

Cornell NutriPhone & KS-Detect

Pictures of Health



Smartphone Based Technologies for Mobile and Global Health

David Erickson
Associate Professor
Sibley School of Mechanical and
Aerospace Engineering
www.ericksonlab.org



David's Odyssey

The last time I got my bloodwork done

Timeline

June – Time to get my Cornell Plan for Healthy living physical

October 1st – Cancelled phlebotomist appointment (overlap with teaching).

October 11th – Visit phlebotomist, have blood drawn, ~ 2hrs.

October 23rd – Visit doctor, get results, vitamin D deficient, need to take supplement (2000 IU).

1Y – Next scheduled blood test to see if actually working.

Lab Acquired: 10/11/12	Test Name	Result	Reference Range
	CBC ELECTRONIC (FMA)	-- Profile --	
	WBC		3.6-9.6
	HEMOGLOBIN (FMA/CMC/CTX)		3.90-5.70
	HEMATOCRIT (FMA/CMC/CTX)		12.1 - 17.2
	PLATELETS		36.1 - 50.3
	LYMPH%		150-400
	MIXED%		20.5-51.1
	NEUTROPHILS %		
	MEAN CORPUSCULAR VOL		82.2-97.4
	MEAN CORPUSCULAR HEMOGLOBIN		27.6-33.3
	MEAN CORPUSCULAR HEMO CONCE		32.0-36.0
	RDW		11.6-13.7
	MEAN PLATELET VOLUME		6.5-11.0
	Lab Acquired: 10/11/12		
	Test Name	Result	Reference Range
	VITAMIN D, 25 OH		30.0-100.0
	Lab Acquired: 10/11/12		
	Test Name	Result	Reference Range
	COMPREHENSIVE METABOLIC PROF	-- Profile --	
	ALBUMIN		3.8-5.5
	ALK. PHOS.		22-95
	ALT (SGPT)		10-40
	AST (SGOT)		5-34
	BUN		6-26
	CALCIUM		8.6-10.2
	CHLORIDE		94-112
	CREATININE		0.6-1.4
	CARBON DIOXIDE		21-32
	GLUCOSE		70-105
	SODIUM		134-149
	TOTAL BILIRUBIN		0.2-1.3
	TOTAL PROTEIN		6.3-8.1
	POTASSIUM		3.6-5.5
	GLOBULIN		2.0-4.8
	LIPID PROFILE	-- Profile --	
	CHOLESTEROL		120-200
	HDL		30-70
	TRIGLYCERIDES		30-200
	LDL (CALCULATED)		0-129
	VLDL (CALCULATED)		0-50

David's Odyssey
The last time I got my bloodwork done

Micronutrient & Vitamins


- Vitamin A, B₁₂, D
- Iron
- Folic Acid

Cholesterol

- 60% of American's have high cholesterol, 37 million have very high.

Test Name	Result	Reference Range
Lab Acquired: 10/11/12		
Test Name: CBC ELECTRONIC (FMA) -- Profile --		
WBC		3.8-9.6
RBC		3.90-5.70
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Lab Acquired: 10/11/12		
Test Name: VITAMIN D, 25 OH		
Result		Reference Range
		30.0-100.0
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ALBUMIN		3.8-5.5
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CHLORIDE		94-112
CREATININE		0.6-1.4
CARBON DIOXIDE		21-52
GLUCOSE		70-105
SODIUM		134-149
TOTAL BILIRUBIN		0.2-1.3
TOTAL PROTEIN		6.3-8.1
POTASSIUM		3.6-5.5
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LIPID PROFILE -- Profile --		
CHOLESTEROL		120-200
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Personalized Molecular Diagnostics
Glucose Meters and Pregnancy Tests




Quantitative Result & Lots of measurements

←

Non-Quantitative Result – Infrequent measurement

↓

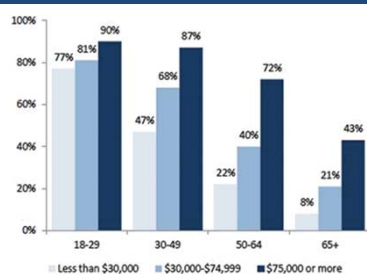




Smartphone Based Molecular Diagnostics

Can help reduce costs and improve the accessibility of healthcare

smartphone adoption in the US



It has everything

- GPS, High-res, Camera, Email, Facebook, computation, power, etc.
- Extremely rugged

