

Mask Recognition in the Safe Entry Scanner



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The SARS-CoV-2 Pandemic

- Causes **COVID-19** disease
 - **USA fatality rate hit 4.7%, now 1.7%**
 - About **10-15% severe, 5% critically ill**
 - Initial recovery in **2-6 weeks**
 - **Longer-lasting effects for some, no cure**
- Incubation time **2-14 days**, during which time one might be **infectious without symptoms**
- **Vaccines** might prevent COVID-19, but it is **still possible to spread virus**

SARS-CoV-2 Transmission

- **Contact transmission**
 - Transfer to mouth, nose, or possibly eyes
 - Virus viable on surfaces for hours to days
- **Droplet transmission** (usually $\leq 6'$)
 - Inhalation of airborne droplets/particles
 - Drop out of air quickly
- **Airborne transmission** (to 20' or more)
 - Smaller, still ***much larger than the virus***
 - Remain airborne for hours

Mask Use

- **Fit matters**
 - cover mouth
 - cover nose
 - want good seal (and no vent)
- Can trap many droplets/particles, reduce spread



1 Wash your hands.



2 Fit the mask across the bridge of your nose and under your chin.



3 Loop the fasteners behind your ears or tie them behind your head, depending on your mask's style.



4 Henceforth, consider the mask's surface contaminated, inside and out. Don't touch it. Don't adjust it. (And wash your hands if you do.)

Image credit: Brown Bird Design via Scientific American

Related Work

- Lots of work detecting masked faces:
 - Real-World Masked Face Dataset (RMFD)
 - *Face-mask recognition has arrived – for better or worse*, National Geographic, 9/20
 - COVID-19 Mask Detector (using RFID)
- What's different?
 - Wider mask variety, but positioned face
 - Detect **proper mask use** vs. **masked face**
 - Part of an **integrated entry scanner**

Covered Safe Entry Scanner Implementation Structure

- Built using C/C++ & OpenCV
- Platforms (24/7 capable with AC power)
 - Develop & test on \$250 Linux laptop
 - Intended to run on <\$100 Android tablet
- Designed for low-quality built-in camera
- Optional:
 - Add-on thermal imager
 - Remote sqlite database via 802.11

Mask Check At An Entry

- Use simple machine vision to automatically confirm a mask is being worn correctly
- Automatically test one person at a time
 - Begin when a person is present
 - Require person to align their face
 - Must be reasonably robust to face masks of many different designs
 - Signal and/or open door (no operator)
 - Optional temp check & contact tracing

Initial Mask Check Algorithm

1. Wait for a person to be detected
2. Show live camera view with alignment outline and instruct user to align their eyes
3. Use HAAR classifier to recognize left and right eyes in the designated areas and at appropriate scale
4. If both eyes were found, use HAAR classifiers to check for nose and mouth
5. Unless sufficient data or time out, go to 3
6. Announce & record nose/mouth statistics
7. Go to 1

