QUICKDRAW GAME – SHAPE DETECTION USING AWS DEEPLENS AND ALEXA ECHO DEVICE

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QuickDraw game

QuickDraw is an interactive drawing game between players and Alexa echo device. An AWS DeepLens will capture what a player draws on a whiteboard or a paper and inference the drawing to the most relevant object. This game is a great way for developers who are interested in deep-learning applications with DeepLens and exploring AWS services and how to connect DeepLens with Alexa Skill.
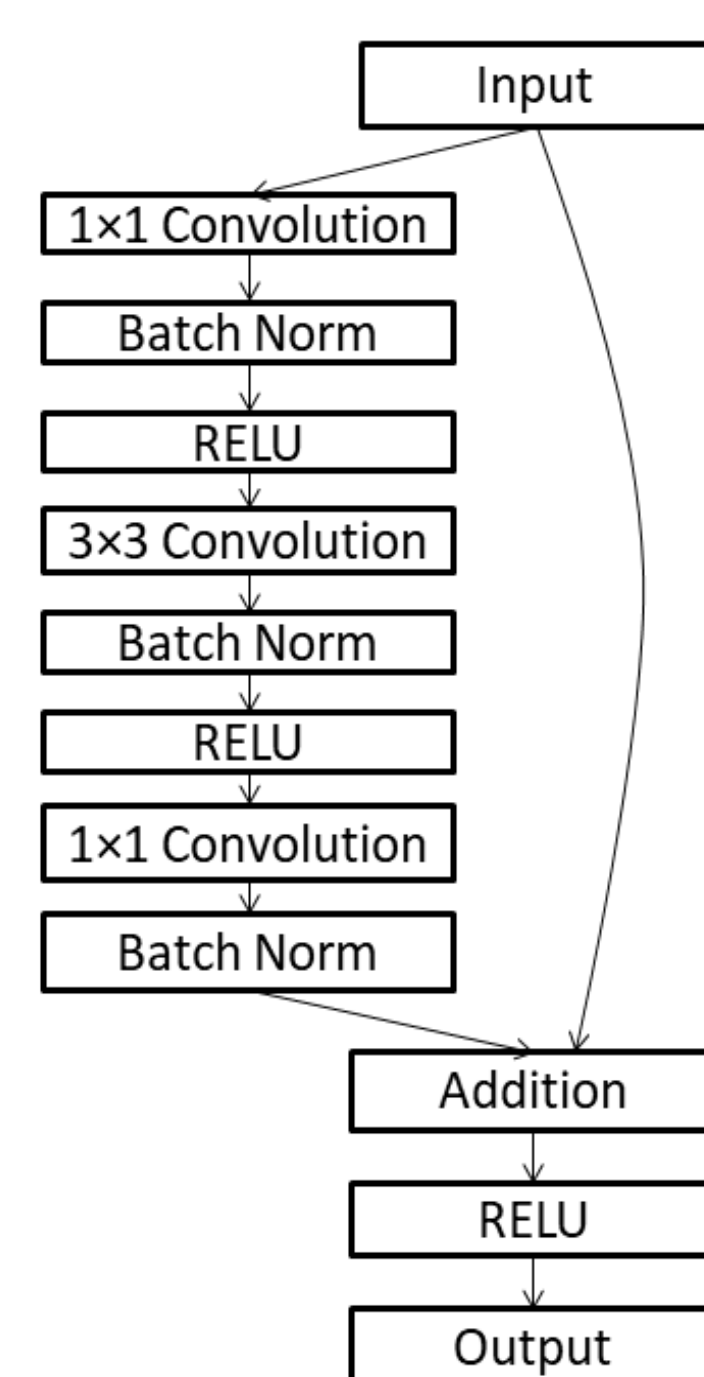
AWS DeepLens

