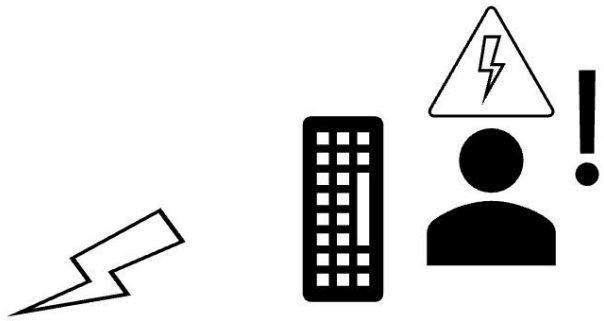
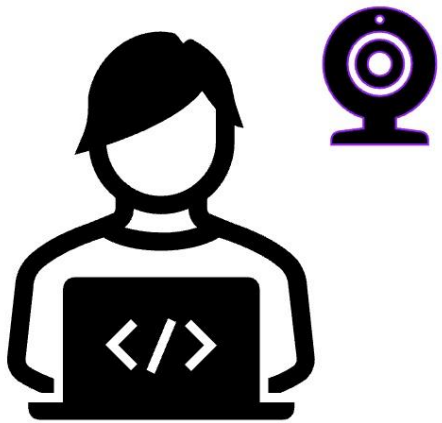
BADNet for Tele-Operated Robotics - Experiment

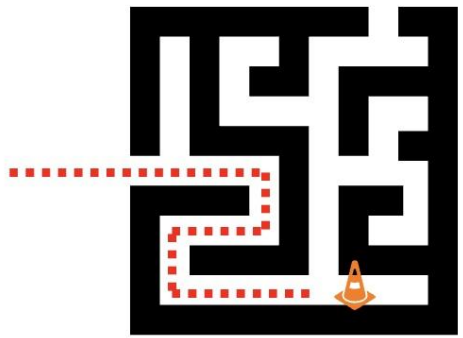
Beyond a dataset of Human reactions to robotic failure.



Robot Teleoperator



Teleoperated Robot



Remote Environment

Demo Task

- A robot dog is navigated by a teleoperator for inspecting the environment
- Webcam tracks user reactions with fine-tuned BADNet *
- An external actor simulates unexpected errors and perturbations in the environment for operator to navigate through
- BADNet tracks user reaction to unexpected robot failure *

Video Demo Data Collection & Model Training

Test-Train Data Split

~18% Train / ~82% Test

-BADNet out of the box performance on unseen people shows weak performance

-BADNet with **small training data size** and **short fine-tuning** training time (~50 epochs) shows strong classification performance

-Implementation of BADNet demonstrates efficiency as it only has 50K parameters (can fit in a floppy disc) but also be adapted to new data easily

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 layer1 (Conv2D)             (None, 112, 112, 16)      784

 dropout (Dropout)           (None, 112, 112, 16)      0

 layer2 (Conv2D)             (None, 56, 56, 32)        8224

 dropout_1 (Dropout)         (None, 56, 56, 32)        0

 layer3 (Conv2D)             (None, 28, 28, 64)        32832

 dropout_2 (Dropout)         (None, 28, 28, 64)        0

 batch_normalization (BatchN  (None, 28, 28, 64)       256
 ormalization)

 global_average_pooling2d (G  (None, 64)               0
 lobalAveragePooling2D)

 flatten (Flatten)           (None, 64)                0

 dropout_3 (Dropout)         (None, 64)                0

 dense (Dense)               (None, 128)               8320

 dense_1 (Dense)             (None, 2)                 258

=================================================================
Total params: 50,674
Trainable params: 50,546
Non-trainable params: 128
_________________________________________________________________
```

Out of Box

```
Accuracy: 0.474679
Precision: 0.773193
Recall: 0.474679
F1 score: 0.391870
Cohens kappa: 0.121736
```

Fine-Tuned

