Vital Monitor and ID Detection through Machine Vision for Improving EMS Communication Efficiency

Computer Integrated Surgery II
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Introduction

- **Implemented detection and optical character recognition (OCR) algorithms** for the extraction of information from driver licenses and the Zoll and LIFEPAK vital monitors using smart glasses video feed.
- **Increased accuracy of extracted data** by using weighted frame averaging algorithm.

This was done to improve on-the-field outcomes by **moving time spent on documentation to patient care**, and by **increasing remote physician confidence and treatment speed**.

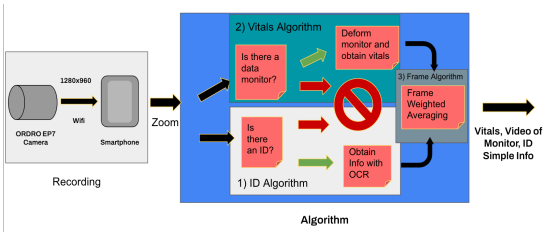
The Problem

- Smart glasses have only recently been introduced within healthcare settings to record and stream medical procedures, [1] and **there is room for AI and Computer Vision**.
- In on-the-field emergency medicine, **1-10 minutes can be spent obtaining simple information** (name, birth date, address, ID#). [2]
- Without recording vitals**, 43.4% of information can be lost**. [3] Furthermore, **physicians are 2-3x more confident and give treatments 2-3x faster** when they can confirm vitals for themselves. [3]

The Solution

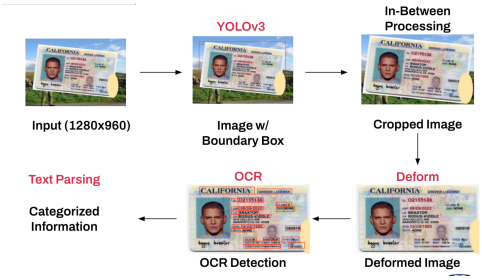
Detection and Extraction Algorithm

- Zoom recording is fed into three components in the algorithm: the ID extraction, the vitals extraction, and the frame averaging algorithm



Individual Detection and Extraction Algorithms

- Used YOLOv3 object detection, Hough Transform Edge detection and deformation, and Tesseract OCR (w/ some localization) to extract data from IDs and vitals.



Weighted Frame Averaging Algorithm

- Implemented weight frame averaging with inspiration from work by Petrova. [4]
- Frames that are in-focus contribute more to a running estimation of data.

Results

Component Tests

- Representative images were fed in, and accuracy was determined as: detected/total, true transform–estimated transform, true words/total words.
- 38ms per frame is too slow for 60 fps camera.

Step	Target Accuracy (or Loss)	Recorded Accuracy (or Loss)	Target Speed	Recorded Speed
YOLOv3	96%	99%	8ms	30ms
Deformation	<0.01	0.008	2ms	2ms
OCR and Location Parsing	96%	93%	3ms	6ms
Overall	88.8%	89.28%	16ms	38ms

Frame Averaging Tests

- Fed representative videos into full algorithm. Frame averaging increases accuracies.

Video	Target Accuracy (or Loss)	Recorded Accuracy (or Loss)
Driver Licenses	95%	94% -> 95%
Vitals Information	95%	~89% -> 99%

Future Work

- Incorporate more types of IDs into algorithm
- Incorporate more types of vitals monitors
- Implement the algorithm into the cloud-based workflow using live smart glasses feed.

Lessons Learned

- Use object detection, deformation, character recognition, and frame averaging algorithms.
- Data augment appropriately for the task.
- Construct tests to evaluate algorithm performance.

Acknowledgements

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References

[1] Vuzix Corporation. Vuzix Corporation, 2020, *VUZIX SMART GLASSES AT THE CHI MEI MEDICAL CENTER, TAIWAN*, ss-usa.s3.amazonaws.com/c/308483104/media/21105f5a523ce21ce43889049199725/Vuzix-Chi-Mei-Medical-Case-Study-2020.pdf.

