Enhancing Global Public Health through Computer Science and Information Technologies

PROFESSOR SHEIKH I. AHAMED, CHAIR DEPARTMENT OF COMPUTER SCIENCE AND DIRECTOR UBICOMP LABORATORY

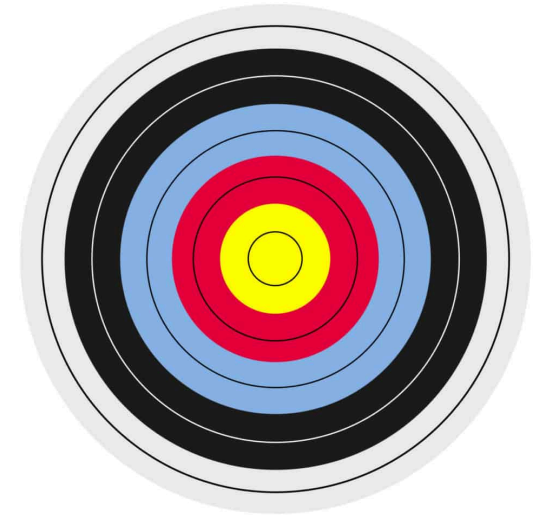Md. HASANUL AZIZ, Ph.D. CANDIDATE, DEPARTMENT OF COMPUTER SCIENCE

DR. RICHARD R. LOVE, ADJUNCT RESEARCH PROFESSOR, DEPARTMENT OF COMPUTER SCIENCE
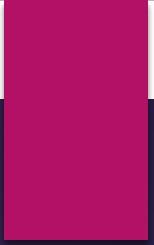
"What we have before us are some breathtaking opportunities disguised as insoluble problems." John W. Gardner

▶ OUR JOB IS TO RUN TO THE FIRES

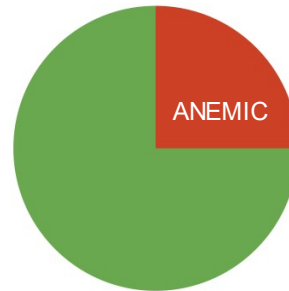# NONINVASIVE FINGERTIP CELL PHONE VIDEO SYSTEMS FOR BLOOD TESTING

Md. HASANUL AZIZ

RECOGNITION AND MANAGEMENT OF COMMON BLOOD DISORDERS

▶ HEMOGLOBIN BLOOD DISORDERS
AFFECT TWO BILLION PEOPLE

WORLD POPULATION

ANEMIC

IN THE MAJORITY OF THESE PEOPLE, ANY DISORDER IS UNRECOGNIZED.
TWO MILLION AMERICANS ARE ANEMIC

AN ACUTE ILLNESS TESTING NEED

WHITE BLOOD COUNT MEASUREMENT IS AN ESSENTIAL TOOL IN MEDICAL EVALUATION AND IN MONITORING COURSES AND TREATMENTS OF PATIENTS WITH INFECTIOUS DISEASES.

ANNUAL TESTS: 50 MILLION IN USA AND 1 BILLION GLOBALLY (FAR FEWER THAN ARE NEEDED)

CURRENT VENOUS BLOOD SAMPLE SYSTEM: LIMITED ACCESSIBILITY

LABORATORY

CURRENT SYSTEM: SLOW AND COSTLY

CHARACTERISTICS OF OPTIMAL BLOOD TEST SYSTEMS

Usable at point-of-care, anywhere
Rapid
Accurate
Inexpensive

AND

NON-INVASIVE

"Imagination at scale is our only recourse." Jonathan Ledgard

UBICOMP LABORATORY HEMOGLOBIN AND WHITE BLOOD COUNT MEASUREMENT SYSTEMS

CELL PHONE FINGERTIP VIDEO SYSTEMS with

*A <u>small lightweight box</u> with infrared light sources, a blue light filter and magnet (WBC system only) a circuit board, an aperture with support and a sensory detector for optimal finger pressure against the camera aperture, and a slot to hold the cell phone and its camera, which provides the lighting power.

* A <u>cell phone app</u> for processing finger-tip videos.

*A <u>cloud server software program</u> for receiving, performing quality control activities, and analyzing the videos, and finally sending back to the cell phone app measurements.

