Explorations in Computer Vision

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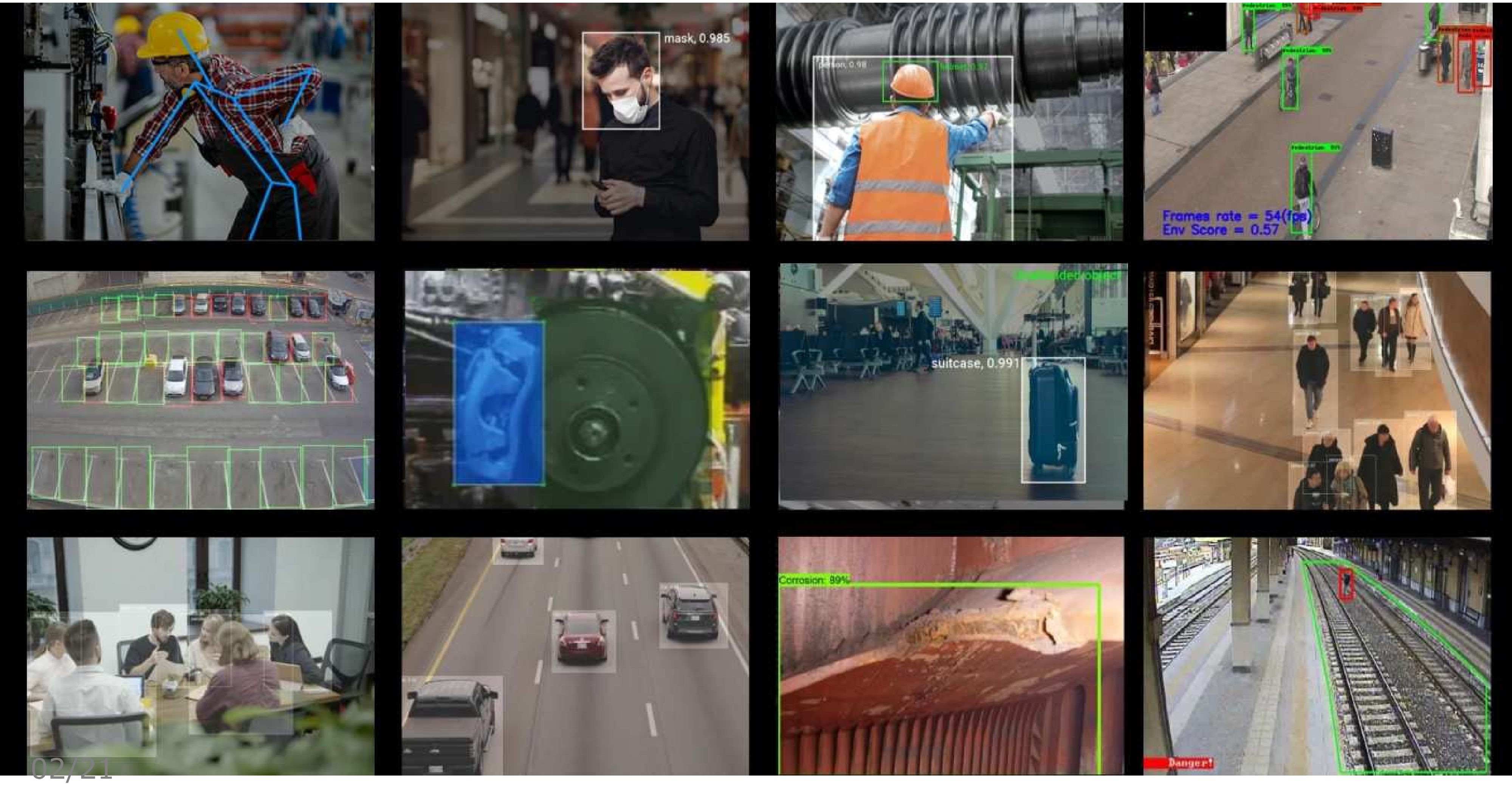
Some Computer Vision Applications



Different Levels of Comprehension

Attention: is there *something* (anything) present ?

Detection: specific *type* of thing (car, person etc) ?

Recognition: which *individual* thing (car, person) ?

Interpretation: what is the thing actually *doing* ?