[2] Crawford S, Kushner I, Wells R, Monks S. "Electronic health record documentation times among emergency medicine trainees." *Perspect Health Inf Manag*, 2019;16:1f.

[3] Schaer, et al. "Using Smart Glasses in Medical Emergency Situations, a Qualitative Pilot Study." *2016 IEEE Wireless Health (WH)*, 2016, doi:10.1109/wh.2016.7764556.

[4] O. Petrova, K. Bulatov, V. Arlazarov, V. Arlazarov, Weighted combination of per-frame recognition results for text recognition in a video stream, Computer Optics. 45 (2021) 77–89. doi:10.18287/2412-6179-co-795.

Datasets

License Dataset

Dataset Characteristics:

- **23834 Data Augmented** Images of ID
  - USA IDs transformed and brightness-adjusted and pasted onto empty backgrounds.
  - Add geometry (pentagon, circle, or oval) of 'skin' and white/grey colors to emulate obstructions.
- **11723 Natural Images** of ID
- **7209 Negative Images**
  - Images of Potential Confusers: Smartphones, Billboards, Books, etc.

[7] [8]

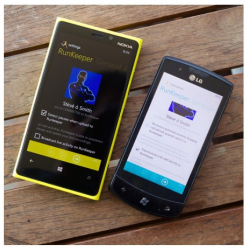
ID transformed and 'pasted' on background.

[7] Gould, Stephen, Richard Fulton, and Daphne Koller. 2009. "Decomposing a Scene into Geometric and Semantically Consistent Regions." *2009 IEEE 12th International Conference on Computer Vision*. doi:10.1109/iccv.2009.5459211.
[8] Shaw, Gabbi, and Frank Olito. 2020. "What a Driver's License Looks like in Every State." *Insider*. Insider. January 21. https://www.insider.com/what-drivers-license-looks-like-in-every-state.

License Dataset

MIDV-500 Natural Images of Non-US IDs [9]

Negative Images of potential confusers [10]



[9] V. V. Arlazarov, K. Bulatov, T. Chernov and V. L. Arlazarov, "A dataset for identity documents analysis and recognition on mobile devices in video stream", *Comput. Opt.*, vol. 43, no. 5, pp. 818-824, 2019.
[10] Kuznetsova, Alina, Hassan Rom, Neil Alldrin, Jasper Uijlings, Ivan Krasin, Jordi Pont-Tuset, Shahab Kamali, et al. 2020. "The Open Images Dataset V4." *International Journal of Computer Vision* 128 (7): 1956–81. doi:10.1007/s11263-020-01316-z.

Vitals Monitor Dataset

Monitors:

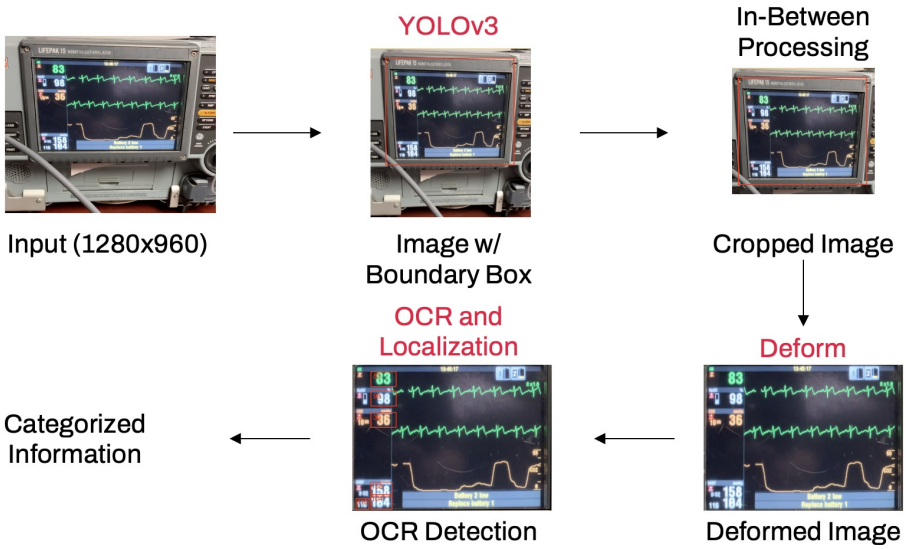
- 3240 Positive Zoll Images
  - Homography, Color, and Brightness Augmented
- 5620 LIFEPAK Images
  - Homography, Color, and Brightness Augmented
- 7209 Negative Images
  - Potential Confusers: Smartphones, Billboards, Books, etc.