You are already trained on it

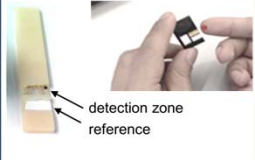
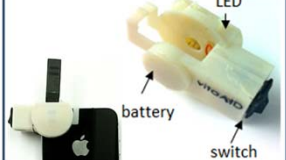

- Technology designed to be easy to use by nearly all age groups

You already own it

- 260 million active smartphones in US by 2016
- Everybody is carrying one all the time

the SmartCard and NutriPhone platforms for cholesterol and micronutrient monitoring

Technology – 3 part system

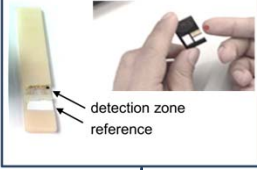
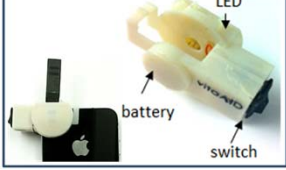
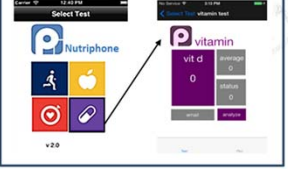
Test Strip	Smartphone Accessory	Smartphone App
<ul style="list-style-type: none"> to detect micronutrients 	<ul style="list-style-type: none"> to read out the test strip 	<ul style="list-style-type: none"> to analyze data and display for users 

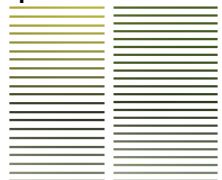
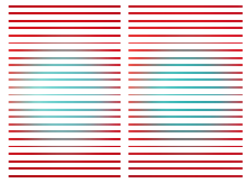




the SmartCard and NutriPhone

platforms for cholesterol and micronutrient monitoring

Technology – 3 part system


Test Strip	Smartphone Accessory	Smartphone App
<ul style="list-style-type: none"> to detect micronutrients  <p>detection zone reference</p>	<ul style="list-style-type: none"> to read out the test strip  <p>LED battery switch</p>	<ul style="list-style-type: none"> to analyze data and display for users  <p>NutriPhone vitamin vit d 0 reference status</p>

<p>pH</p>  <p>Chemical reaction</p>	<p>cholesterol</p>  <p>Enzymatic reaction</p>	<p>vitamin D</p>  <p>Gold nanoparticle immunoassay</p>
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 EricksonLab
ADVANCED BIOMEDICAL AND MANUFACTURING SYSTEMS

diet alkalinity monitoring


important in preventing enamel decalcification bellow a critical saliva pH



dietary choices

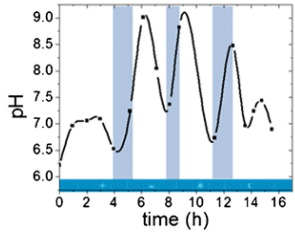


acidity and diet

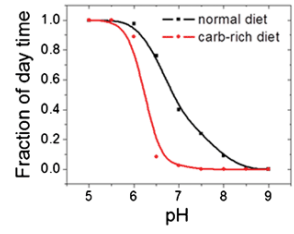


enamel decalcification bellow pH 6.2

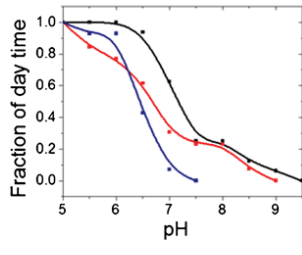
saliva pH variations




Effect of different diets



average pH for different users




Oncescu, V., Erickson, D. " A smartphone platform for cholesterol colorimetric testing" *Lab-on-a-Chip* (2013)


