

# Industrial application pipelines with Gstreamer

---

Marianna S. Buschle  
msb@qtec.com

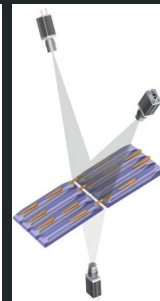
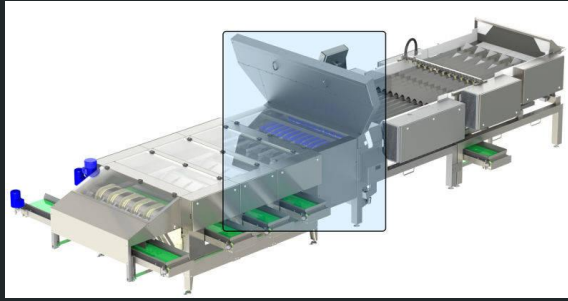
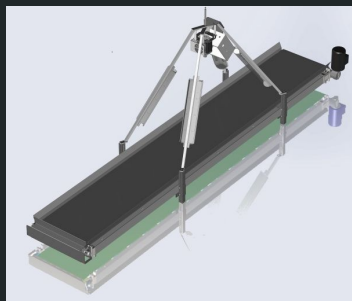
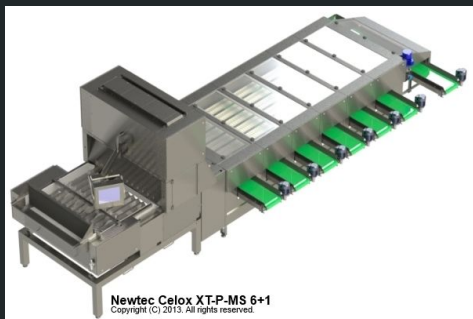
# Qtechnology

- Modular smart cameras
- CPU/GPU processing + FPGA support
- Interchangeable heads:
  - Color/Mono CMOS (IR filter)
  - Hyperspectral (mosaic or diffraction pattern)
  - Thermal
- Open source standards
  - Linux (video4linux)
  - OpenCV/OpenCL
  - Gstreamer



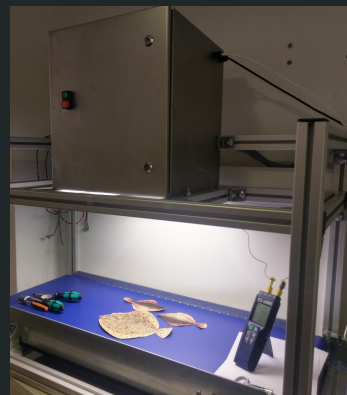
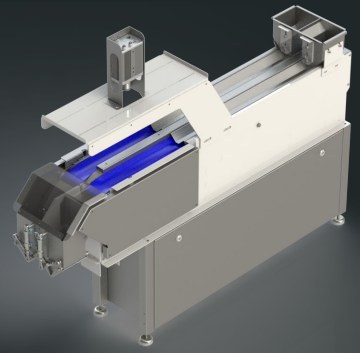
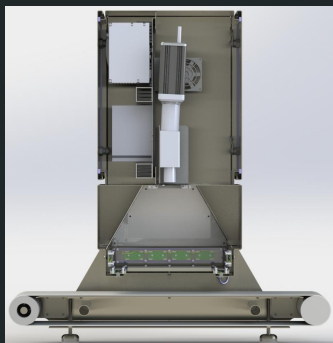
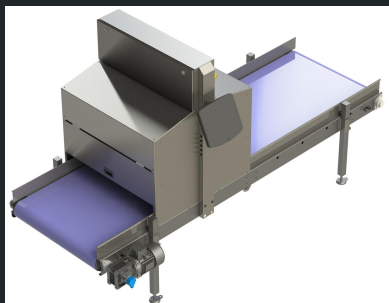
# Industrial Applications

- Optical inspection / quality control food



C + openCL

openCV + openCL



openCV + openCL

Gstreamer (openCV + openCL)

