An Enhanced Algorithm for the Quantification of Human Chorionic Gonadotropin (hCG) Level in Commercially Available Home Pregnancy Test Kits

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ACHIRA Medical Diagnostics at your doorstep

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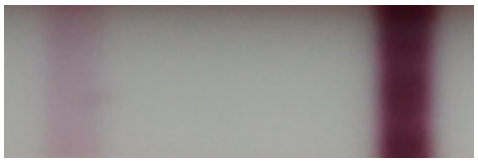
Introduction and Motivation

- Home pregnancy test kits ubiquitous

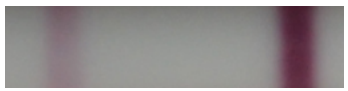
- Test results fairly accurate
- Qualitative (yes/no) result
- Can the test be made semi-quantitative?
  - Tracking hCG concentration levels over time (every 48 hours)
  - Quantitative testing (lab) expensive
  - Mobile-based diagnostics very promising

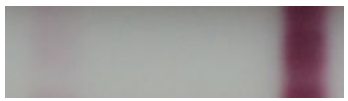
Problem Statement

- Develop a calibration function based on output color



- Challenges:
  - Variability in luminance within and across tests
  - Intra-concentration variability. E.g. at 100 mIU/ml:





  - Noise

Simple Solution

- Preprocessing: noise smoothing and variable luminance correction
- Edge detection and stripe identification
- Classification:
  - SVM training (offline)
  - SVM testing

Experimental Setup

- Samples:
  - Four concentration levels: 0, 25 mIU/ml, 100 mIU/ml, 250 mIU/ml
  - Cipla test kits
  - Male urine samples spiked with $\beta-$hCG
- Imaging:
  - Standard while light source $\approx$ 1000 lumen
  - Nikon DSLR on tripod set 15 cm from sample
- SVM training and testing:
  - 100 training samples (L*u*v* color space) per class
  - 2000 testing samples across classes
  - Polynomial kernel function

Results: Preprocessing

(a) Sample commercial strip

(b) Adjusting for lighting irregularities

(c) Denoised lines in RGB color space

(d) Denoised lines in LUV color space

Figure: Segmentation results on commercial strip at 100 mIU/ml.

Results: Classification

	Output (proposed method)			
Input	0	25 mIU/mL	100 mIU/mL	250 mIU/mL
0 mIU/mL	98.58	1.42	0	0
25 mIU/mL	1.22	98.78	0	0
100 mIU/mL	0	0	95.22	4.78
250 mIU/mL	0	0	1.45	98.55

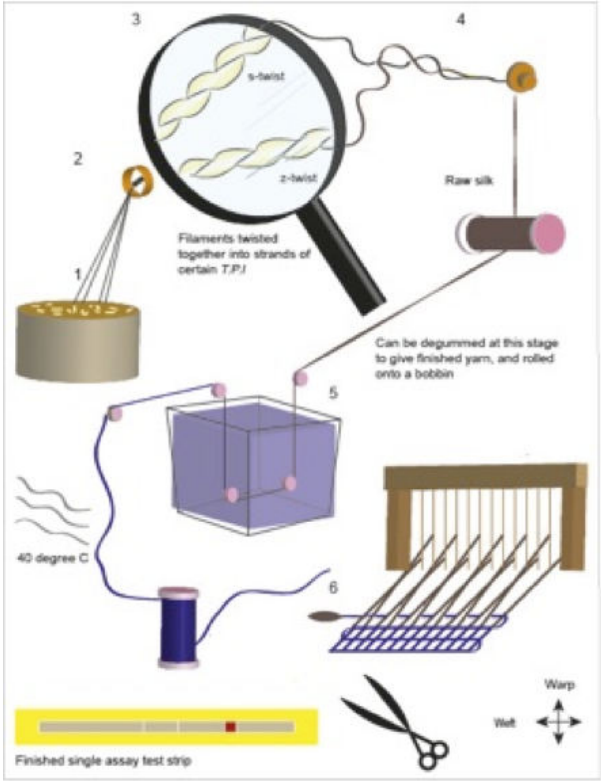
Conclusions and Future Work

- An image processing solution for a practical problem
- Solution ported to Android
- Portable devices becoming increasingly powerful
- Mobile-based diagnostic solutions very promising - especially in the Indian context

IITH-Achira Labs Collaboration

Achira Labs, Bangalore:

- CEO: Dr. Dhananjaya Dendukuri, BTech IITM (Chem), PhD MIT
- Fabric based diagnostics:



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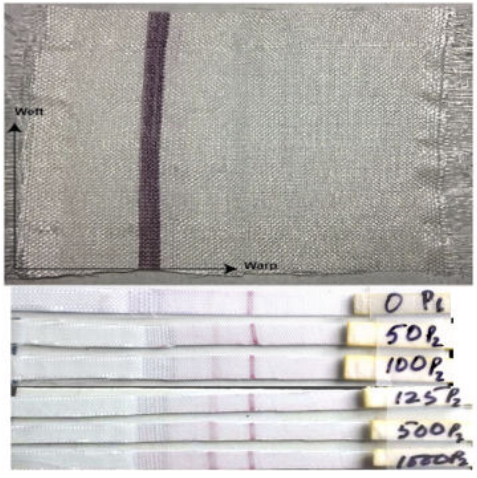
- hCG detection:



- Collaboration: Microfluidics (Dr. Siva Vanjari, IITH) and Image processing