presentation	Turn in paper do presentation	Turn in paper do presentation