Leveraging Cloud Computer Vision for a Real-Time Consumer Product

COCOONCAM

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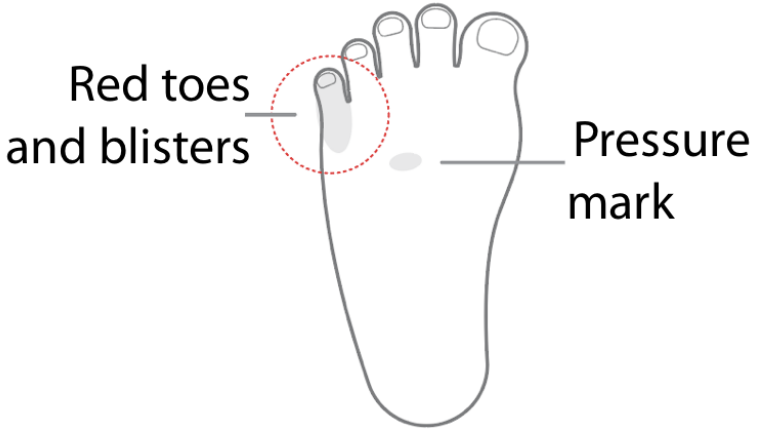
No Insights + Discomfort by Current Baby Monitors

Audio and Video Baby Monitors

Can you believe this is a video? It doesn't look like the baby is moving!

Wearable Devices



Wearables cause more worry. (Image from Owlet website)

