



Data Acquisition System in Low-Resource Settings

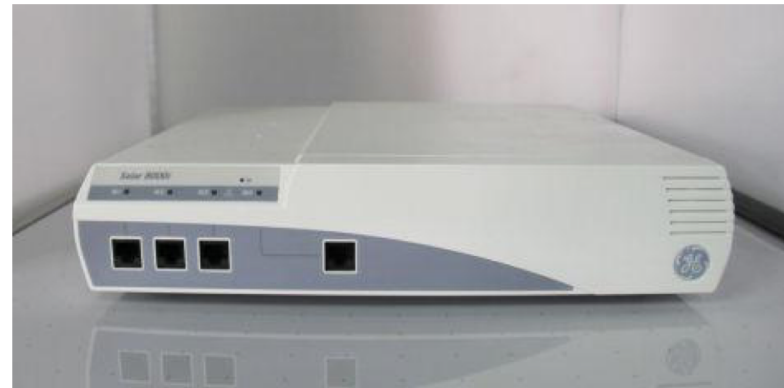
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Background

- Malaria: infection caused by *Plasmodium falciparum*
 - Affects African children less than 5 y.o.
- Cerebral malaria (CM): complication due to malaria
 - Leads to coma
 - Not clear how parasite causes coma
- Blantyre Malaria Project (BMP) studies interventions for CM in children
- Identify marginally compensated physiological states through **heart rate variability (HRV)** and **pulse waveform (PW)** analysis
- HRV and PW analysis is also used to identify increased brain volume in CM progression

Problem

- Have necessary equipment to measure biomarker data but no way to obtain it at a high resolution for analysis
- Restricted by cost
- Frequent power outages
- No structured electrical wiring
- No ability for remote access



GE Solar 8000i monitor. Retrieved from http://www3.gehealthcare.com/~media/downloads/us/services/equipment%20services/support-center/daylight-savings-time/patient-monitoring/monitors/gehc-service-manual_solar-8000m-i-patient-monitor-v5-2008.pdf

Need Statement

There is a need for a device to **digitally transmit and archive high-resolution physiological data** from patient monitors in low-resource settings (LRS), so that remote medical experts can develop new diagnostic and treatment protocols.

Project Scope

The data acquisition system needs to:

- Collect and archive real-time the patient's:
 - 4-lead ECG and arterial waveform data at a high resolution (min. 100 Hz, ideally 200 Hz)
 - Discrete blood pressure
 - Oxygen saturation value
- Upload the biomarker data to a central hub that can be remotely accessed
- Portable, cost-efficient (<\$500), easily reproducible

Deliverables (by mid-April 2019):

- Electronic hardware compatible with GE Solar 8000i monitor
- Associated software and design of server network

Overall System

GE Solar 8000i
Patient Monitor

Collects relevant biomarker data, outputs data to the data acquisition unit.

Data Acquisition
Unit

Receives data from the GE Solar 8000i patient monitor, sends it wirelessly to the server

Server Unit

Receives data from data acquisition unit, archives it and makes it available for download

Design Specifications - Data Acquisition Unit

Specification	Details	
Measurement	Waveform: ECG (4-lead), invasive arterial blood pressure	
	Discrete: non-invasive blood pressure, pulse oximetry	
Frequency	Min: 100 Hz	Ideal: 200 Hz
Compatibility	GE Solar 8000i Patient Monitor and related hardware	
Power	Wall power: 230 V, 50 Hz, single phase	
	Backup generator	
Transmission	Wireless. Real-time. Digital output to server.	
	Between buildings, across brick and steel walls. Approximately 200-300 yards.	

Design Specifications - Server Unit

Specification	Detail
Storage	Flexible. Will depend on data format and remote storage by client.
Power	Wall power: 230 V, 50 Hz, single phase
Software	Receives and archives data in real-time from multiple monitors
Accessibility	Remotely view and download real time data archived data
Maintenance	Remote access of software code for maintenance and updates

Existing Solutions: Wireless Monitoring Devices

- Wearable devices that can measure vital signs, such as blood pressure and heart rate, and can output this information wirelessly
- Allow physicians to quickly access information and make diagnoses
- Ex. Caretaker®

Why is this not the best solution?

- Inherently non-invasive
- Accessory devices need to be Bluetooth-enabled
- No information archival



Comstock, J. (2017). Caretaker Medical Device. Retrieved from <https://www.mobihealthnews.com/content/caretaker-medicals-continuous-blood-pressure-monitor-gets-2nd-fda-clearance>

Existing Solutions: Telemedicine

- Real-time, interactive communication between a patient and a remote physician
- Accomplished using special telemedicine equipment
 - Examination cameras
 - Medical scopes
 - Software systems
- Ex. InTouch Health robot

Why is this not the best solution?

- Limitations in tech
- Number of remote physicians
- No data storage and transmission



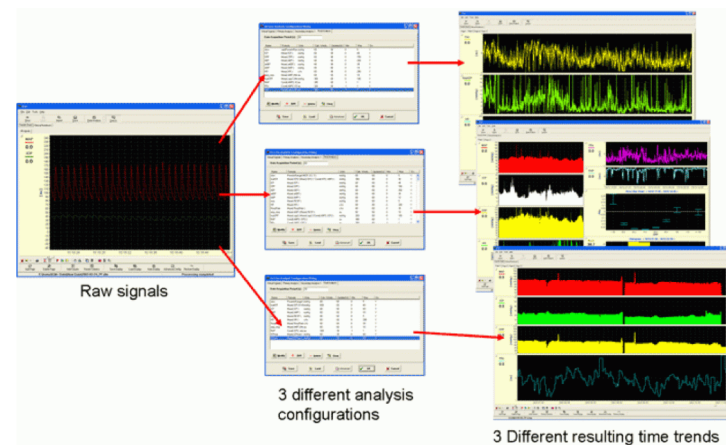
Owano, N. (2013). FDA gives green light to RP-VITA hospital robo. Retrieved from <https://phys.org/news/2013-01-fda-green-rp-vita-hospital-robot.html>

Existing Solutions: Networking Software

- Connect and archive data from multiple patient monitors to a central, accessible database
- Collect data via wired connections to each patient monitor
- Ex. Unity Network and NantHealth®, BedMasterEx, ICM+

Why is this not the best solution?