# Image processing

- Background separation
  - NNet, threshold, image subtraction...
- Image filtering and enhancement
  - Morphological filters (open, close), sharpening
- Image Stitching
- “Blob” processing
  - Contour finding
  - Object properties: size, position, color...
- Tracking
- Decision making



# Development Cycle

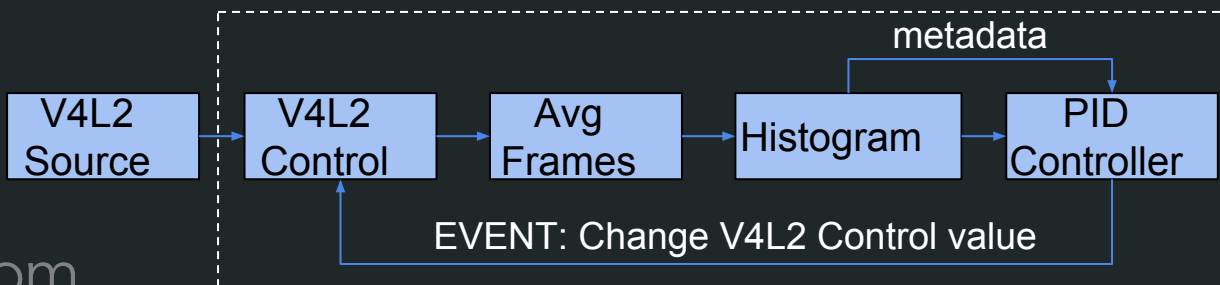
- Lot of common elements
  - Re-usable
- Rapid prototyping
- Library?
  - Distribution?
  - Language?
- Camera Interface
  - Web-based (GWT)
  - Settings
  - Calibrations
  - Sandbox / Features Showcase

# Gstreamer

- Pipelines
- Re-usable elements
- Easy prototyping
  - Sandbox
- Faster development
  - Common elements
- Open source
  - distribution
- Many elements already available
  - not for image processing
- “Easy” to develop new elements
  - Image processing elements
    - OpenCV
    - OpenCL