 EricksonLab
ADVANCED BIOMEDICAL AND MANUFACTURING SYSTEMS

monitoring cholesterol levels

high serum cholesterol increases coronary heart disease mortality

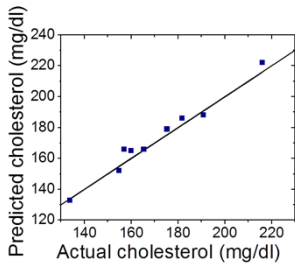


increase in mortality rate for serum cholesterol levels above 210mg/dl



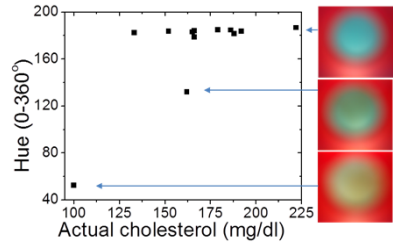
expensive devices
low accuracy
low tracking ability

accuracy in user trials




Actual cholesterol (mg/dl)	Predicted cholesterol (mg/dl)
130	130
150	150
160	160
170	170
180	180
190	190
200	200
210	210
220	220

Detecting erroneous measurements




Actual cholesterol (mg/dl)	Hue (0-360°)
100	40
125	180
150	180
175	130
200	180
225	180

Oncescu, V., Mancuso, M., Erickson, D. "A smartphone platform for cholesterol colorimetric testing" *Lab-on-a-Chip* (2013)




vitamin D deficiency testing

deficiency is highly prevalent and has been linked to many health issues

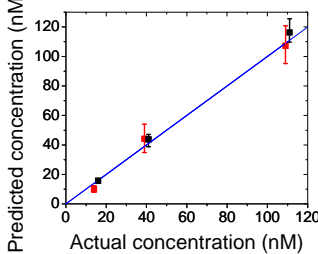


chronic deficiencies



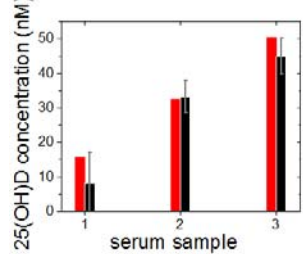
hard to quantify supplement effects

accuracy vs ELISA kit




Actual concentration (nM)	Predicted concentration (nM)
10	10
20	20
40	40
110	110

serum samples



Serum Sample	25(OH)D concentration (nM)
1	15
2	32
3	48

Lee, S., Oncescu, V., Mancuso, Mehta, S., Erickson, D. "A smartphone platform for the quantification of vitamin D levels" *Lab-on-a-chip* (2014)




24-06-2013

Mobile Internet Penetration in Nigeria Stands at 28percent

Thursday, April 4th, 2013

Africa's smartphone revolution



Smartphone use in Africa is on the rise, and major distributors are starting to pay attention to the market by producing devices that cater to the needs of the continent. How will increased smartphone use revolutionise the continent?


By Matthew Labrooy

Smartphone growth in Africa has increased by 43% every year since 2000, and experts predict that by 2014, smartphone use will have increased to 43%. As a result, smartphone manufacturers are showing increased interest in the region in a bid to gain their share of half a billion potential customers. A simple budget smartphone produced for the African market is available on the streets of Lagos for €37 (US\$50) and has sold more than 300,000 units across the country.

Smartphone penetration in Africa is estimated between 17-19%, though rates vary by country. Nigeria, Africa's most populous nation, has a smartphone penetration as high as 19%. Samsung Electronics West Africa explains the sudden influx of smartphones saying: "The advent of new privately owned submarine cables and their landing on the West African nations, including Nigeria, have significantly reduced the cost of increased the adoption of smartphones on the Continent."

African Smartphone Penetration to Reach 40 Per cent by 2017

By Vince Matilde | Friday, June 21st, 2013 at 11:04am | 0 Comments |



Africa on the brink of a smartphone revolution

by Eric Van Rookhuyzen
3 June 2013
Mobile


23 15 34 1

tweet Share Like +1

Africa is on the brink of a smartphone revolution with renewed mass market penetration into the African and South African market already underway thanks to a host of new entry level models from well-known brands like Samsung, Nokia, BlackBerry and others as well as numerous 'unknowns' from China.

