Democratization of Next-Generation Imaging, Sensing and Diagnostics Toward Connected Health

Aydogan Ozcan, Ph.D.
Electrical Engineering Department & Bioengineering Department & California NanoSystems Institute
University of California, Los Angeles (UCLA)

ozcan@ucla.edu
http://www.innovate.ee.ucla.edu/

COI Disclosure: Co-founder of Holomic LLC (holomic.com)
“Technology – broadly defined” will be part of the solution for cancer.

It may not be the most significant or critical element/ingredient for better patient care and outcome, but transformative technologies might open up new avenues and opportunities that could not be imagined before.
“Technology – broadly defined” will be part of the solution for cancer.

It is not the most significant or critical ingredient for better patient care and transformative technologies might open up new avenues.
-- Can we convert patient’s home into an advanced 24/7 laboratory for medical diagnosis, monitoring of patients, high-risk and aging populations, preventive & personalized medicine?

-- Manage costs better, early diagnosis, better treatment, better adherence, etc?

-- Global health & under-served communities: Can cancer diagnostics and care be practiced in resource limited settings using innovative and cost-effective technologies at massive scales?

-- Harnessing Big/Small Data for better patient outcomes
Digital Diagnosis
Smart-phones as super-computers

Processor Speed Comparison (Mobile Phone vs. PC)

- Clock Rate (GHz)
- Year

Graph showing the processor speed comparison between mobile phones and PCs from 2000 to 2014.
Cell phones are now everywhere: A great potential for connecting patients

World Bank

- ~7 billion cell phones are being used worldwide.
- ~15 billion cell phones have been sold so far.
- > 75% are in developing countries. (International Telecommunication Union)
New platforms for connected health

Lensfree Microscope

Tomographic Microscope

Cellphone Fluorescent Microscope

Lensfree Super-resolution Microscope

Albumin Tester

Cellphone Holographic Microscope

Imaging Flow-Cytometer

Ozcan Research Lab @ UCLA
Imaging and reconstruction of shadows

Lensfree
Super-resolution
Microscope
Imaging and reconstruction of shadows

Breast Cancer Tissue
Imaging and reconstruction of shadows [2]

Breast Cancer Tissue
Lensfree imaging of histopathology slides

Science Translational Medicine - AAAS (2014)
Imaging and Sizing of Single DNA Molecules on a Mobile-Phone

ACS Nano, 2014
New platforms for connected health

Lensfree Microscope

Tomographic Microscope

Cellphone Fluorescent Microscope

Lensfree Super-resolution Microscope

Albumin Tester

Imaging Flow-Cytometer

Cellphone Holographic Microscope

Ozcan Research Lab @ UCLA
New platforms for connected health

E. coli sensor

Allergen detector

Heavy metal detector

Google Glass based Diagnostics

Diagnostic test reader (HIV, malaria, etc.)

Blood Analyzer
The μ-Internet

Big Data & Connectivity
New opportunities in micro- and nano-analysis, medical diagnostics and epidemiology
-- Can we convert patient’s home into an advanced 24/7 laboratory for medical diagnosis, monitoring of patients, high-risk and aging populations, preventive & personalized medicine?

-- Manage costs better, early diagnosis, better treatment, better adherence, etc?

-- Global health & under-served communities: Can cancer diagnostics and care be practiced in resource limited settings using innovative and cost-effective technologies at massive scales?

-- Harnessing Big/Small Data for better patient outcomes
Some of the Challenges:
- Cost sensitivity (instruments, reagents, connectivity/data interface, analysis)
- Standardization of measurement tools, apps, platforms (similar to internet protocol)
- Quality control of data/information (different than internet/http analogy) \( \rightarrow \) affects harnessing of data and automated predictions
- Complexity of use/test for an average patient
- Regulatory approvals (also consider the short lifetime of an average consumer electronic device)
- Adoption & Deployment
A different view of the Moore’s Law

Mega-pixel Count on Mobile Phone Cameras vs. Transistor Count in CPUs

Pixel Count (Mega-pixel)

Transistor Count (in Billion)

Year

1999 2001 2003 2005 2007 2009 2011 2013