Other Figures

Performance - Identification

Step	Target Accuracy (or Loss)	Recorded Accuracy (or Loss)	Target Speed	Recorded Speed
YOLOv3	95%	99%	8ms	30ms
Deformation	<0.01	0.009	2ms	1ms
OCR	95%	96%	3ms	6ms
Text Parsing	95%	99%	3ms	<1ms
Overall	85.7%	94%	16ms	37ms

Technical Approach - Vitals Monitor



Performance - Vitals Monitor

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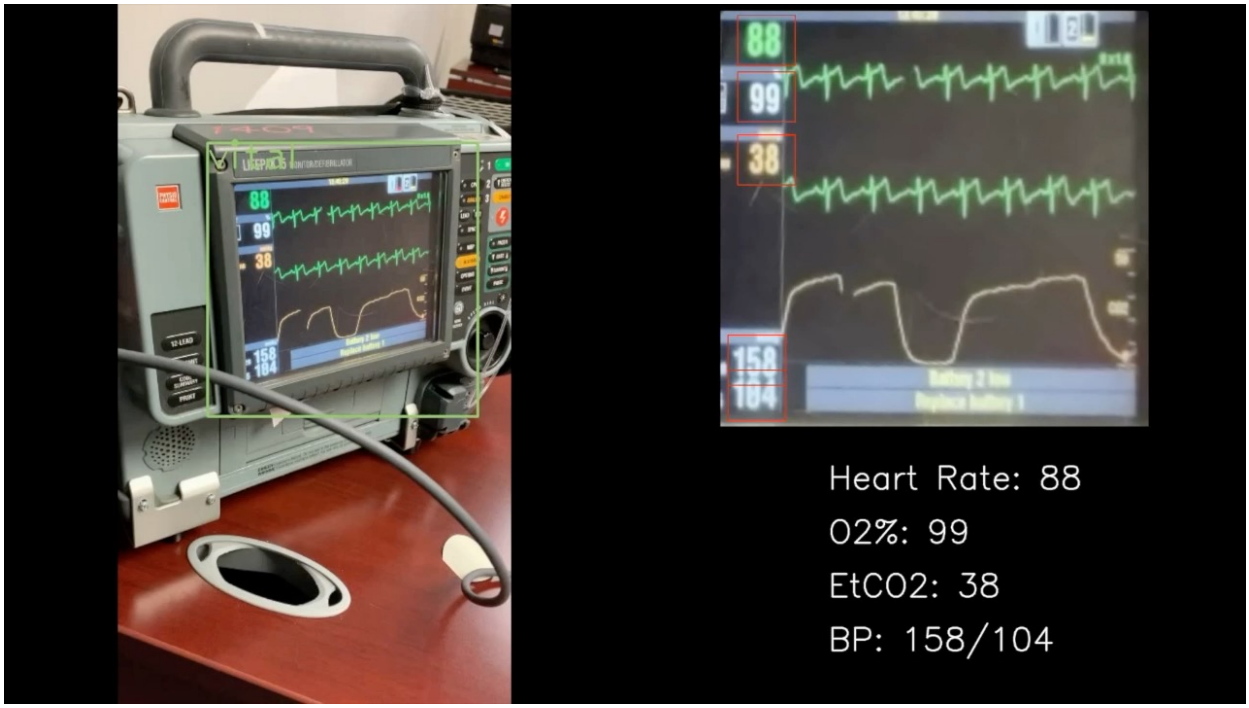
pharmacy


88
99
38
158
104
Heart Rate: 88
02%: 99
EtCO2: 38
BP: 158/104