Against this backdrop the Starcom MediaVest Group's digital division Liquid Thread, under the stewardship of strategist Eric Van Rookhuyzen, is championing the rise of digital in the local market.

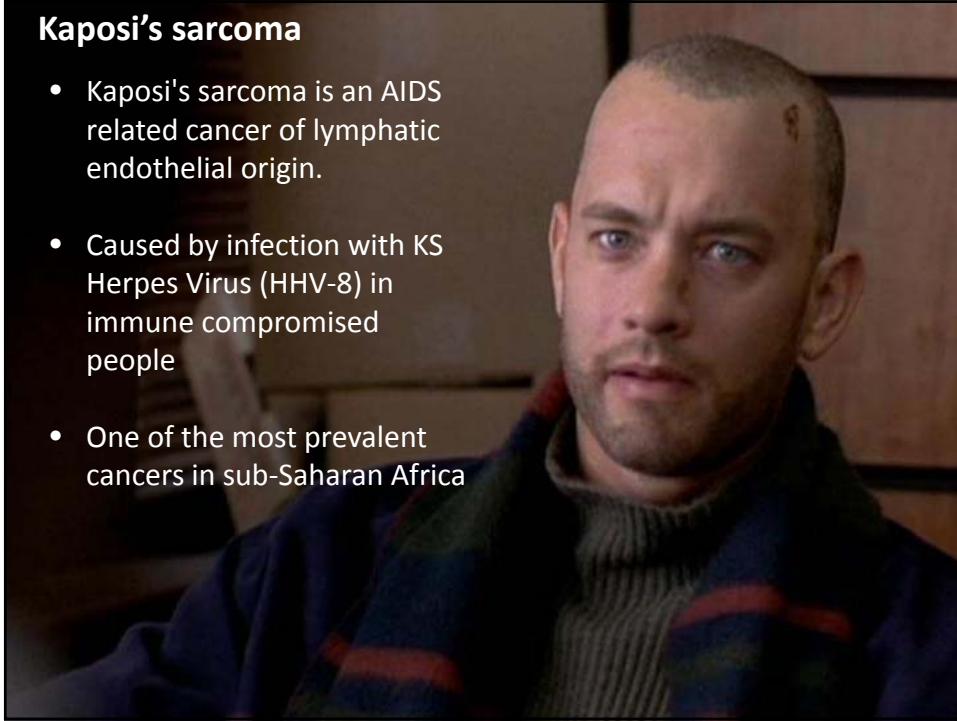
The local market for smartphones is diversifying. Whereas before it was a purely high end segment there are now also distinct middle and entry level brands. This means the price of smartphones is definitely dropping, in fact they're becoming so ubiquitous that consumers can now even buy them on their clothing account.





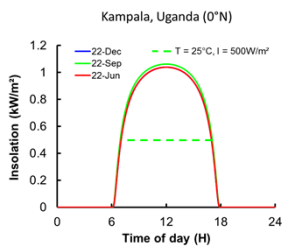
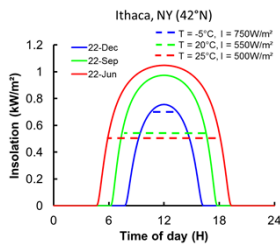
Kaposi's sarcoma

- Kaposi's sarcoma is an AIDS related cancer of lymphatic endothelial origin.
- Caused by infection with KS Herpes Virus (HHV-8) in immune compromised people
- One of the most prevalent cancers in sub-Saharan Africa



Solar-Thermal Molecular Diagnostics

Solar energy and Smartphones for PCR



Ithaca, NY (42°N)		Kampala, Uganda (0°N)		Durban, South Africa (30°S)	
Wed May 22	84° 67' PM T-Storms	Wed May 22	84° 67' Mostly Sunny	Wed May 22	80° 53' Sunny
Thu May 23	74° 47' Scattered T-Storms	Thu May 23	84° 67' Sunny	Thu May 23	77° 58' Mostly Sunny
Fri May 24	53° 42' Partly Cloudy	Fri May 24	82° 66' Sunny	Fri May 24	76° 55' Mostly Sunny
Sat May 25	58° 41' Mostly Cloudy	Sat May 25	81° 66' Sunny	Sat May 25	79° 58' Sunny
Sun May 26	61° 41' Partly Cloudy	Sun May 26	81° 67' Mostly Sunny	Sun May 26	76° 56' Partly Cloudy