HEMOGLOBIN THE NEXT STEP:
A DISCOVERY PHASE STUDY

▶ **1240 patients from the Hematology clinic at Froedert Hospital, Medical College of Wisconsin, with full range of hemoglobin levels**

Usual venous blood sample laboratory hemoglobin test in single certified lab and finger-tip videos with both new system and current Masimo system.

Estimate: Mean average percentage error of 1%+/-

WHITE BLOOD COUNT THE NEXT STEP: A DISCOVERY PHASE STUDY

240 patients from the Hematology clinic at Froedert Hospital, Medical College of Wisconsin

Usual venous blood sample laboratory white blood count test and finger tip videos with new system

GOALS

By 2023, public use of both systems by provision of open source descriptions of hardware and software details.

DEVELOPMENT OF USER-FRIENDLY HEALTH DATA MANAGEMENT SYSTEMS

PALLIATIVE CARE

WORLDWIDE

- INDEQUATE NUMBERS OF PROVIDERS
- WEAK HEALTH SYSTEMS
- QUALITY OF CARE POOR

MANDATE

EFFICIENT, EFFECTIVE PUBLIC HEALTH

MODEL SYSTEMS

UBICOMP LAB SYSTEM AND TOOLS

▶ **FOR PATIENTS**: SYMPTOM REPORTING **CELL PHONE** "APP", EASY TO USE. NURSE/COMMUNITY HEALTH WORKER HELP DOWNLOAD APP, TEACH USE AND COMPLETE DEMOGRAPHIC AND MEDICAL HISTORY SUMMARIES

▶ **FOR PROVIDERS**: **WEB** "APP" WITH SECURE ACCESS TO:

   * PATIENTS' SYMPTOM REPORT AND HISTORY DATA→ SPECIFIC PROBLEM MANAGEMENT ALGORITHMS

   * LINKS TO GUIDELINES FOR TREATMENTS

   * MENU OF 'TIP' IDEAS TO SEND TO PATIENTS

      *

UCH SYMPTOM ASSESSMENT SURVEY

Username

Password

☐ Remember me

SIGN IN

Please rate how severe the following symptoms have been for you over the last THREE days. Select a number between 0 (symptom has not occurred at all) to 10 (symptom has been very severe) for each symptom by touching the red dots and sliding your finger to the appropriate points on the scales.

YOUR WORST PAIN

NOT PRESENT   VERY SEVERE

0

YOUR USUAL PAIN

NOT PRESENT   VERY SEVERE

0

PREVIOUS   NEXT
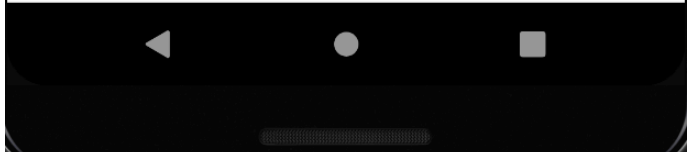
CHRONIC FATIGUE SYNDROME (CFS)

MAJOR SYMPTOMS

Permanent disabling fatigue-muscle weakness made worse by exertion

Non-restorative sleep

Malaise

with

Cognitive impairment

- ▶ NO DIAGNOSTIC TEST AND
- ▶ NO OBJECTIVE MEASURES OF DISEASE

LONG COVID CASE ESTIMATES

▶ **GLOBAL COVID CASES 250 MILLION**

        @   10%=   25 MILION

        @   20%=   50 MILLION

▶ **USA COVID CASES APPROACHING 50 MILLION**

        @ 10%=   5 MILLION

        @ 20%=   10 MILLION

LONG COVID

MAJOR SYMPTOMS

FATIGUE

- PAIN

- DIFFICULTY REMEMBERING

- REDUCED PHYSICAL ACTIVITY

- POOR SLEEP

CFS/LONG COVID TOOLS FOR MEASUREMENT OF PHYSICAL ACTIVITY-SOCIAL INTERACTION

THREE TOOLS MEASURING DURATION AND EXERTIONAL LEVELS

▶ **Shoe insole** with sensors: WALKING, CLIMBING, STANDING

▶ **Wrist sensor**: RAISING, REPETITIVE, WRITING

▶ **Cell phone**: CONVERSATIONS: ONE-MORE THAN ONE PERSON; NOISE

▶ **Cell phone: VALIDATION MESSAGES, SYMPTOM ASSESSMENT, ANALYSIS**

SPECIFIC MANAGEMENT

QUIXOTES