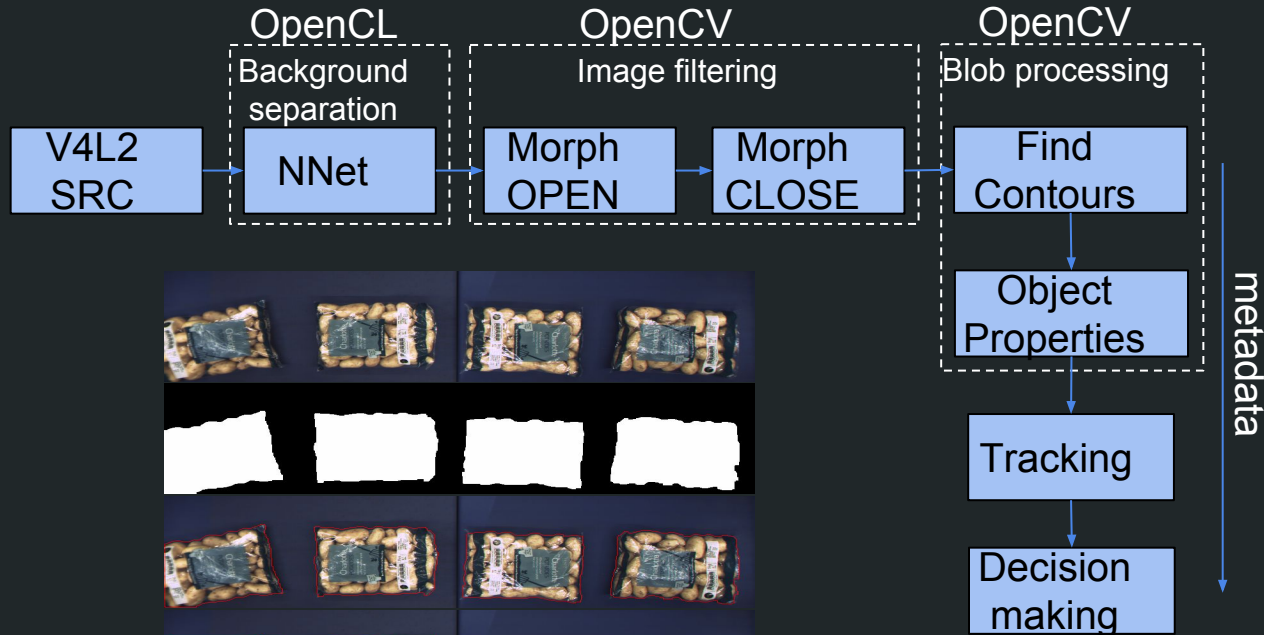
# Camera Calibrations

- First Gstreamer test
  - Substitute python
- Control loops
  - Take image
  - Measure
  - Adjust
- 1st elements:
  - pidcontroller
  - v4l2control
  - histogram
  - avgframes
- Issues:
  - Pre-rolling



# Image Processing Pipelines

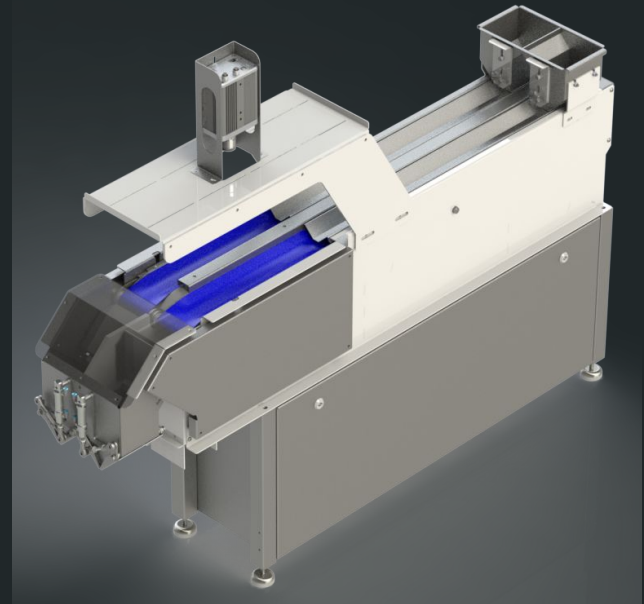
- Identify steps
- How to pass the information? Buffers vs Metadata