Cocoon Cam PLUS, 2018

Breathing Monitoring

Real-Time Graph/Circle

Cry Detection

Sleep/ Wake Up Alerts

Caregiver Management

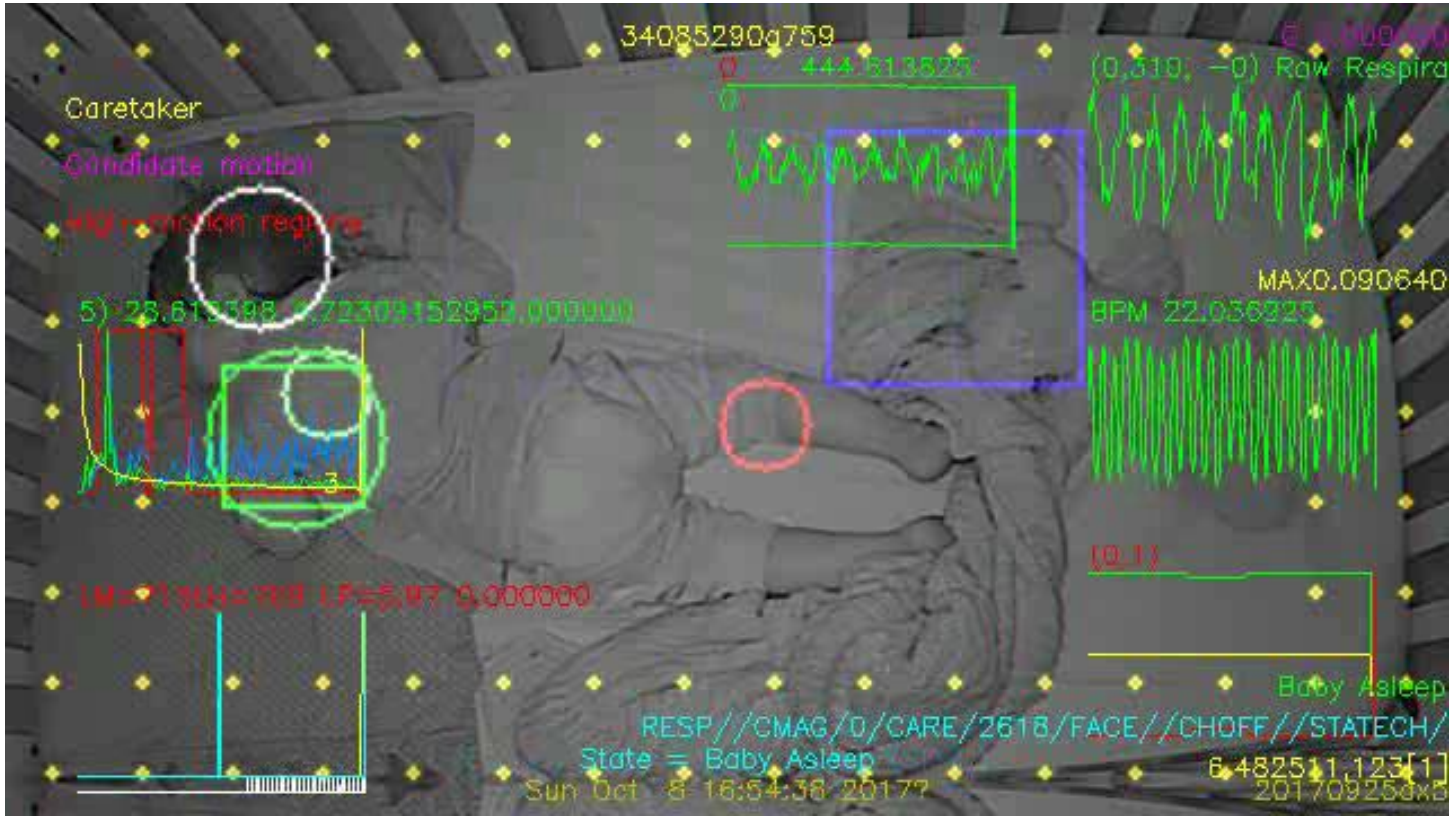
Swaddle Stories

Support for Twins

Pinch to Zoom

PLUS all features of a traditional video & audio baby monitor.

Cocoon Cam Technology



Our Design Constraints

- Low development & production cost
- Low end-to-end latency for computer vision
- Run real-world tests before production
- Low upfront end-user cost
- Ability to scale services easily

We Observed Two Trends

amazon web services™ Google Cloud Platform Microsoft Azure

IP Cameras are a Commodity

- Starts at $15 for a 720p HD camera with 2-way audio
- Supports multiple resolutions and video encoders

Rise of Cloud Computing

- Easy and inexpensive to provision & maintain
- Scalable, reliable and faster time to market

Limitations of Real-Time CV in Cloud

- **High recurring & operating costs**
  - Might not work for one-time sale products
- **Dependent on network connectivity**
  - Poor internet results in poor CV service
- **High network bandwidth consumption**
  - Approximately 100GB/month for 480p video
- **No off-the-shelf infrastructure allows real-time CV**
  - Latency might be an issue

Is Cloud CV really cost prohibitive?

- **Cocoon Cam**
  - 3x CNNs, CV Tracking, Signal Processing
  - Compute requirement: 5 to 10 GFLOPS

- **Amazon t2.micro instance**
  - 1 GB RAM, 1vCPU
  - Compute performance: 30 GFLOPS
  - Cost: $8.5/ month of continuous use

- **Raspberry Pi 3 ($35)**
  - Compute performance: 150 MFLOPS

Cost Per Compute in Cloud is Down

General Purpose Instance Hourly Pricing (7.5GB RAM, 2vCPUs)

Region	Instance Type	Platform	Price start date	Price
sa-east-1	m1.large	Linux/Unix	Dec. 15 2011	$0.46
sa-east-1	m1.large	Linux/Unix	Mar. 8 2012	$0.46
sa-east-1	m1.large	Linux/Unix	Jan. 11 2013	$0.32
sa-east-1	m1.large	Linux/Unix	Jan. 4 2014	$0.23
			Apr 1, 2018	**$0.17**

Pricing of next-generation General Purpose Instances

M3.large : $0.133/hr
M4.large : $0.100/hr
M5.large : $0.096/hr
T2.large : $0.092/hr