Various Image Analysis Techniques

- Image differencing (change in Brightness, Hue etc.)
- Searching for specific colours (RGB, Hue, Sat. etc.)
- Scanning for specific shapes (person, car, letter etc.)
- Matching relative structures (e.g. face detection)

Our Approach

We *could* try to train a machine learning model
In order to identify objects/structures in an image
But this wouldn't give much insight into the process
(We'd just be training, rather than experimenting)

Instead we will take a much lower-level approach
Focusing on writing code to analyse images/video
Using a number of pixel manipulation techniques

The Application

We need some form of visual material to process

We'll make use of a recording of a webcam stream

From the "Marine Biological Association" in Plymouth

It's a nice view, with lots of activity going on !

PlymouthCamSolution

Processing Template

To get you started, we provide a template project

This template illustrates how you can:

- Open up an MP4 video file
- Extract a single image ("frame") from the video
- Draw that frame onto the screen
- "Mask off" unwanted areas of the frame
- Analyse remaining pixels contained within the frame

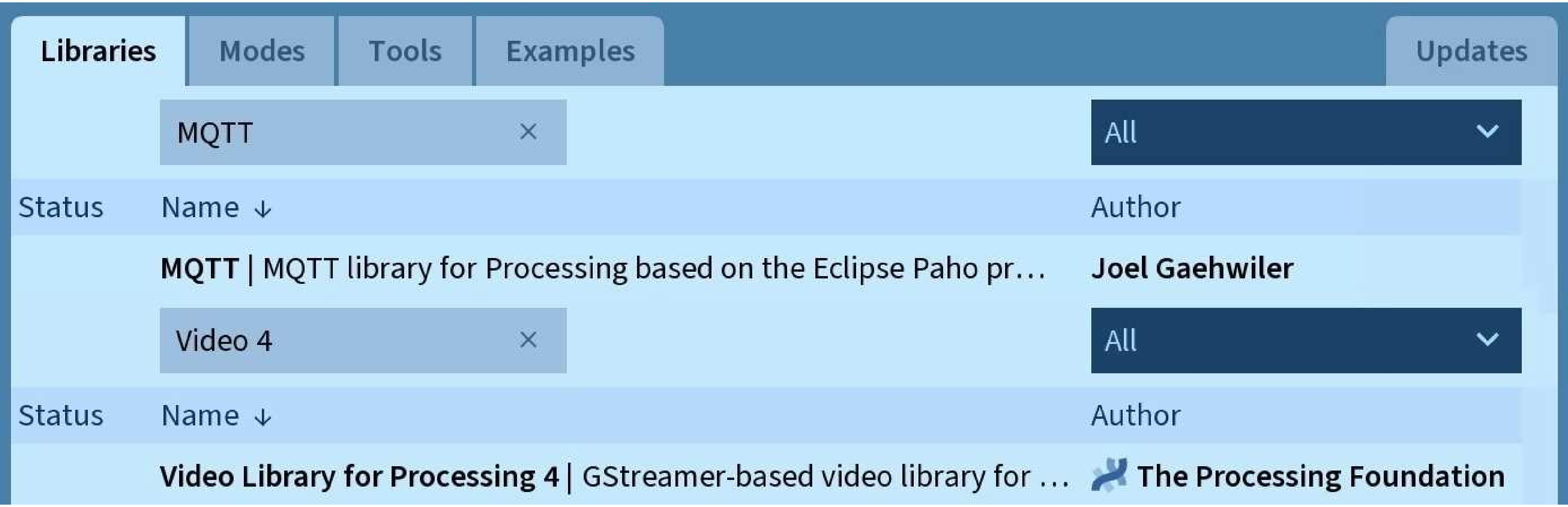
PlymouthCamTemplate

Libraries

Note that in order to run the template project

You will need to install a couple of libraries using:

`Sketch > Import Library > Manage Libraries`



Status	Name ↓	Author
	MQTT | MQTT library for Processing based on the Eclipse Paho pr…	**Joel Gaehwiler**

Status	Name ↓	Author
	Video Library for Processing 4 | GStreamer-based video library for …	**The Processing Foundation**

Search: MQTT — All

Search: Video 4 — All

Checking the Colour of Individual Pixels

We can get the colour of a particular pixel using:

```
int pixelColour = currentFrame.get(x,y);
```

We can then extract various pixel properties using:

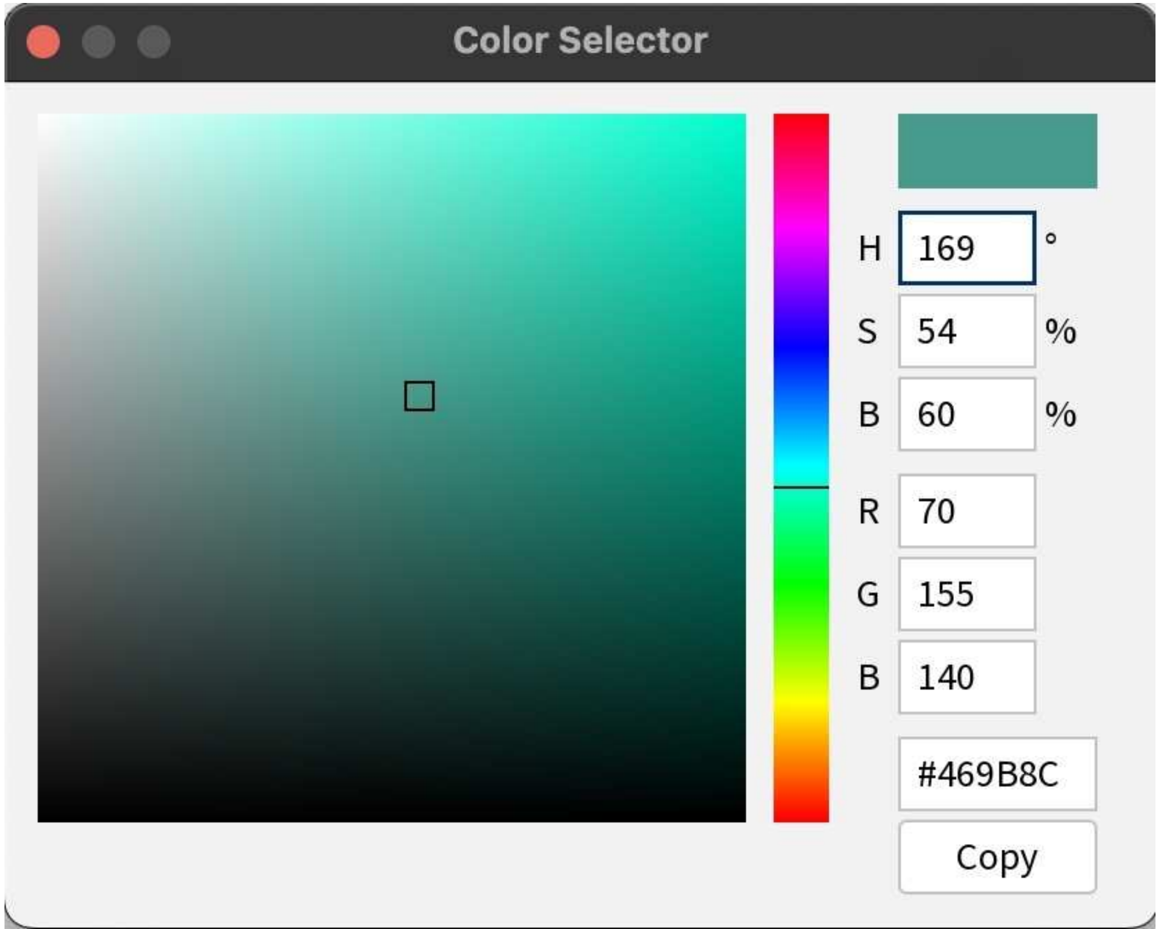
```
int redness = red(pixelColour);
int greenness = green(pixelColour);
int blueness = blue(pixelColour);
int whichColour = hue(pixelColour);
int howBright = brightness(pixelColour);
int howSaturated = saturation(pixelColour);
```

Drawing Pixels within the Frame

- Before any drawing, call "beginDraw" on the frame
- To mask off areas set "fill" colour to black
- Mask off Rectangle, Triangle or Polygon areas
- To draw individual pixels set "stroke" colour...
- Then draw an individual "point" (pixel) in that colour
- After drawing, be sure to call "endDraw"

Hue / Saturation / Brightness / RGB

Warning: All values in Processing are in range 0-255



H 169 °
S 54 %
B 60 %
R 70
G 155
B 140
#469B8C

Blob Detection

Blob Detection is a more advanced technique
(But something still achievable within this session)

Involves scanning for coherent clusters of pixels
(Based on the pixel brightness or colour)
Narrowing down the bounding box to get a tight fit

BlobDetection

Your Objective

Select an aspect of the scene to analyse/monitor
You are free to choose any element that you like...
But try to choose something with a clear "purpose"
(Something it might actually be useful to monitor !)