```
Accuracy: 0.844991
Precision: 0.892596
Recall: 0.844991
F1 score: 0.848564
Cohens kappa: 0.690859
```

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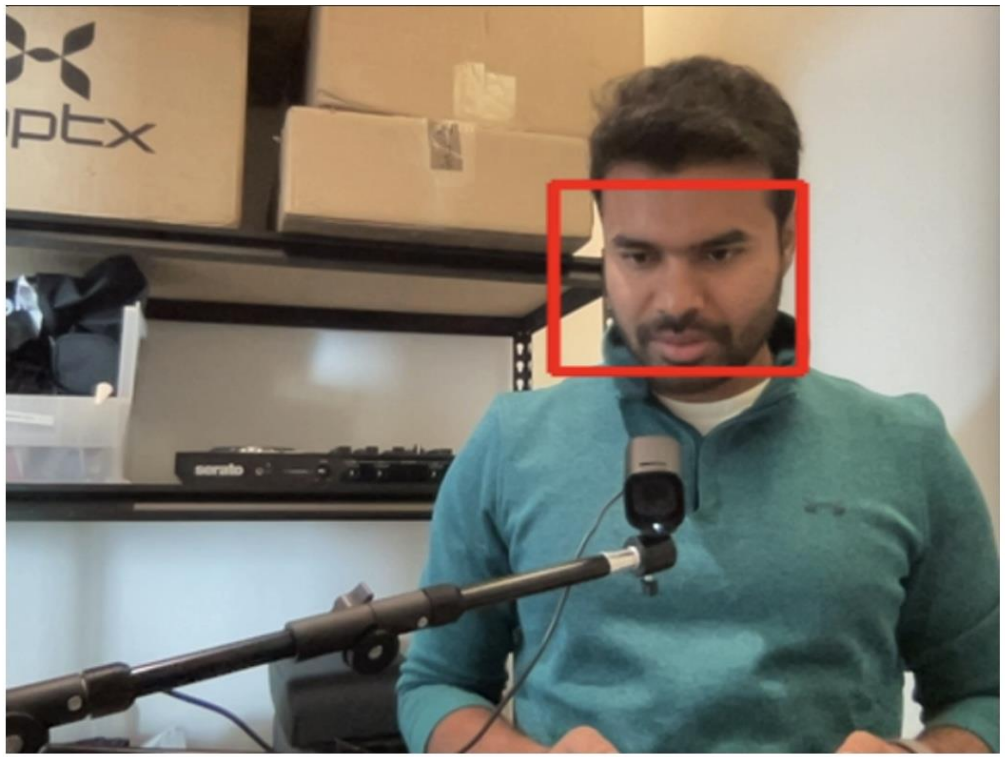

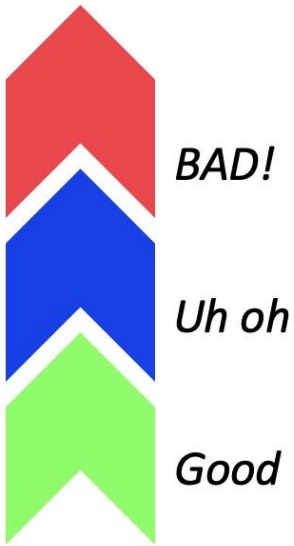

-Deployment of BADNet during the tele-operation of semi-autonomous robot.
-Operator navigates robot through front binocular view
-Random perturbations and unexpected obstacles elicit reactions from operator
-Robot dog unexpectedly crashes and BADNet tracks robot error through user reactions

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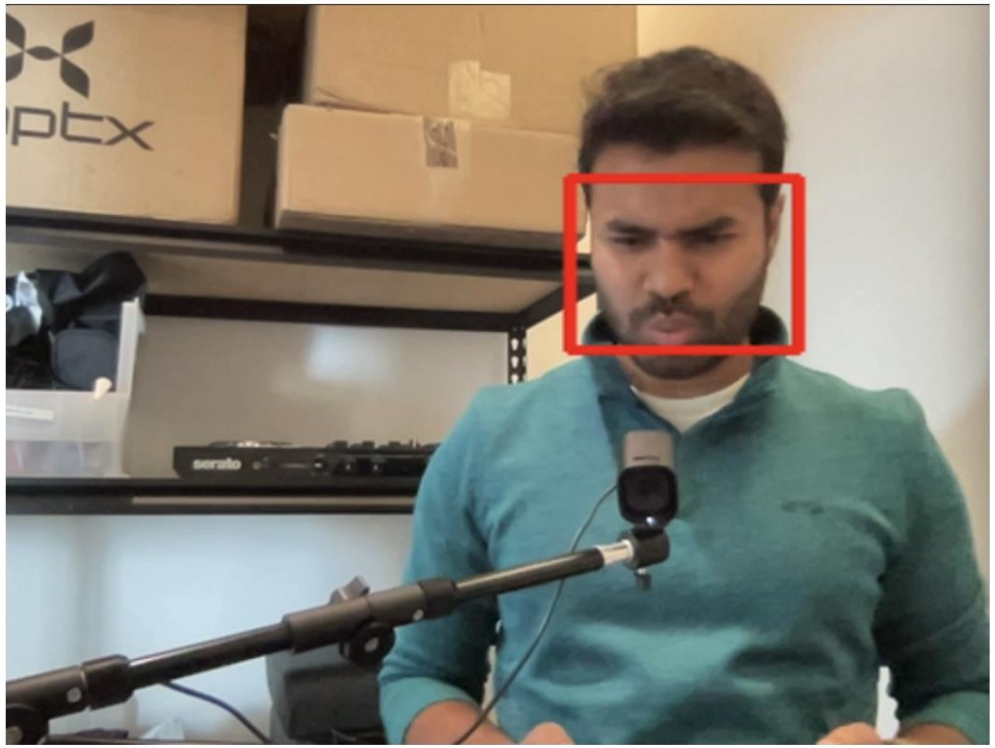

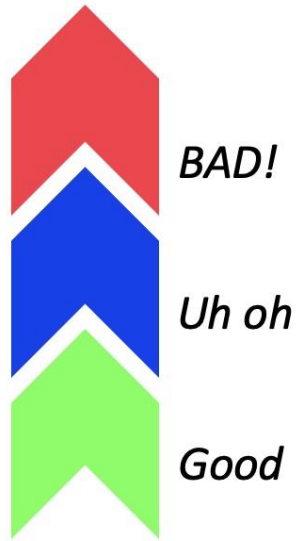

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