Weather data retrieved from weather.com




KS Detect

Self-Contained Low Power Smartphone Driven PCR Based Diagnostics


1. Biopsy Collection

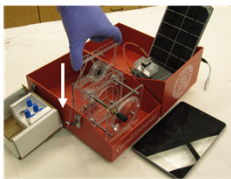
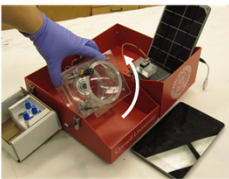
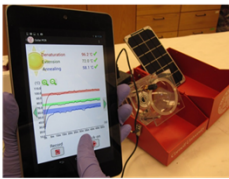
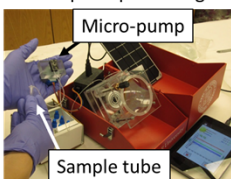
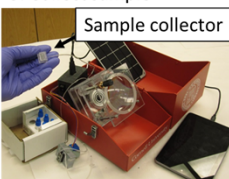
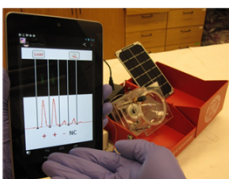


2. Solar-thermal PCR




3. Smartphone Assay



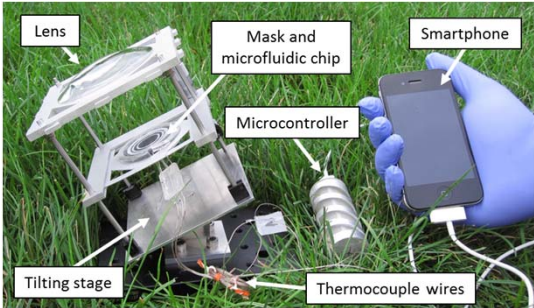
1. Insert cassette 
2. Tilt stage towards sun 
3. Read temperatures 
4. Pump sample through  **Micro-pump**
5. Collect sample  **Sample collector**
6. Read out results 

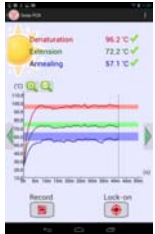
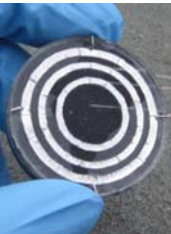

Sample tube




Solar-Thermal PCR

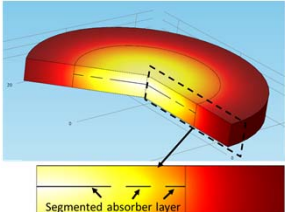
How it works



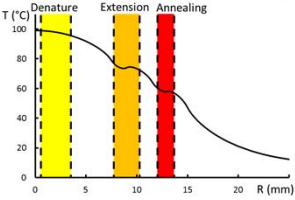







Annealing Extension Denaturation




Segmented absorber layer






KS Detect

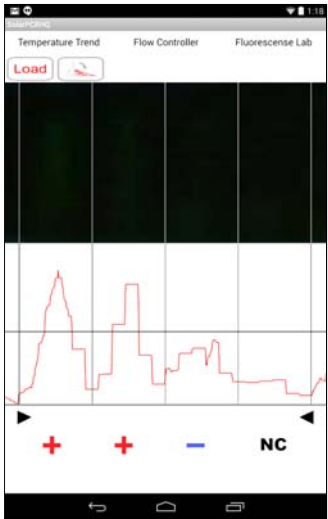
Field testing in Eldoret Kenya and Kampala Uganda