Later, we will be send someone a notification
When a particular situation occurs in the scene

What Will You Choose ?

To Work !

Possible Notification Mechanisms

- Sound an audible alert (using the "SoundFile" class)
- Post onto Facebook/Twitter/X/Instagram etc.
- Publish notifications via MQTT...

Message Queue Telemetry Transport (MQTT)

Message passing protocol (ideal for notifications !)
You can "publish" messages to "topics" (channels)
Other people "subscribe" to receive notifications

Connect to broker by adding this to setup method:

```
mqtt = new MQTTClient(this);
mqtt.connect("mqtt://broker.hivemq.com:1883");
```

Then to publish message/notification to topic call:

```
mqtt.publish(topic, parameter);
```

Topic must start with "plymouth/" for example:

```
mqtt.publish("plymouth/birds", "5");
```

Monitoring Published Messages

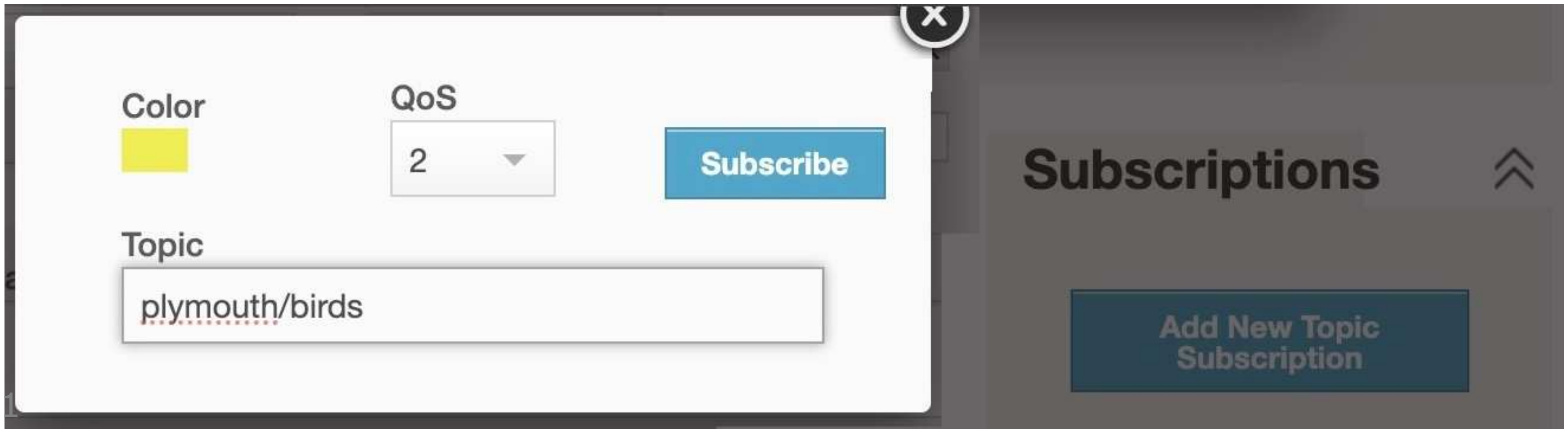
Monitor published messages using the web client:

https://www.hivemq.com/demos/websocket-client/

Connect using the default settings

"Subscriptions" > "Add New Topic Subscription"

Then add "topic" of interest (e.g. "plymouth/birds")



Color: 🟨

QoS: 2

Topic: plymouth/birds

Central Monitoring of Published Messages

NotificationMonitor

To Work !

What is happening right now ?

https://www.mba.ac.uk/mbawebcam/

Want test your code analysing the live video feed ?
Find all instances of: drawMovieOntoFrame
And replace them with: drawLiveFeedOntoFrame

For example:

```
drawMovieOntoFrame(currentFrame);
```

Would become:

```
drawLiveFeedOntoFrame(currentFrame);
```

Be careful - try not to behave like a DoS attack !