MRI Patient Connections

"Umbilical" Project, Sponsored by Philips

Initial Project and Group Identification Document

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II. Project Description

The Philips Company strives to improve lives through innovation and creativity. As a leader in the health industry they are always looking for ways to take advantage of emerging technologies, seeking passionate individuals to assist them on their quest as they demonstrate exceptional care and concern for the wellbeing of others.

MRI patients are monitored for up to seven vital signs during their procedure. Currently this requires multiple hoses and cables, a spider's-web of cabling causing unneeded complication and added anxiety to patients. Philips seeks a clean solution that will reduce or eliminate the need for these connections.

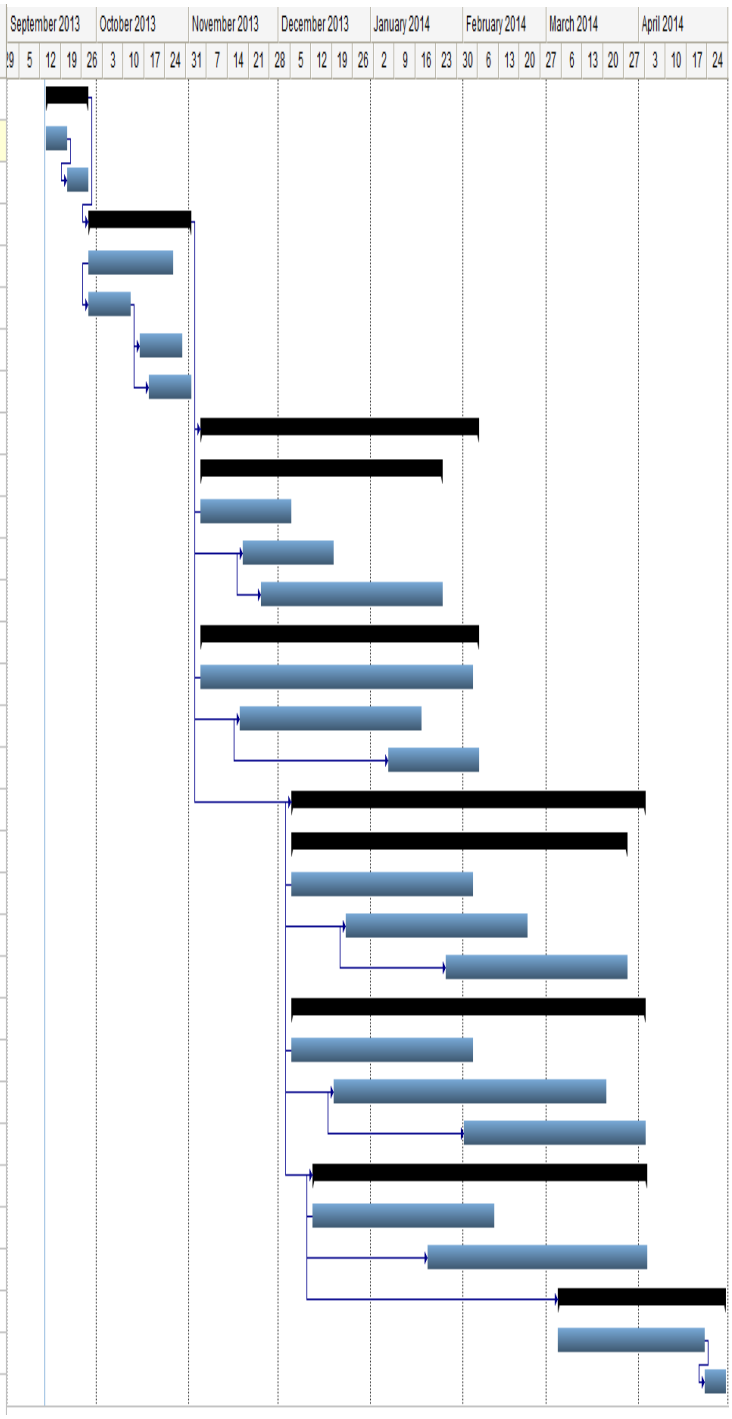
The solution to this problem must take into consideration the strength of the magnetic field produced by the MRI, as well as the constant activation of the magnet itself. The vital signs that must be monitored include: NiBP (a pressured air signal), ECG (an electrical signal), SpO2 (a fiber optic signal), CO2 (a pressure/gas measurement), and IPB (an electrical signal). This cabling solution cannot create any interference with the MR image, and must also be suitable for O.R. and general hospital ward use. Throughout the design process the team will work with an external vendor to produce functional prototypes of the proposed solution, as well as a model shop to quickly manufacture such prototypes for testing.