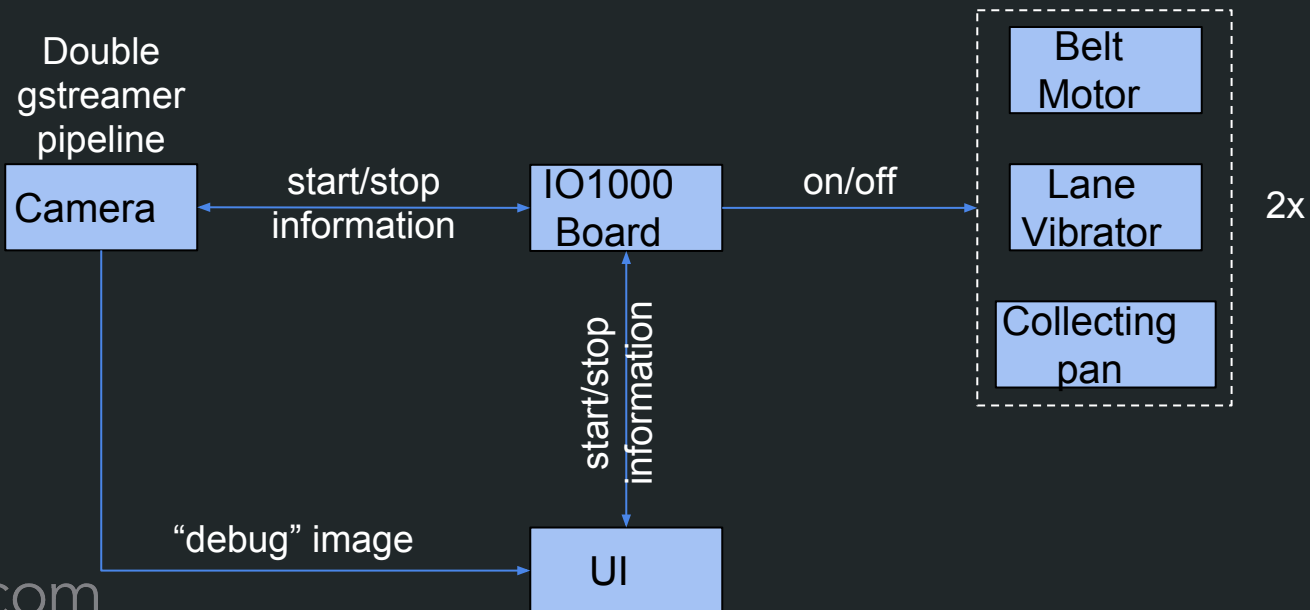
# Portion Machine

- Counts and create portions of screws, nuts, bolts, etc
  - modular machine
- First application developed in gstreamer
  - Time consuming (8 months)
  - Creation of a lot of openCV elements
  - Understanding gstreamer
    - Lack of documentation
    - Real-time (can't drop frames)
      - Task priorities
    - Profiling performance
    - Synchronization
    - Gstreamer app vs gst-launch



