Automated Oatmeal Overflow Detection

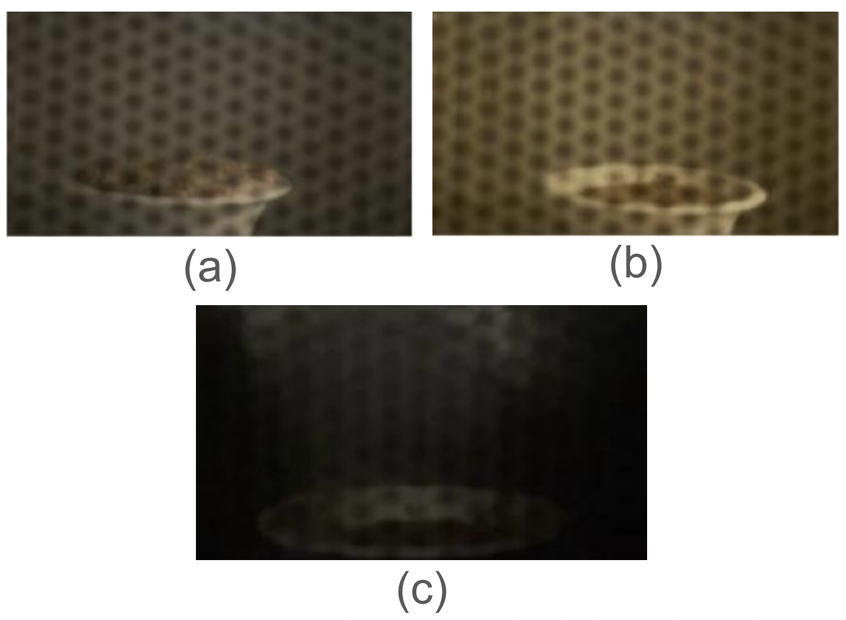
Gautham Anant
gpsa@uw.edu

Motivation

- We want to prevent microwave oatmeal overflow with vision
- Existing approaches require camera inside microwave and regular CV fails is challenging within microwave environment

Dataset

- We collect 33 videos of oatmeal heating
- Frames are sampled every 300ms and classified as off, safe, or unsafe, for 1744 frames in total
- Since unsafe frames only occur in the last second or so before heating must stop, there is a class imbalance of only 16% unsafe images



(a) (b)

(c)

Fig 1: an of a (a) unsafe (b) safe (c) off fram unsafe frame

Fig 2: data collectiaffectingon and inference setup

Architecture

- We remove the last 10000 way classifier of MobileNetV3 and replace it with a 3 way linear classifier layer (the *head*)

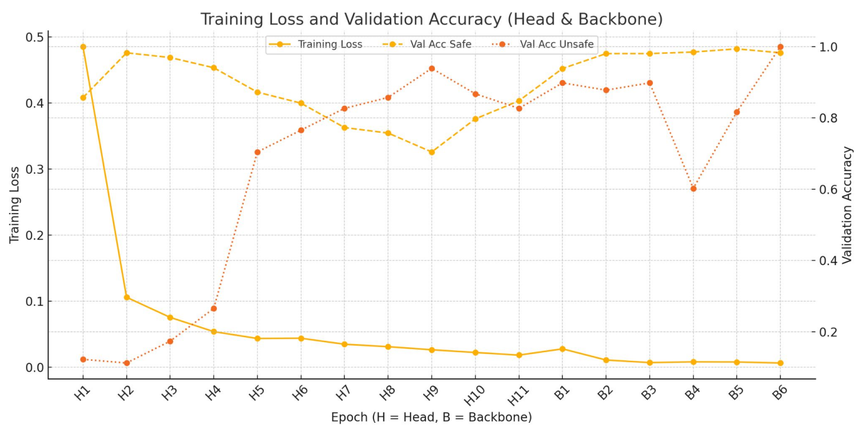


Fig 3: validation and test accuracy and loss over training

Training

- We counteract our class imbalance by sampling training frames proportional to their inverse sample count with a 10x oversampling of unsafe frames
- In addition, we use focal loss with $\alpha = 7.0$ for unsafe samples and $\gamma = 2$ for all classes
- We train the head while holding the backbone (the rest of the model) constant until 75% validation recall is achieved on all classes
- Then, we unfreeze the backbone and train the entire model until 90% validation recall is achieved on all classes

Results

- >99% recall for all classes for the backbone included model
- >90% recall for all classes for head only model

Inference

- Inference takes approximately 7ms on a CPU
- Interestingly, images must be JPEG compressed before being fed into the model, since the model trained on JPEG compressed inputs
- Currently, the model does not generalize to other cameras due to the microwave mesh
- Empirically, we find that stopping heating a single unsafe prediction prevents overflow better than other approaches due to latency

Prototype

- We tape a servo operated arm to the microwave controlled by a Raspberry Pi 3 B+ which our overflow detector calls over http to press the STOP button on the microwave
- We find that all overflow situations are avoided

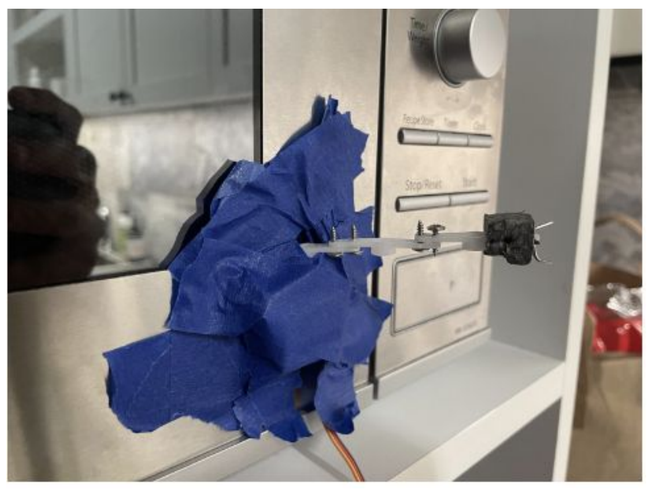


Fig 4: Servo arm used to stop microwave

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