III. Specifications and Requirements

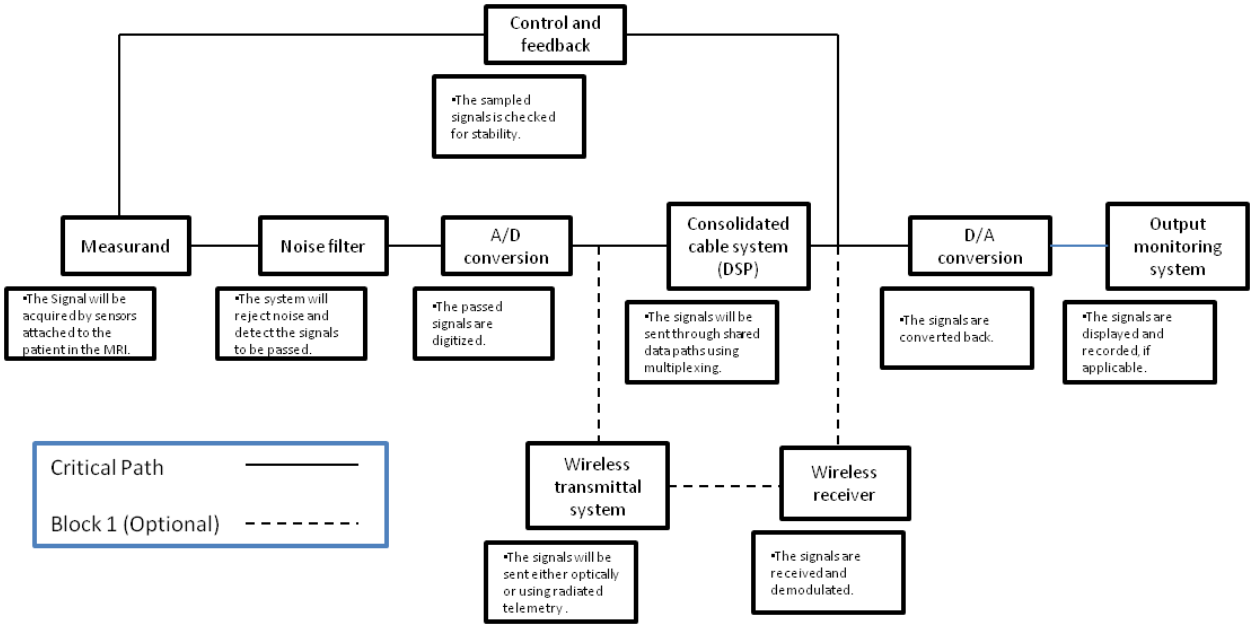
No.	**Specifications & Requirements (for wireless route)**
I.	No Ferro-magnetic materials; however, if used, they must be protected against 1,000 Gauss to 15,000 Gauss or approximately 0.1 to 1.5 Teslas (Basically, 10 ft to 0 ft distance from the MRI. If device is protected against 2 Teslas, it can be used anywhere in the room including inside the MRI). EMF (electromagnetic) resistant is what the device should ultimately be.
II.	Monitors should operate in a different frequency band from the MRI so there is no interference with imaging process.
III.	Should be powered by cord or batteries if handheld which all should fall into the requirements of No. I. (maybe everything can be fiber optic)
IV.	Device should be able to monitor at least 4/7 vitals that are needed for MRI (which ever combination works best to give optimum cleanliness and portability for scanner and overall hospital use).
V.	Should sound/show an alarm if vitals fall outside of a normal range
VI.	Consolidate the IPB, Temperature, ECG, and the SpO2 tests into one cord of electrical or fiber optic cables. SpO2 test will have to have converter from fiber optic to electrical or just an electrical SpO2 test.
VII.	Try to consolidate NiBP, CO2, and Agents test for gas based tests.
VIII.	Electrical pads that all connect throughout the body into one spot and send a very large signal or small multiple signals to receiver, all in a different band that follows Requirement No. II. If multiple signals then maybe 12 pads should be made, trying to keep requirement VII in mind, for the main purpose of the ECG testing and incorporating everything else into the 12 pads with transmitters for each pad. Each pad should be no bigger than approximately half a modern cell flip phone watch (no more bulkier than a bigger version of a wristwatch).
IX.	Battery use should also be explored, possibly within the range of AAA to D batteries(y). Or a corded scanner with rechargeable batteries (synonymous to our cell phone's battery).
X.	Scanner will need impact shield for screen and body for general use in and outside the MRI room. The shield could be integrated into No. I's requirements.