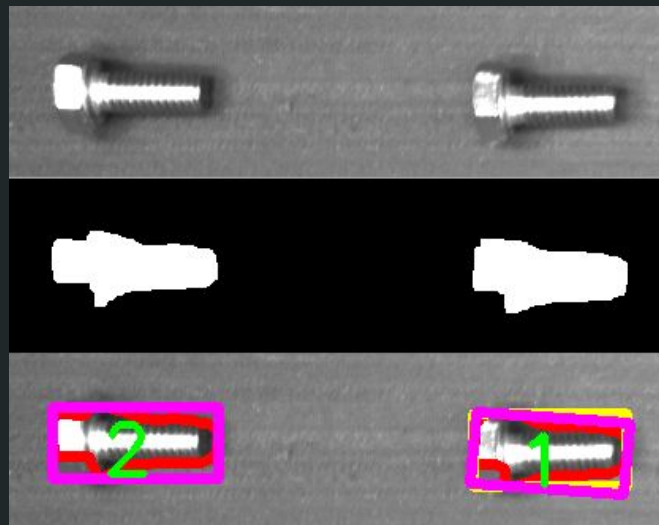
# Portion Machine System

- Complex distributed system
  - Communication?
    - UDP sink
    - Thrift sink



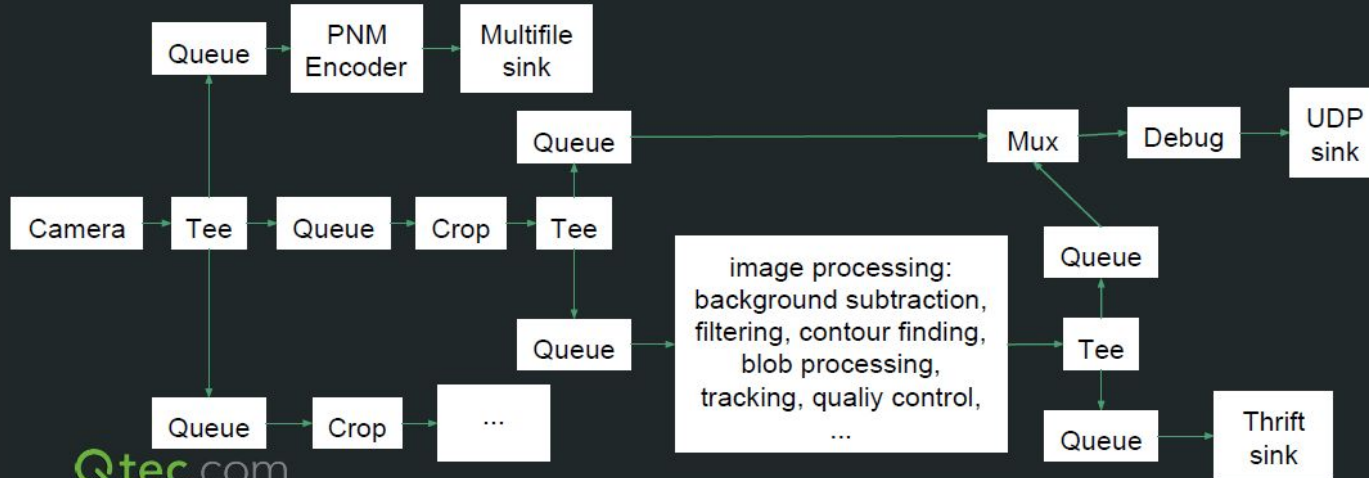
# Metadatamuxer

- Image processing “destroys” original frame
- Debugging / Visualizing Results
- Mux together original frame + object metadata
  - Easy with opencv program
  - Harder with gstreamer
- VideoAggregator
  - Real-time!
  - Time-stamp matching
    - processed frame is delayed



# Portion Machine pipeline

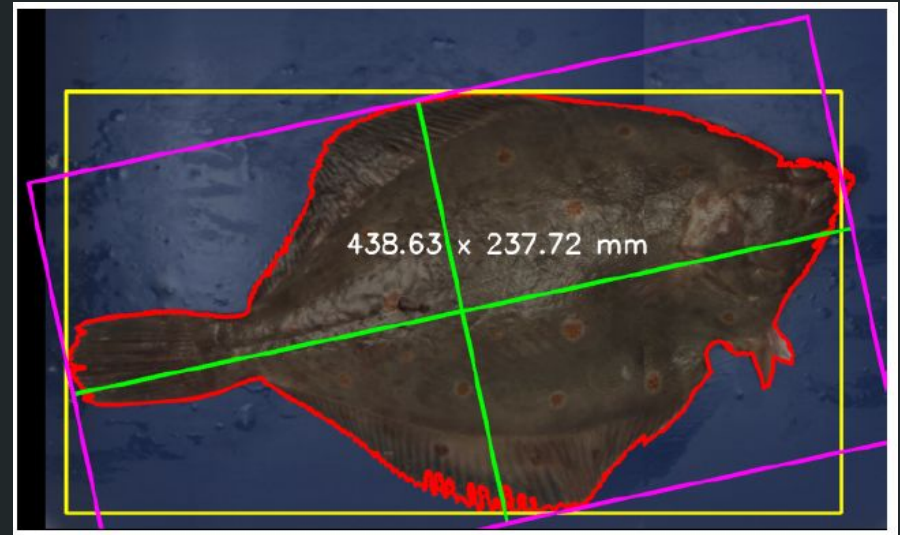
- Gstreamer advantages
  - Duplicated pipeline: 2 lanes
  - Sinks and sources



# Portion Machine video

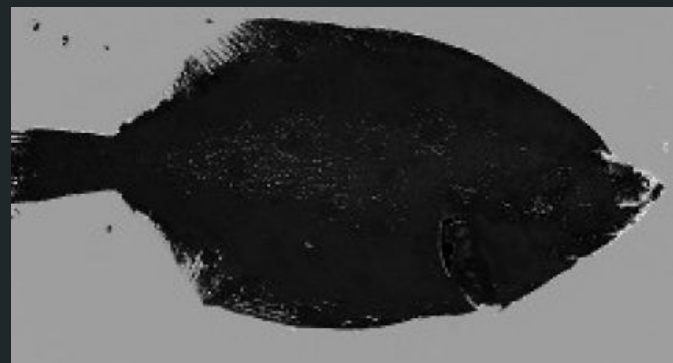
# Fish Scanner

- Measures fish size
- 2nd application developed in gstreamer
  - A lot faster development
    - 4 months (10 weeks)
  - Re-used most elements
  - Knows gstreamer
  - Color conversions
    - RGB <-> HSV
  - Image stitching



