VISION
Through Early Cataract
VISION
Through Advanced Cataract
90% of population develops cataracts

3.8M cataract surgeries per year

40 surgeries done by each surgeon per day

3 Months of wait time
90% of population develops cataracts
3.8M cataract surgeries per year

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3 Months of wait time
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90% of population develops cataracts

3.8M cataract surgeries per year

40 surgeries done by each surgeon per day

3 Months of wait time
CATARACT SURGERY

98% SUCCESSFUL
Average 10 minutes each

2% SUBOPTIMAL
76,000 surgeries
CATARACT SURGERY

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76,000 surgeries
CATARACT SURGERY

98% SUCCESSFUL
Average 10 minutes each

2% SUBOPTIMAL
76,000 surgeries
GOAL

More effective surgeries.
Why more effective surgeries

Less time with surgical tools in your eyes
Why more effective surgeries

Less time with surgical tools in your eyes

Less physical damage
Why more effective surgeries

Less time with surgical tools in your eyes

Less physical damage

Better recovery
Why more effective surgeries

More surgeries can be performed
Why more effective surgeries

More surgeries can be performed

1% improvement
Why more effective surgeries

More surgeries can be performed

1% improvement

38,000 more surgeries per year
Why more effective surgeries

Surgeons can spend more time with patients diagnosing their problems.
Surgeons and athletes watch replays to improve themselves.
SOLUTION

- Use machine learning to obtain useful data from surgery videos by tool detection
- Provide surgeons surgical analysis for self improvement
- Improve overall surgical performance
WHY TOOL DETECTION

- Tools can indicate surgery procedures. Eg. scalpel means some sort of cutting performed on patient
- Measuring the time of each tool being used will give us an overview of the surgery performed
- Therefore, we successfully extract surgical procedure out of surgery videos
USER FLOW

Surgery Videos

Upload

Machine Learning Tools Analysis

Evaluation Function

Get Insights
USER FLOW

- Surgery Videos
- Upload
- Machine Learning Tools Analysis
- Get Insights
- Evaluation Function
USER FLOW

Surgery Videos → Upload → Machine Learning Tools Analysis → Get Insights

Evaluation Function
USER FLOW

Perform Better Surgery In the Future
SURGICAL TOOL RECOGNITION

Image 400*400 ➔ Convolutional Neural Network

- Slit Knife
- Capsule Grabber
- Canula
SURGICAL TOOL RECOGNITION

Image 400*400 ➔ Convolutional Neural Network ➔ Slit Knife, Capsule Grabber, Canula
SURGICAL TOOL RECOGNITION

- Image 400*400
- Convolutional Neural Network
- Probability Score
  - 17% Slit Knife
  - 14% Capsule Grabber
  - 56% Canula
SURGICAL TOOL RECOGNITION

Image 400*400 → Convolutional Neural Network

Probability Score
- Slit Knife: 17%
- Capsule Grabber: 14%
- Canula: 56%
TWO SURGICAL TOOL RECOGNITION

Probability Score

- Slit Knife
- Capsule Grabber
- Canula
TWO SURGICAL TOOL RECOGNITION

Probability Score

- Slit Knife: 67%
- Capsule Grabber: 92%
- Canula: 23%
NO SURGICAL TOOL RECOGNITION

Probability Score

- **12%** Slit Knife
- **9%** Capsule Grabber
- **17%** Canula
PIPELINE

WEB
React

SERVER
Flask

DATABASE
Firebase
Training Data

- Difficult to access due to patient privacy
- Almost none of them are labeled
- Eventually we have to record the data in Alcon’s surgery room
CHALLENGE

Machine learning design

- Trade off between long training time and better accuracy
- Limit parameters to find the balance
  - input image size
  - hidden layers
- Final result:

  6 HOURS TRAINING TIME
  87% ACCURACY
- Extend to more kinds of surgeries
  - Correlate post-surgery outcomes with surgery procedure
  - Get more data such as motion detection beyond tool recognition
FUTURE IMPLEMENTATIONS

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- Correlate post-surgery outcomes with surgery procedure
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FUTURE IMPLEMENTATIONS

- Extend to more kinds of surgeries
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- Get more data such as motion detection beyond tool recognition
CONCLUSION

- **Goal: Better and more efficient surgery**

  A webapp that understands surgical details and provide valid insights.

- Surgeons can then use the insights to self improve

- Benefit both the patients and the surgeons
CONCLUSION

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CONCLUSION

- Goal: Better and more efficient surgery
  - A webapp that understands surgical details and provide valid insights.
  - Surgeons can then use the insights to self improve
  - **Benefit both the patients and the surgeons**