AMPATH
Eldoret, Kenya

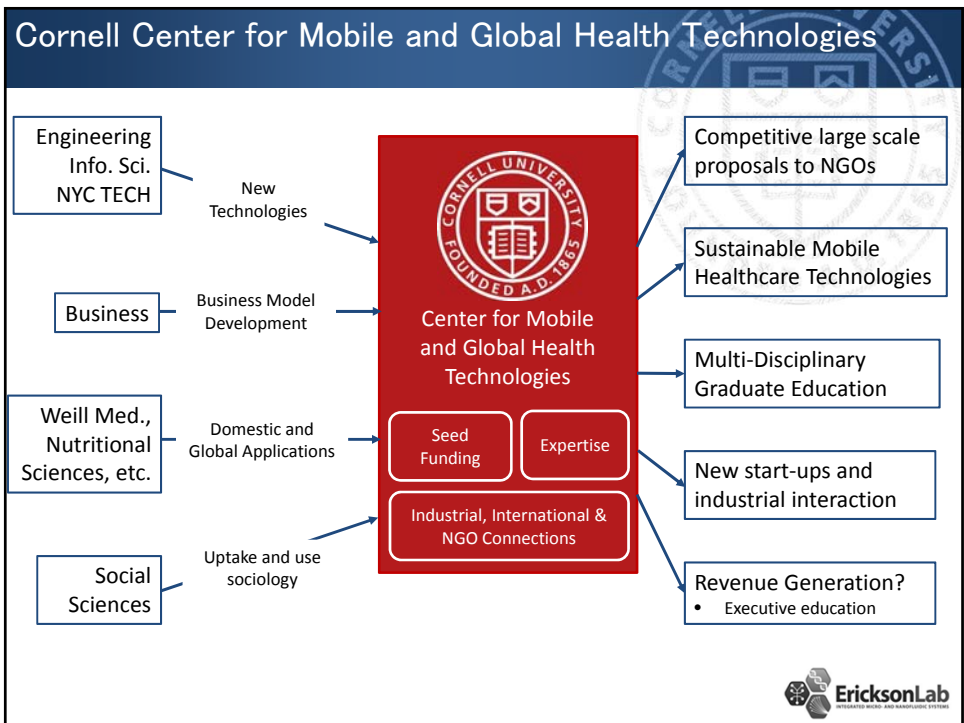


Infectious Diseases Institute
Kampala, Uganda









Cornell Center for Mobile and Global Health Technologies

Engineering
Info. Sci.
NYC T

Competitive large scale
proposals to NGOs

Busi

mobile
technologies

Key Differentiators

1. Focus on mobile enabled technologies.
2. Focus on sustainable business case development from day #1.
3. Exploitation of broad Cornell expertise.

Weill N
Nutrit
Sciences

ary
cation

Social
Sciences

Uptake and use
sociology

NGO Connections

Revenue Generation?
• Executive education

Optofluidics, Inc.

Cornell Start-up on Nanoparticle Analysis (opfluid.com)

2013 – Nature paper

LETTERS

Optical manipulation of nanoparticles and biomolecules in sub-wavelength slot waveguides

Alan H. J. Yang¹, Sean D. Moore¹, Bradley S. Schmidt¹, Matthew Kling¹, Michel Lipson¹ & David Erickson^{1*}

2011 – Begin operation in PHL, NSF + DARPA SBIR PI, private seed

2012 – Series A, sign license with Cornell.

2013 – NanoTweezer Product launch, first sales revenue.

2014 – Growth, planned series B, V2 system, foreign sales.

VitaMe Technologies, Inc.
Smartphone-based diagnostics

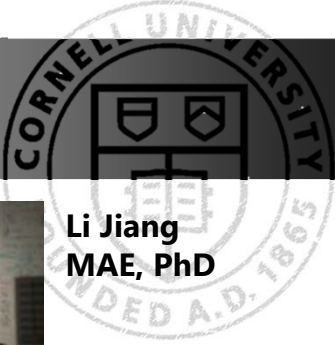


heart
Cholesterol average 289 mg/dl
status v-high
small




vitaMe
Technologies


Thank you
Any questions?




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Li Jiang
MAE, PhD



Mathew Mancuso
BME, PhD



 EricksonLab
INTEGRATED MICRO- AND NANOFUIDIC SYSTEMS