- DeepLens is a deep learning enabled video camera that allows developers to implement their machine learning/computer vision/deep learning models on a physical device.
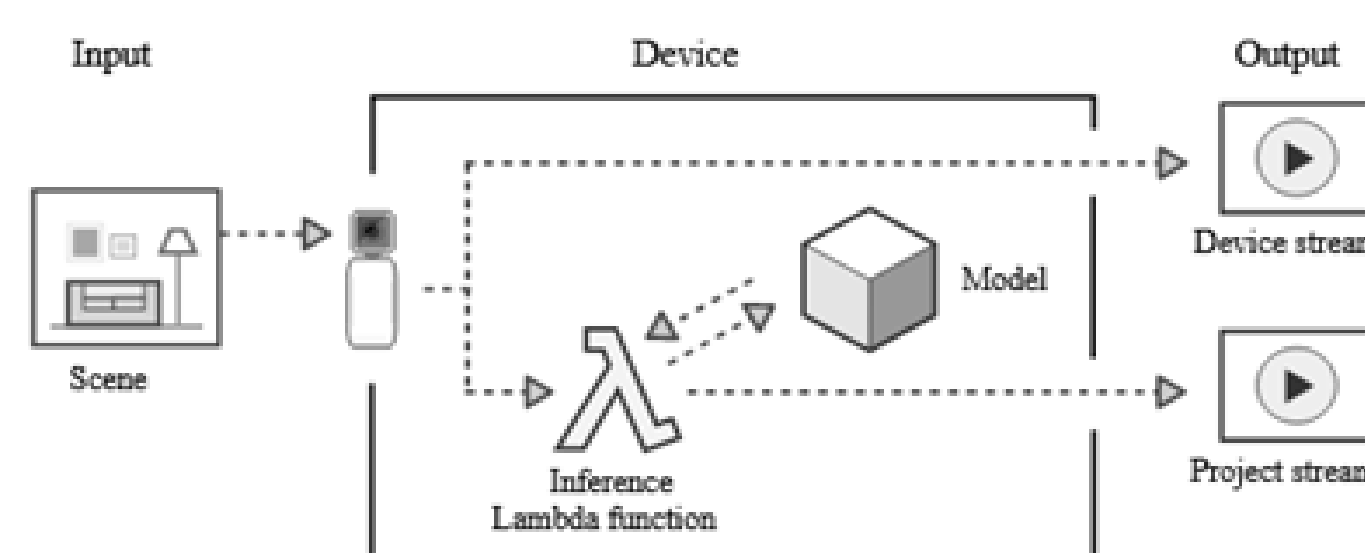
Shape Detection Deep Learning Model

- Data: 32x32 arrays representing binary shapes of various objects from Quickdraw open dataset [1].
- We applied edge detection to detect objects within a certain field of interest as a part of preprocessing for the test data.
- Training processing:
  - Resized images to 224x224.
  - Finetuned a Resnet 50 and MobileNet Architecture for classifying 35 objects.
  - Data augmentation of random rotation, horizontal and vertical flips, random crops from the resized images for robust results.
  - Trained the architecture with 80-20 train-test split. We took 1600 images for training and 400 images for testing for each class.
  - Training time varied from 24-36 hours.
  - Resnet 50 outperformed MobileNet in terms of accuracy..

Input
↓
1×1 Convolution
↓
Batch Norm
↓
RELU
↓
3×3 Convolution
↓
Batch Norm
↓
RELU
↓
1×1 Convolution
↓
Batch Norm
↓
Addition
↓
RELU
↓
Output