Mask Check Performance



About 85% correct rate...
most wrong imagine seeing mouth

Improving Mask Check

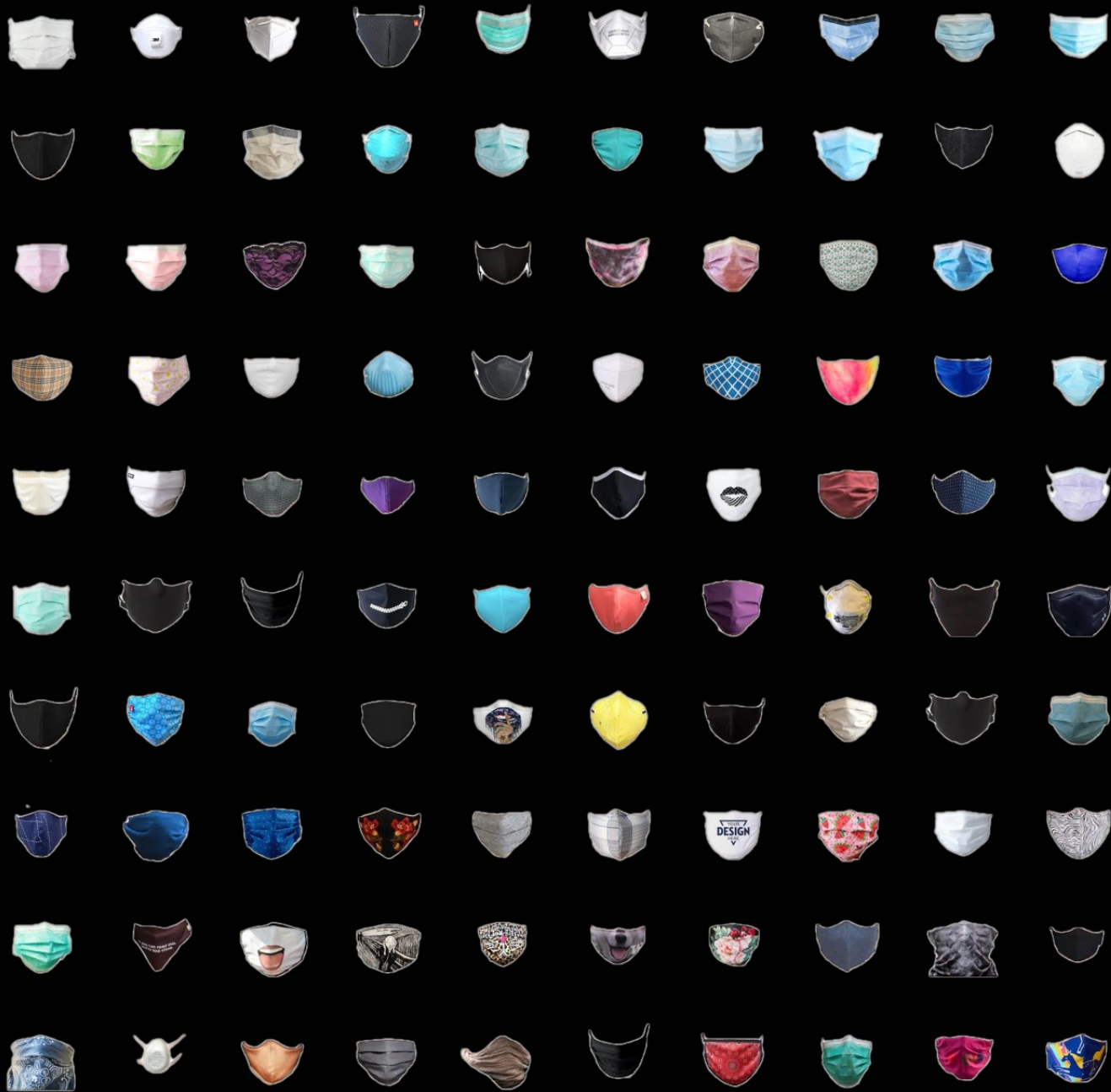
- Mouth is almost never uncovered if nose is covered:

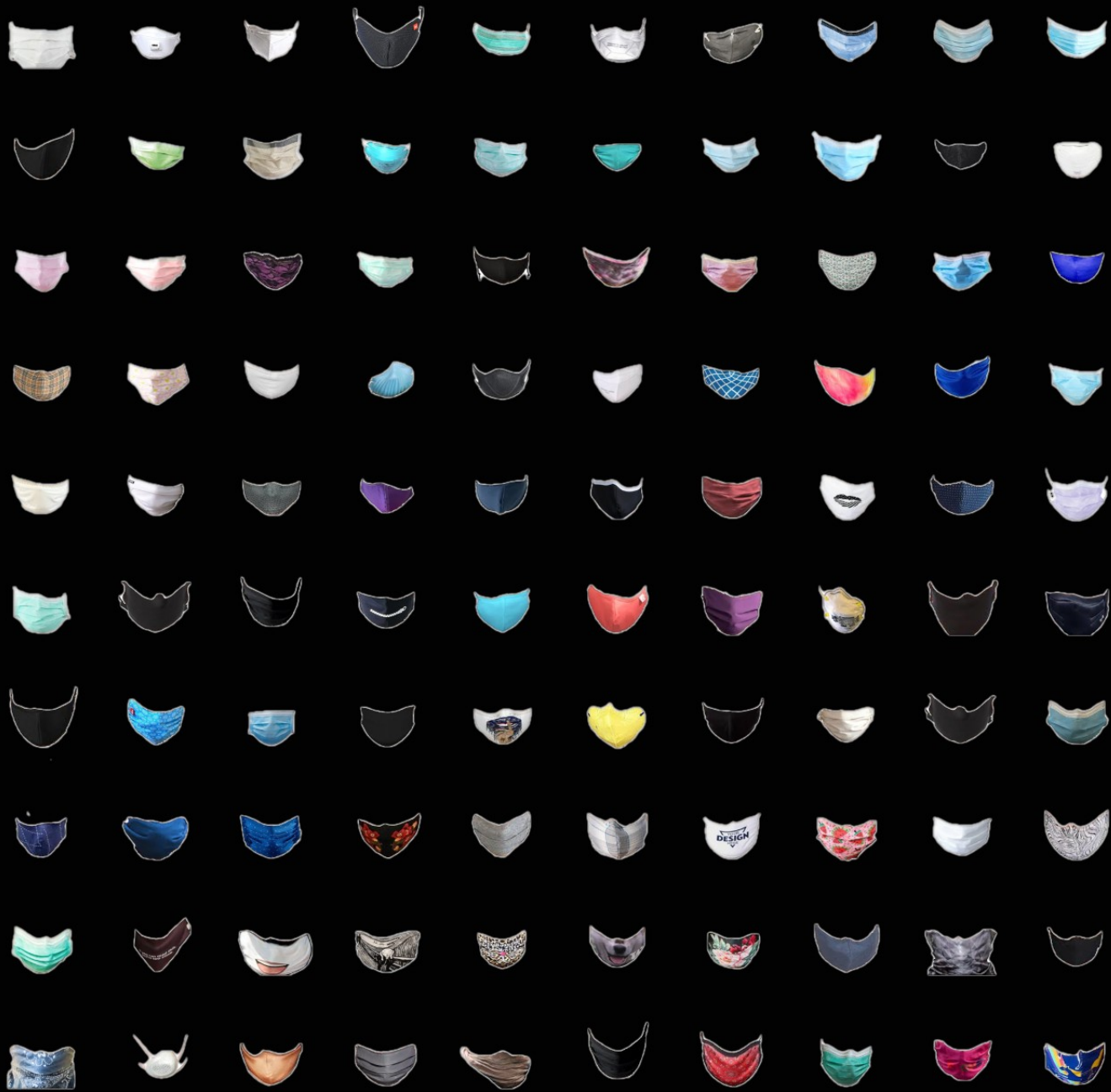
covered nose \Rightarrow covered mouth

- Improves accuracy, but not real-world tested
- This also **handles masks with clear sections**, such as those designed to permit lip reading

Improving Mask Check

- Train a recognizer to distinguish masked, nose uncovered, and both nose and mouth uncovered in eye-aligned images
- Training data set
 - Collected & extracted **100 mask images**
 - Manually warped mask images to make improperly-worn variants
 - Collected **~2000 diverse** face images
 - Software randomly places **aligned** masks or variant masks on faces



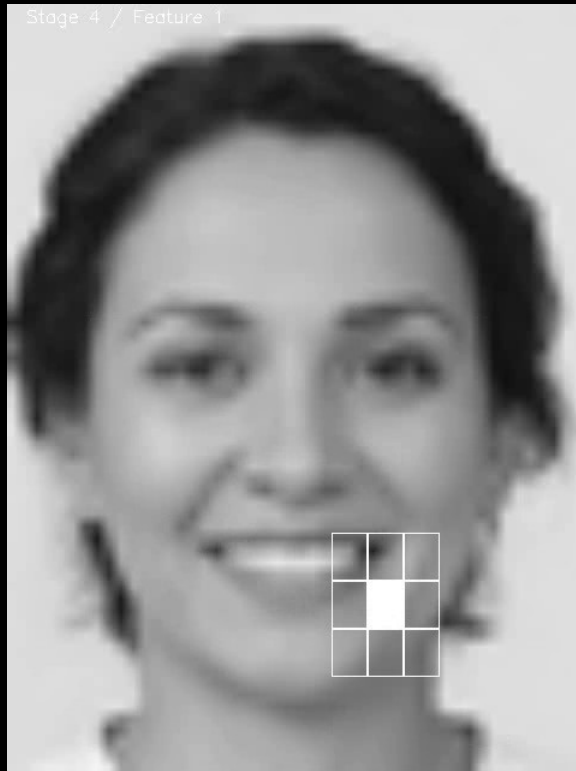


Sample Training Images



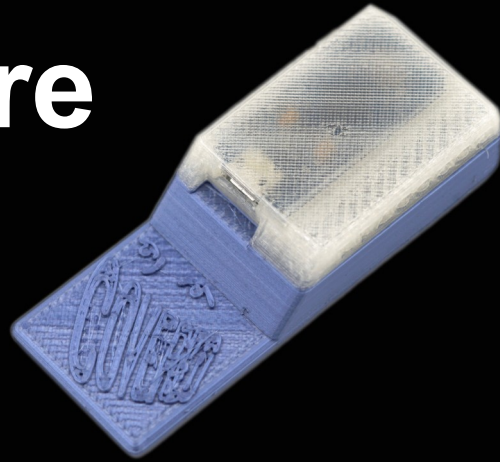
Faces of people who don't exist... with aligned masks imposed at random

Training Results



Mouth covered tests only around mouth, but
nose+mouth tests mostly for nose

Temperature Check



- Temperature checks often mandated as a COVID-19 check, but are **not reliable**
 - Poor correlation with infectiousness
 - Most sensors not accurate enough

- **\$50 USB thermal imager** based on **KVIRP**

<https://doi.org/10.2352/ISSN.2470-1173.2020.14.COIMG-392>

Contact Tracing (Optional)

- The system **never matches/records a face**; to identify yourself, you show a **QR code**
- **Contact tracing using QR codes**
 - Each person has **one ID** and **n QR codes**
 - Each entry/exit is QR code tagged
 - Infection/quarantine status by QR code
 - Person can use ID to check status online or gets flagged by QR code at entry;
no personal/contact data in the database
 - Bypass checks for recently cleared IDs

Conclusions

- Recognizing proper mask use:
 - Mostly **not seeing the tip of the nose**
 - **Mask/mouth recognition much harder**
- **Getting people to install a scanner is hard**
 - UK filed **provisional patent**, but didn't allow installation: **prototypes need refinement**
 - **Potential liability** if one does install it?
 - **DIY unappealing** to store owners

CoveredScanner . Com