# Colorspace conversions

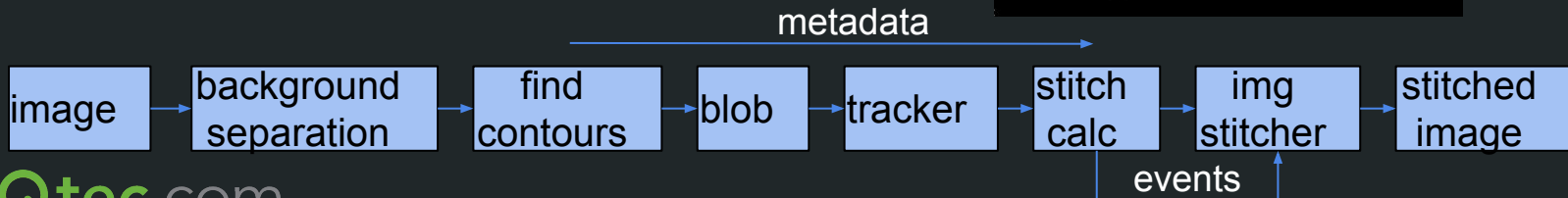
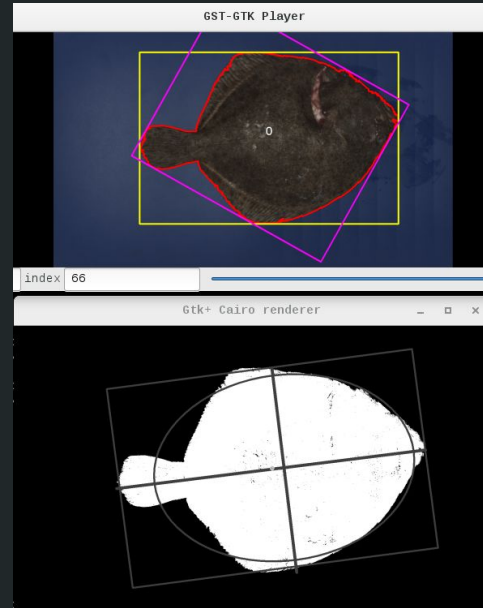
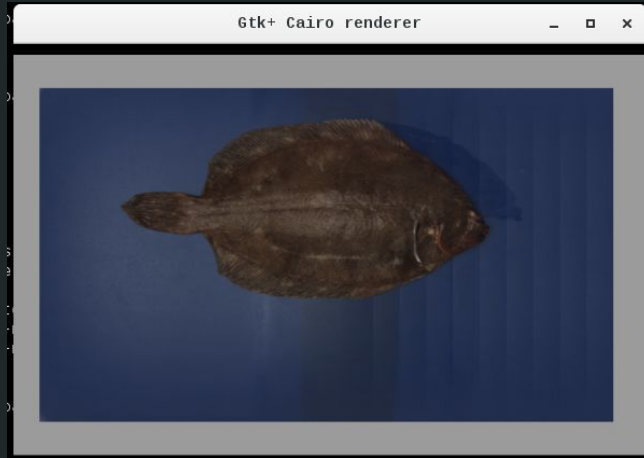
- HSV is a good color space for image processing
- Lacks support (format)
  - Video4Linux
    - under review
  - OpenCV
    - supports RGB $\leftrightarrow$ HSV conversion
    - PAM (extended PNM)
  - Gstreamer
- SW conversion (slow)
- HW support (fast)
  - RGB-Hue



