Motion capturing via computer vision and machine learning

A live demonstration & talk

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What is Stringless?

- Facial motion capture ("expression tracking") system
- Integrates directly into Autodesk Maya
- Extendable to other animation software
- Undemanding system requirements, minimal hardware requirements
  - Intended user: casual/non-professional animator, visdev purposes
- A prototype, not a complete product
Motion capture at a glance

- Digital recording of person’s facial movements, applied to CG character's face
- Markered vs markerless tracking
- 2D vs 3D (single camera vs multi-camera, respectively)
- Realtime vs capture-only

Facial motion capture systems, from top left to bottom left, clockwise:
* Unnamed Avatar Capture System (Weta Digital), Facerig (Holotech Studios), Faceshift (faceshift AG), Medusa (Disney Research)
Defining characteristics of Stringless

- Markerless
- Monocular camera input
- Real-time
Stringless operation flow

1. Server process:
   a. Captures image frames from webcam
   b. Detects a face in frame
      i. Locate facial landmark positions
   c. Sends landmark data (*FrameData*) to shared memory

2. Maya plug-in:
   a. Creates a unique face rig separate from the 3D rigged face model
   b. Creates a device to read live data from shared memory
   c. Links device data to face rig joints
   d. User selectively constrains 3D face model controls to face rig
Stringless system architecture
Stringless system architecture
Face Detection Technology

Implemented with dlib machine learning toolkit

- Histogram of Oriented Gradients (HOG)
- Linear classifier
- Image pyramid
- Sliding window detection scheme
Histogram of Oriented Gradients
Linear classifiers

iBUG 300 Faces In-The-Wild Challenge (300-W), IMAVIS 2014

Image pyramids

https://en.wikipedia.org/wiki/Pyramid_(image_processing)
Sliding window detection scheme
Face detection pipeline

One Millisecond Face Alignment with an Ensemble of Regression Trees by Vahid Kazemi and Josephine Sullivan, CVPR 2014
Downsides to my approach

- Single camera = two dimensions
- POSIX Shared Memory compatible only systems
Current performance

- Pipeline fully functional
- Two-dimensional data
- Localized delta calculations
- Max of 120 fps possible at 640x480!
  - Max 90 fps @ 1280x720
  - Max 60 fps @ 1920x1080
  - ~26 fps @ 4k
- Capture quality needs work
Localized delta calculations

- Neutral face definition
- Localized face defined by deltas from neutral face
- Pitch, yaw, roll not yet calibrated for
Demo time!
Optimizing performance

Current:

- Face detection sampling rate
- Image downsampling

Future:

- Adaptive sampling rate
- Regional face detection
- Multi-threaded and/or GPU-based face detection
Known issues

- Face identification failure with expressions/gaze too distant from training data
- Lighting conditions must be decent
- Capture system requires consistent face direction (for now)
- Noisy capture data (needs filtering and/or higher resolution image input)
- Definitive bottleneck: face detection
Future goals

● Calibrate face rig data for pitch, yaw, and roll of the head
● Eye tracking
● Cross-platform
● Integration with other animation software
● Endless quality improvement & optimization
Possible future use cases

- Visdev for 3D animation
- Input to facial expression driven applications (games, interactive media)
- Emotion recognition
- Low bandwidth/high compression video communication system
- Medical examination tool / symptom detection
Types & applications of computer vision
Recognitional tasks

- Object recognition/classification
  - Facial detection
- Identification
  - OCR
  - QR codes
  - Facial recognition
- Detection
  - Pose estimation
Motion analysis

- Tracking
- Egomotion (3D camera tracking)
- Optical flow (apparent motion)
Other uses

- Scene reconstruction
- Image restoration
Applications

- Automatic inspection
- Identification tasks
- Detection/surveillance
- Human/computer interaction (input)
- Modelling objects/environments
- Navigation
- Organization
Questions?

Project homepage: https://www.sjsuvrlab.org/project_stringless.html

Source code is available! https://github.com/justint/stringless

http://justintennant.me