- Requires ethernet wiring



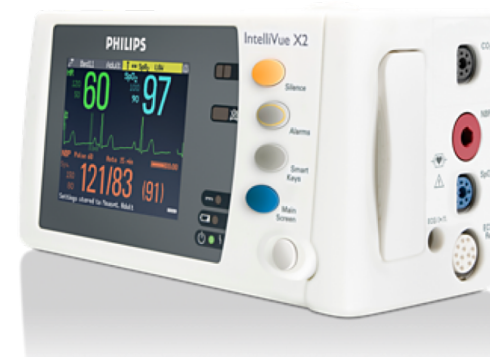
Processing of raw data. Retrieved from <https://icmplus.neurosurg.cam.ac.uk/home/icm-features/>

Existing Solutions: Patient Monitors

- Can store data for export and archive via network connection
- High-resolution output
- Ex. Phillips IntelliVue X2 monitor

Why is this not the best solution?

- Cost-prohibitive



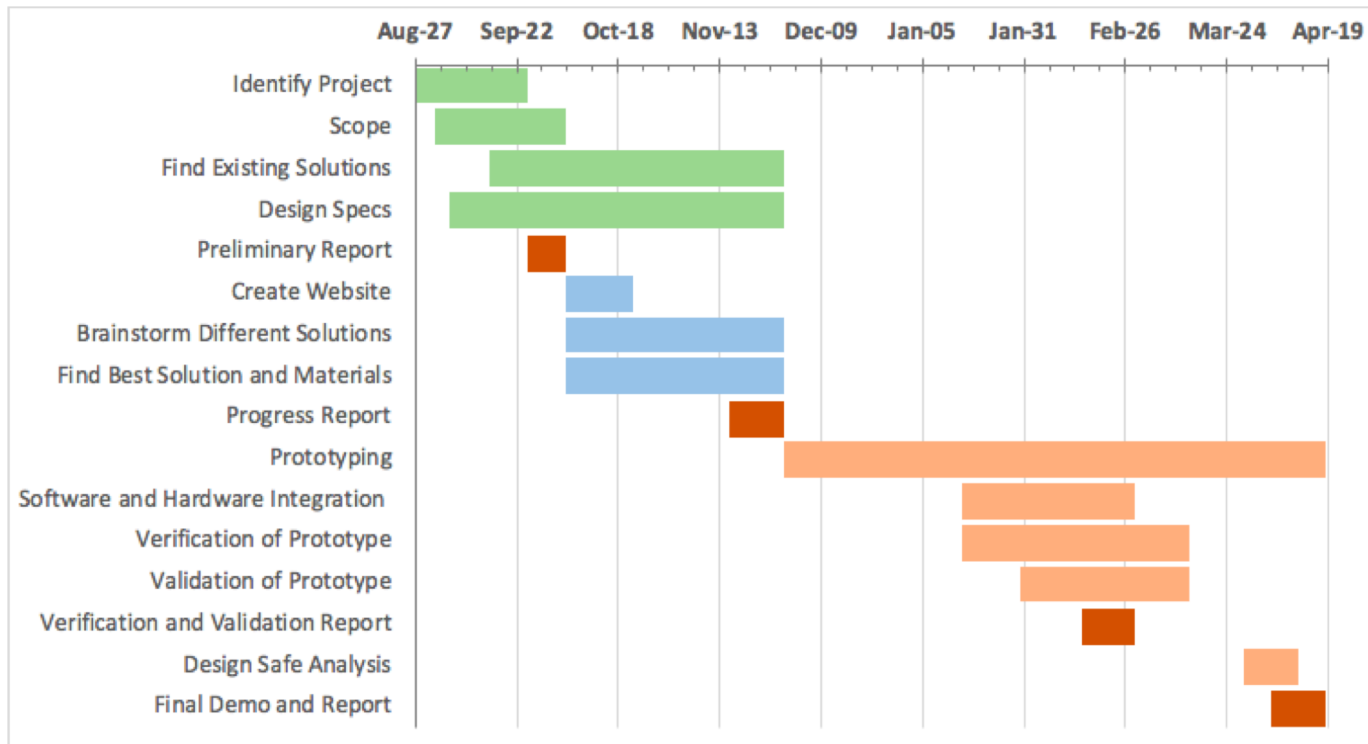
Phillips IntelliVue MMS X2 measurement module and patient monitor.
Retrieved from
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Summary of Existing Solutions

- Existing solutions are...
 - Not able to collect parameters of interest
 - Not able to archive the data
 - Too technologically advanced and cannot be supported by the infrastructure in the hospital
 - Hardwired
 - Too expensive

- Best solution: build something that is compatible with the equipment that is already in Malawi.

Preliminary Design Schedule



Organization of Team Responsibilities

Task	Team Members		
	<i>Connie Lee</i>	<i>Alexeis Ong</i>	<i>Tina Tang</i>
Research and Design	x	x	x
Hardware Development		x	x
Software Development	x		x
Testing	x	x	x
System Integration	x	x	
Communications and Client Support	x		x
Website Maintenance	x	x	
Budget			x
Weekly Reports		x	

Questions?

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