# Image stitching

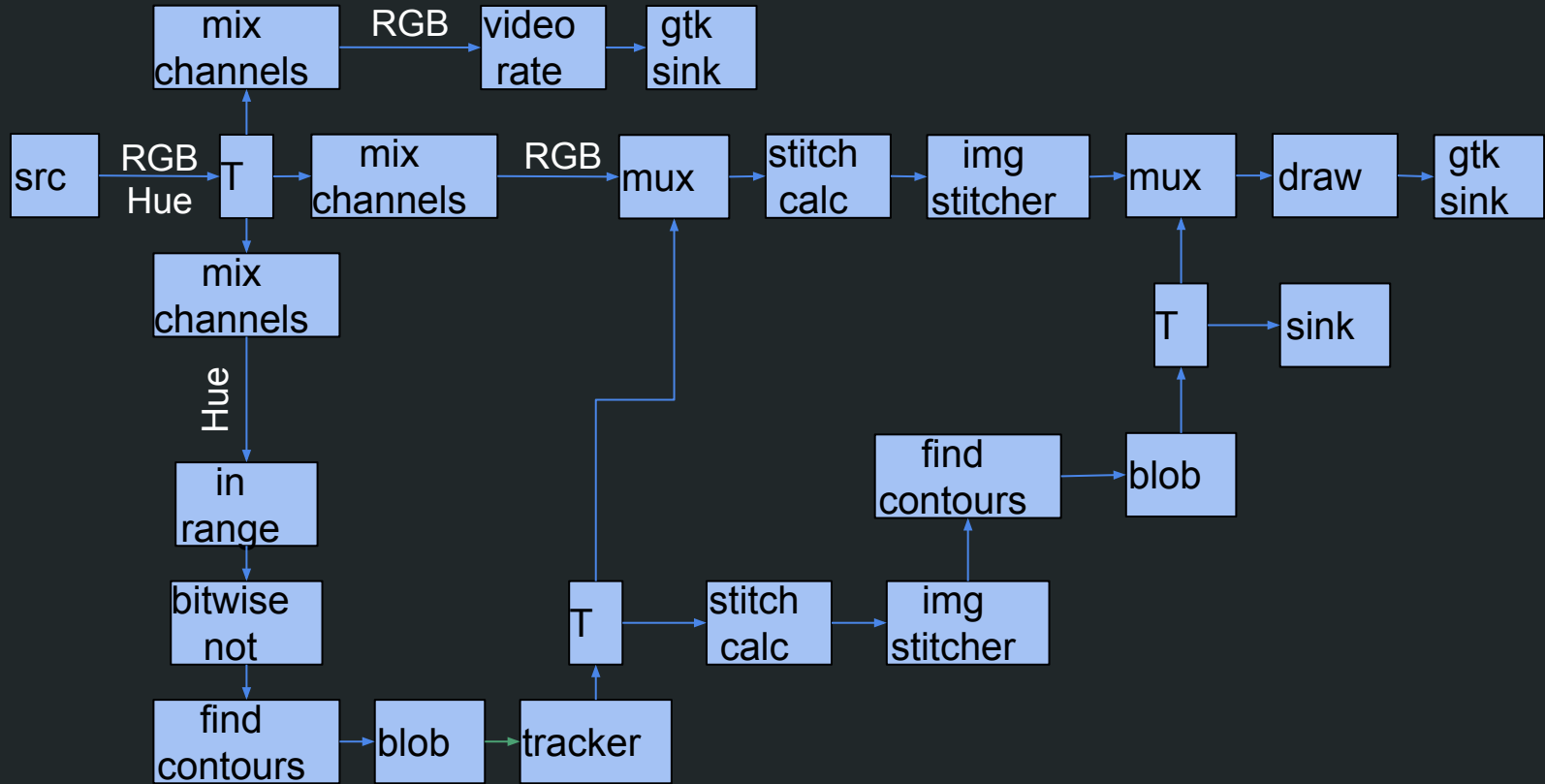
- Stitching efficiently?
- Issues with metadatamuxer
  - Uneven frame generation

- Process or stitch twice?





# Fish Scanner pipeline



# Fish scanner video

# Next steps

- Python
  - GObject introspection in an embedded system
  - Even faster prototyping
    - Faster creation of gst apps
    - Elements
      - opencv python
- Web interface
  - Gstreamer sandbox
    - “gst-parse-launch”
    - graphical?

# Conclusions

- Love and hate
- Image processing vs Multimedia applications
- Performance
  - Profiling
  - Task priorities
- How to separate blocks?
  - Generic elements
  - Gstreamer application
  - Communication

Questions?