Data Preprocessing Methodology

- Since the images DeepLens captures have fisheye distortion, we perform our fisheye calibration algorithm to get the information of the lens and eliminate the distortion caused by the DeepLens' ultra-wide-angle lens. This step could straighten the edges and clarify the drawing region so that the ROI locating performs more robust and accurate [2].
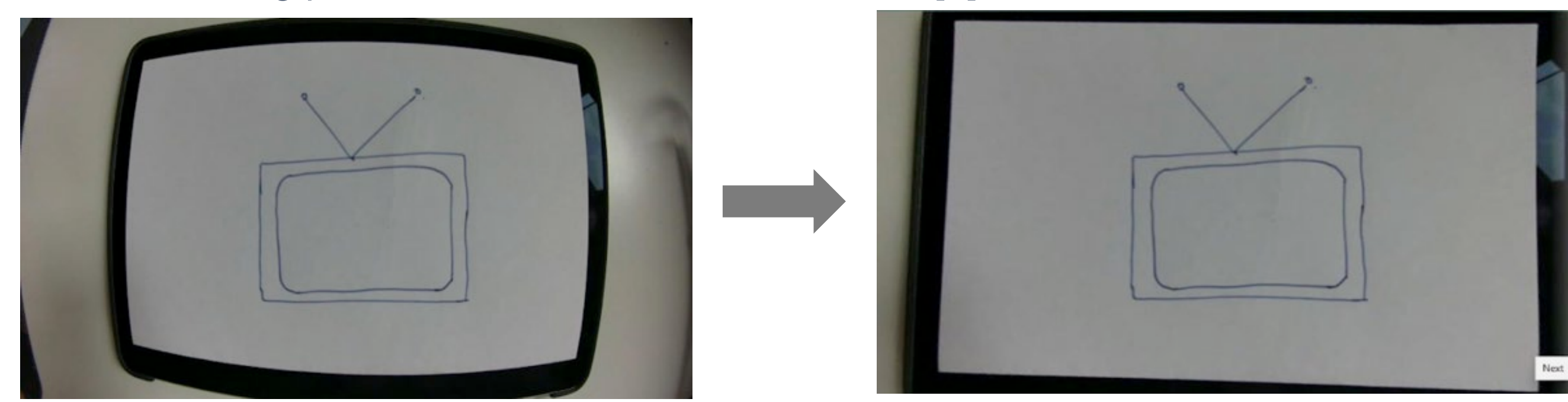