Understanding Network Limitations

- **Is network connectivity good enough?**
  - We have observed 99%+ uptime in homes
  - Our systems have less than 5 sec end-to-end latency
- **Can we stream low-resolution video?**
  - We can use 360p @ 5FPS video for real-time CV
  - Max. bandwidth utilization is 200GB per month
- **Can networks handle 200GB bandwidth?**
  - Most network providers have 1TB data limit

1PB+ Real-time Data Processed Per Month

Hardware Sensor

AWS Lambda

ECS Containers

Compute

Postgres DB

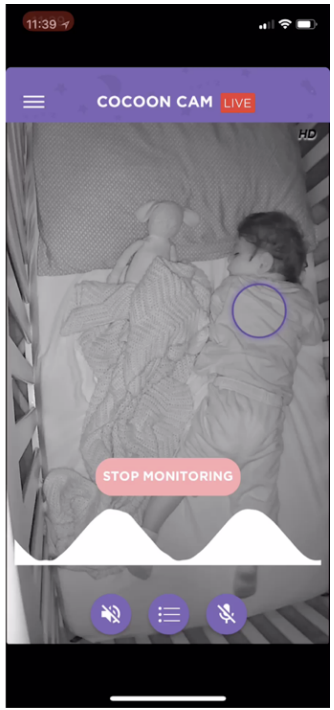
Cassandra DB

Amazon S3

Redis

Kafka

Data



User Interface

Minimizing Latency with CV in Cloud

- **Making use of efficient data pipelines**
  - Kafka, Redis, Cassandra, Containerization
- **Make use of temporal information**
  - Unlimited storage/retrieval is possible in cloud
- **Not EVERY algorithm has to be run in real time**
  - Ex: Tracking along with CNN for object detection
- **Several Intel compiler optimizations are available**
  - SSE, MMX, AVX etc.

Develop Faster & Deliver Higher Quality

- **Continuous experimentation**
  - Develop and test many algorithms at once
  - Get more analytics on algorithm enhancements
  - Reduced fragmentation & hardware testing cycles
- **Continuous integration and continuous delivery**
  - No need for scheduled firmware updates
  - Easily rollback any unwanted updates
  - Faster build and release cycles

Summary

- CV in the cloud offers significant advantages, such as low upfront and ongoing cost, unlimited compute and storage availability
- CV in cloud offers unlimited and on-demand compute & storage availability. This is great for subscription-based services.
- CV in the cloud is great for development teams since they can run more experiments to deliver a faster & more reliable product.

Additional Resources

- Real-time Video Analytics – the killer app for edge computing https://www.microsoft.com/en-us/research/wp-content/uploads/2017/06/CO_COMSI-2017-03-0045.R1_Ananthanarayanan.pdf
- Video Stream Analytics Using OpenCV, Kafka and Spark Technologies https://www.infoq.com/articles/video-stream-analytics-opencv
- A Holistic Cloud-Enabled Robotics System for Real-Time Video Tracking Application https://pdfs.semanticscholar.org/0089/426b9827019c58f2e628c5345ef1655b33ba.pdf
- Microsoft Azure: How to Analyze Videos in Real-time https://docs.microsoft.com/en-us/azure/cognitive-services/computer-vision/vision-api-how-to-topics/howtoanalyzevideo_vision

Thank You

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Leveraging Cloud Computer Vision for a Real-Time Consumer Product

The capabilities of cloud computing are expanding rapidly and the compute costs are going down. At the same time, internet-connected cameras that can stream video and audio are becoming a commodity in the market. This makes it increasingly attractive to implement computer vision in the cloud, even for cost-sensitive applications requiring real-time response. In this presentation, we explore the benefits and limitations of computer vision in the cloud today – both for initial prototyping and for product deployment – based on Cocoon Cam's experience creating the first vision-enabled baby health and wellness monitor.