Pulse Oxi*tele*metry

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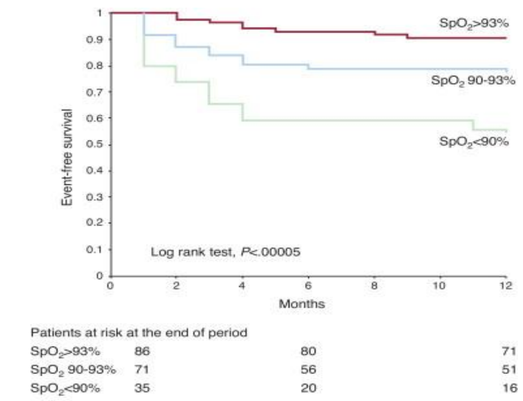
Problem Statement

It is vitally important to measure blood oxygen saturation data for patients with chronic diseases like congestive heart failure, chronic obstructive pulmonary disease or asthma. However many of these patients do not need to remain in a hospital setting. This pulse oxitelemetry device will collect real time blood oxygen saturation data from patients in a variety of environments made accessible by wireless data transmission. In doing so the patient's quality of life will be increased due to freedom of mobility.

Background and Motivation

- Pulse Oximetry is an essential piece of information for physicians to accurately assess a patient's health.
- Pulse oximetry utilizes the absorption wavelengths of two different types of hemoglobin to monitor the arterial oxygen saturation in a patient.
- Patients are limited to a hospital or home environment at which they are receiving treatment.
- The physician has limited options for receiving oximetric data from a patient that is under a home care system.



Patients at risk at the end of period

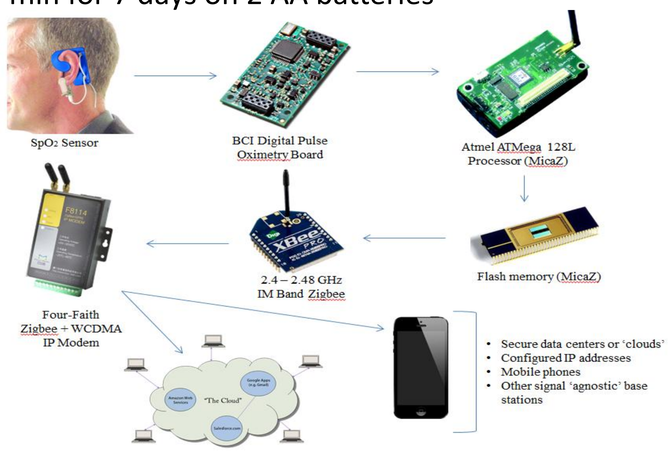
SpO_2>93%	86	80	71
SpO_2 90-93%	71	56	51
SpO_2<90%	35	20	16

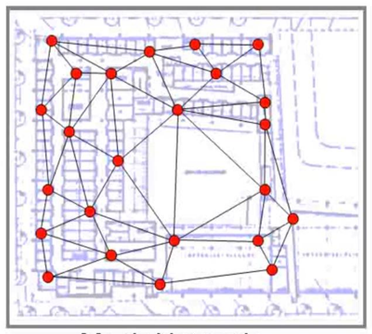
Client Requirements

- Wirelessly transmit oxygen saturation readings acquired from the device to a base station at predetermined intervals, such as every 30 seconds aka non-continuous acquisition
- Oxygen saturation percentage alarm threshold should be adjustable
- Battery should last at least a week while the device is undergoing discontinuous monitoring
- An ear oximeter sensor is preferred
- Device should be light enough to be worn behind the ear, similar in size to a hearing aid

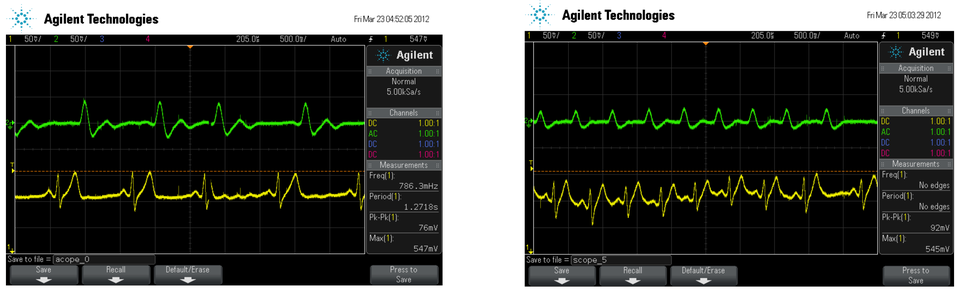
Final Design

- Discrete earlobe sensor with mechanical lobe clamp for improved sensor stability, minimized motion artifacts, and hands free lifestyle
- Digital pulse oximetry board for signal processing accurate to 0.2% perfusion index tolerance
- MicaZ mote supporting ATmega128L microcontroller, flash memory, and Zigbee stack protocol
- EDGE 3G network IP Modem for globally compatible, secure, transmission to up to 5 base stations simultaneously
- Optimized low power system can transmit 900 measurements every 15 min for 7 days on 2 AA batteries




Mesh Network

Testing Protocol



Criticare positive control pulse waveform and ECG at rest vs. during mild exercise
Pulse waveform (green) and ECG signal (yellow) during rest (left) and mild exercise (right)

- Position pulse oxitelemeter >10 m away from Zigbee base station and 3G <2 km from 3G base station
- Instruct 4 subjects to perform varied levels of physical exertion on an exercise bike for 5 minutes each
- Simultaneously collect pulse oximetry data through Zigbee, 3G Cellular, and Criticare device
- Export 4 sets of data per each of the 3 outputs from LabView DAQ into Excel/Matlab
- Subtract 3G data points and Zigbee data points from control data points individually (3G / Zigbee delta values)
- Calculate mean, standard deviation, maximum, and minimum %SpO_2 for each of the 3 data sets, 3G delta values, and Zigbee delta values.
- Create and analyze Fourier-transform plots for each data set and identify signal frequency concentration differences

Budget

Final Budget and Expenses

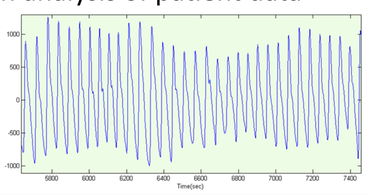
Device:	Final Price	Quantity
MicaZ	$0.00	2
Shipping	$50.00	-
F8414 IP Modem	$160	1
Shipping	$40.00	-
Digital MicroPower Oximetry Board	$255.00	1
Shipping	$0.00	-
Reusable Nortell Finger Sensor	$0.00	1
Disposable Nonin Ear Sensor	$0.00	1
AA Batteries	$0.00	4
Final Budgeted:	**$500.00**	-
Total Project Expenses:	**$505.00**	**10**

Conclusions

- Meta-analysis of contemporary research established that this concept is fully feasible
- Identified and purchased 'best in class' system components that maximize patient mobility and improve upon current wireless limitations
- Eliminated need for patient compliance through ergonomic design considerations
- Constructed comprehensive patent database and found minimal to no overlap with our final design

Future Work

- Obtain MIB programming interface board
- Program MicaZ microcontroller via TinyOS interface utilizing open source Code and Ubun TOS tool chain
- Configure IP Modem to SMS and PC trigger ways
- Implement testing protocols
- Enhance and modify existing GUIs
- Compact device onto smaller, single circuit board in collaboration with ProActive engineering
- Explore prognosis improvement opportunities through analysis of patient data



Acknowledgements

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