- Next, we design white paper edge detection algorithm to crop every frame and locate the ROI (paper or whiteboard) and achieve the drawing area by removing the background.
- The preprocessing pipeline: image undistort → enhancing color and contrast of images → locating and cropping the drawing region → cropping image enhancement.
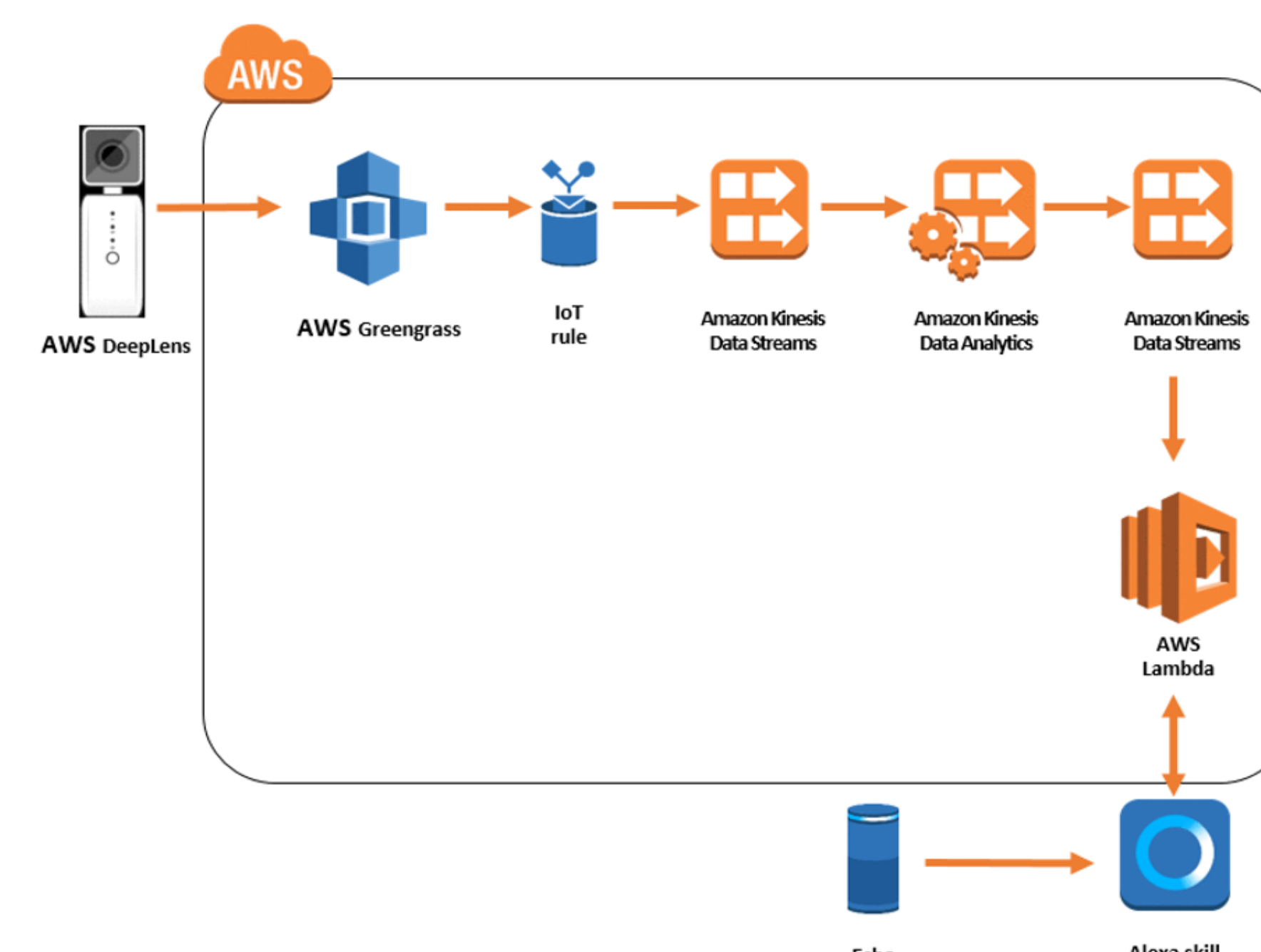
Before preprocessing   After preprocessing
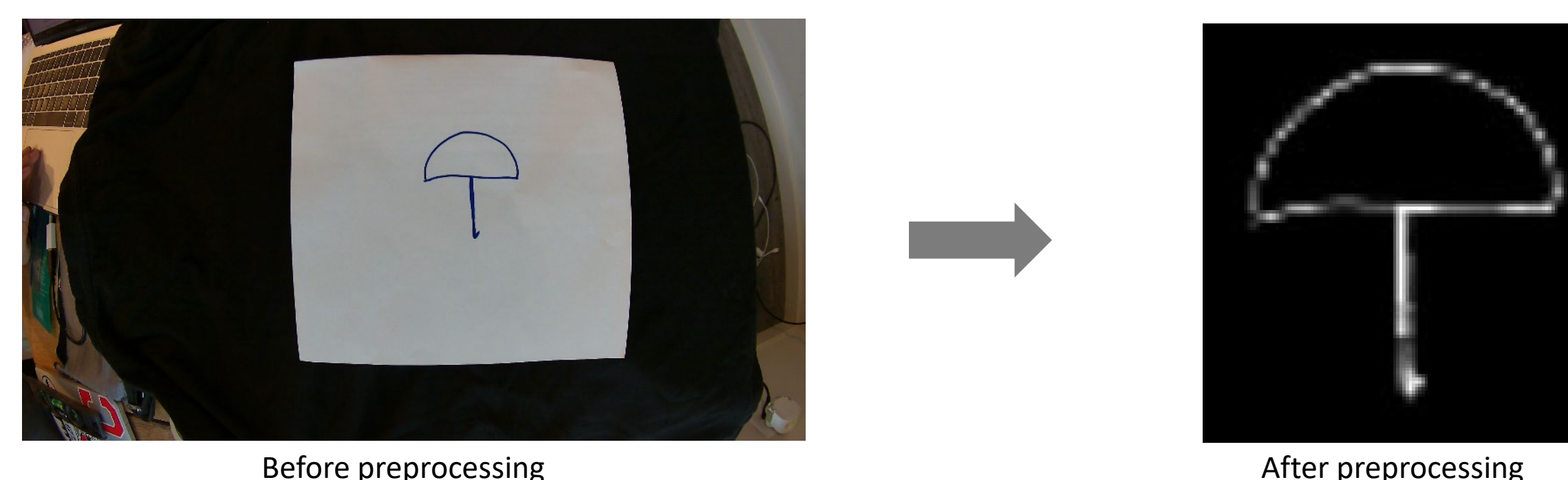
Model Result