IV. Project Timeline

Name	Duration	Start	Finish
Definition	**2w**	**09/13/2013**	**09/27/2013**
Contact Philips	7d	09/13/2013	09/20/2013
Define Project	7d	09/20/2013	09/27/2013
Research	**1.13m**	**09/27/2013**	**10/31/2013**
MRI technology	4w	09/27/2013	10/25/2013
Sensors used during MRI	2w	09/27/2013	10/11/2013
Existing datapaths	2w	10/14/2013	10/28/2013
Viable communication systems	2w	10/17/2013	10/31/2013
Design	**92d**	**11/03/2013**	**02/03/2014**
Hardware	**80d**	**11/03/2013**	**01/22/2014**
Cable system	1m	11/03/2013	12/03/2013
Integration with existing sensors	1m	11/17/2013	12/17/2013
Wireless communication (if applicable)	2m	11/23/2013	01/22/2014
Software	**92d**	**11/03/2013**	**02/03/2014**
Signal processing platform	3m	11/03/2013	02/01/2014
Signal acquisition interface	2m	11/16/2013	01/15/2014
Network system software	1m	01/04/2014	02/03/2014
Prototype	**117d**	**12/03/2013**	**03/30/2014**
Hardware	**111d**	**12/03/2013**	**03/24/2014**
Cable system	2m	12/03/2013	02/01/2014
Integration with existing sensors	2m	12/21/2013	02/19/2014
Wireless communication system	2m	01/23/2014	03/24/2014
Software	**117d**	**12/03/2013**	**03/30/2014**
Signal processing platform	2m	12/03/2013	02/01/2014
Signal acquisition interface	3m	12/17/2013	03/17/2014
Network system software	2m	01/29/2014	03/30/2014
Test	**110.42d**	**12/10/2013**	**03/30/2014**
Component level testing	2m	12/10/2013	02/08/2014
All up round testing	2.41m	01/17/2014	03/30/2014
Final	**55.38d**	**03/01/2014**	**04/25/2014**
Documentation	1.61m	03/01/2014	04/18/2014
Presentation	1w	04/18/2014	04/25/2014



V. System Block Diagram



VI. Budget Estimation

System Component	Part	Qty.	Unit Price	Total Cost	Product Site/Notes
Measurand	SpO2 sensor	1	$120	$120	http://www.cablesandsensors.com/collections/types?page=2&q=One-Piece+SpO2+Sensors
	NiBP Cuff	1	$50	$50	*Adult arm cuff w/ pressure sensor
	ECG sensor	1	$90	$90	http://www.cablesandsensors.com/collections/types?q=Single+Piece+ECG+Cables
	CO2 sensor	1	$30	$30	
	IBP (?)	1	$20	$20	*Approx. price of 1 disposable transducer
Noise Filter	Op Amp	10	$1	$10	
	Basic Comp.	1	$5	$5	Analog components (Resistors, capacitors, etc.)
A/D Converter		1	$4	$4	Price estimate for ~1 MSPS
Cable System		1	$20	$20	Supplies used in cable consolidation; not sensors.
D/A Converter		1	$4	$4	Price estimate for ~1 MSPS
Control/Feedback	Microcontroller	1	$20	$20	Necessary processing power is undetermined.
Output Monitor	Keyboard/Input	1	$20	$20	
	Display	1	$70	$70	
Power Supply		1	$10	$10	Rough estimate.
Misc. Supplies		-	$25	$25	(Wiring, PCB, data cables, etc.)
Wireless (optional)					TBD

Estimated Total: $498