- Achieved 95.3% accuracy on training set.
- Achieved 93.1% accuracy on test set with 94% precision.

AWS DeepLens to Alexa Skills

- The results of the model will go to IoT rule in AWS and lead to Amazon Kinesis Data Streams where we obtain the results in real time.

- The lambda function designated for QuickDraw game with Alexa Skills will get the outputs of Kinesis Data Streams once the Alexa echo device is triggered to play the game.

AWS DeepLens   AWS Greengrass   IoT rule   Amazon Kinesis Data Streams   Amazon Kinesis Data Analytics   Amazon Kinesis Data Streams   AWS Lambda   Echo   Alexa skill

QuickDraw Game Interaction with Alexa Echo Device

- The players can interact with an Alexa Echo Device to play QuickDraw by saying "Alexa, play QuickDraw with DeepLens."
- The game has clear instructions and playful interactions between Alexa and players.
- The logics of the game is shown below:
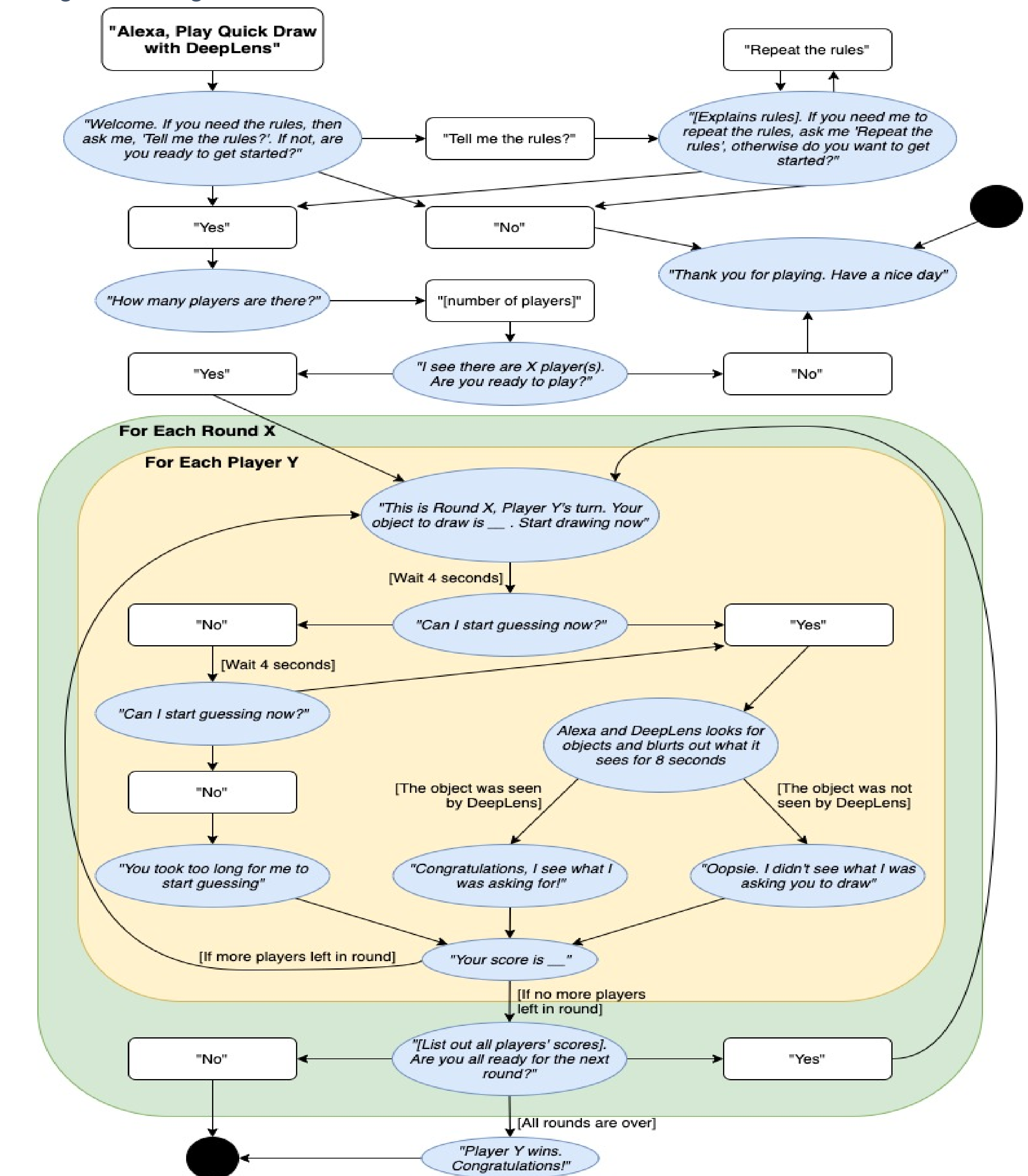
Future Work, References, and Acknowledgments

- Improve our current white paper edge detection by taking factors such as reflections on whiteboards, bad lighting, noisy background, etc into consideration.
- Develop a deep-learning model that takes fewer training data and finds a drawing region automatically.

Industry Mentor: Phu Nguyen

[1] Google Inc. QuickDraw Dataset. [Online]. Available at: https://github.com/googlecreativelab/quickdraw-dataset.
[2] "Fisheye camera model," OpenCV. [Online]. Available: https://docs.opencv.org/master/db/d58/group__calib3d__fisheye.html. [Accessed: 26-May-2020].

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