ACMX TECHNOLOGIES, LLC

Scalable Dynamic Editing Solutions for Content Moderation

Powered by Prime Image

Whitepaper

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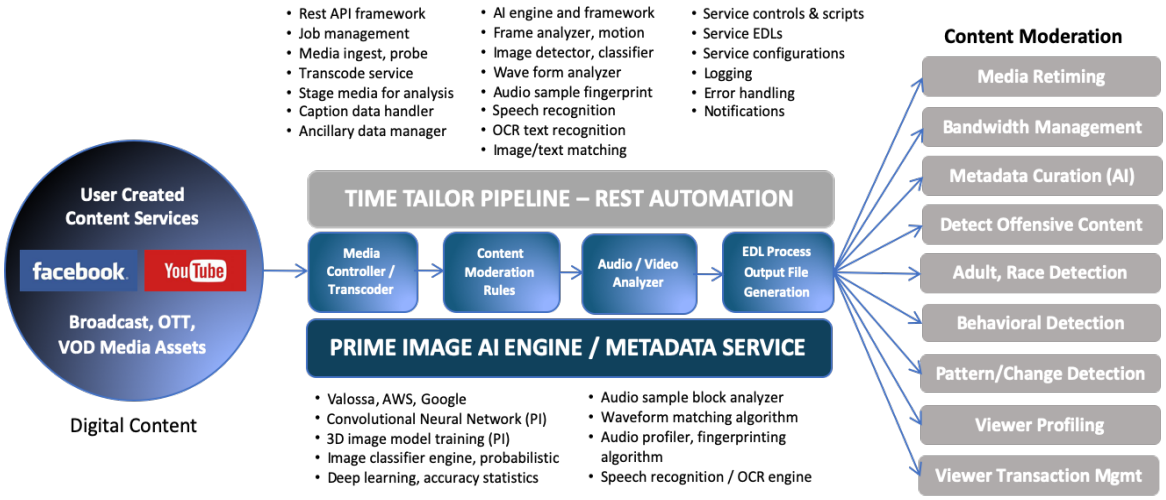
The volume of user generated content uploaded to the major technology platforms has significantly outpaced the ability of those platforms to manage, filter and modify content posted for public consumption. ACMX has licensed a unique, proprietary solution for automating the last step of content moderation. The Prime Image Automated Content Intelligence Pipeline ("AI Pipeline") is a proven solution for that can be scaled to automate video management and dynamic editing processes for large platforms and their outsourced providers of content moderation services. We plug in multiple third party AI models to identify objectionable content, and based on a user determined set of rules, our technology automatically edits the videos and outputs a broadcast quality video file ready for distribution without human intervention.

Content Moderation

All major platforms are using professional IT service firms to provide large scale human review methods for objectionable content e.g., offensive images, copyright infringement, violence, extreme sexual content and other content that violates platform rules. Human intervention is not scalable and the IT service providers are unable to effectively review and make defensible decisions on the large and growing volume of content being uploaded daily. For the platform content moderation teams and their outsourcing vendors, constant viewing of content with offensive and horrific images and audio samples has resulted in mental health damage, employee turnover, lawsuits, and objectionable content leaking through to consumers and young adults.

Technology infrastructure and AI services are deploying tools to help the humans police community rules within the major platforms. There is an emergence of detection rules, content filters and unique AI services that can flag content with objectionable material before it becomes available for public consumption. ACMX's AI Pipeline service is differentiated because we not only leverage third party AI tools and models to find objectionable material; we take the next and most important step to automate the alteration of content to output a file ready for distribution.

Our unique AI framework enables the AI Pipeline to respond dynamically to content moderation rules and filters by automating detection, edit decisions, frame and audio adjustments, and content adjusted output files for distribution. See workflow diagram below:



Our AI pipeline is highly adaptive to changes and improvements in moderation rules, detection techniques and AI services. The extensible automation framework is configurable to moderate rules based on content type and output file requirements to reduce transcode operations and optimize turnaround for streaming services. The pipeline architecture scales using standard elastic cloud infrastructure and load balancers to fully utilize processor and GPU resources.

Prime Image has over a 25-year history managing media asset runtime with major US broadcasters, cable providers and streaming service platforms. It's patented media asset technology, coupled with the AI detection pipeline and automation framework packaged in a standard cloud container is perfectly positioned to help contain and control this growing epidemic of undesirable and offensive content.

Technology Overview

Prime Image's automation first framework was originally designed to manage media assets, allowing media operators to queue jobs and dynamically and accurately edit broadcast programming with little to no human interaction. The first generation of the technology was deployed 25 years ago, when Prime Image revolutionized the television industry with the Time Tailor, an editing automation appliance used by broadcasters and cable networks. The Time Tailor allowed editors to scale their output inside of a network operations center by managing the length of their linear programming to meet desired clock times without a human having to make hard cut edit decisions. Whether with live or recorded programs, Time Tailor became an indispensable tool inside of every major North American broadcast network helping them automate editing functions with no degradation to content quality.

Prime Image developed a proprietary media asset pipeline leveraging patented Intellectual Property (IP) around media asset clock management. The AI Pipeline is fully extensible using a proprietary automation framework built on both Linux Ubuntu and Windows Server 2016. The web container is Glassfish and the framework fully utilizes related tools and rest standards to support and manage all API transactions. The AI Pipeline includes a software transcoder that supports bi-directional asset transcoding, decoding and encoding of standard broadcast and OTT formats. Decoding of the media stream happens in memory to reduce processing latency, specifically for those jobs that don't require new video outputs. The automation framework works in both frames and time code (TC), which enables customers to build Edit Decision Lists (EDLs) or equivalent job descriptors into segments, chapters or total frame counts.

The AI Pipeline's core model is centered around the OpenCV library. This tool provides the construct for frame inspection down to polygons or blocks of pixels, coupled with our proprietary algorithms to measure motion, object vectors and pixel similarity. The core model also includes an audio processor that analyzes every audio sample in 512 blocks and runs a proprietary waveform algorithm to identify matches, followed by splicing to remove samples and re-blends the audio stream. This process is not detectable during playback and does not require pitch correction.

Utilizing the pipeline and native AI functionality, we are addressing the obvious need to disintermediate the highly disparate AI media service industry through a single

input/output interface and pre-classifying job type to optimize AI results. Prime Image's patented vertical cut (VC) detector is a key differentiator in the AI processing sequence. The AI Pipeline auto-runs the VC detector on all media assets, this metadata provides frame sequences by camera and is used to capture specific frames within the sequences to be passed to AI services. This reduces the number of frames and processing time by media asset.

AI Pipeline Service Description

Prime Image developed a standalone AI pipeline and service controller to support native AI model processing and to further mediate input compliance to third-party AI model partners. This service interface leverages the media asset management pipeline and inherent filters and analyzers to improve and optimize AI processing intelligence resulting in fewer false positives and reduced processing costs by job request. The AI pipeline contains Prime Image models, along with partner models from Google Image Recognition Service, Amazon AI Services and Valossa. Any number of 3rd party models could be added to this extensible framework, including Microsoft Cognitive Services or other AI model requests from customers and partners.

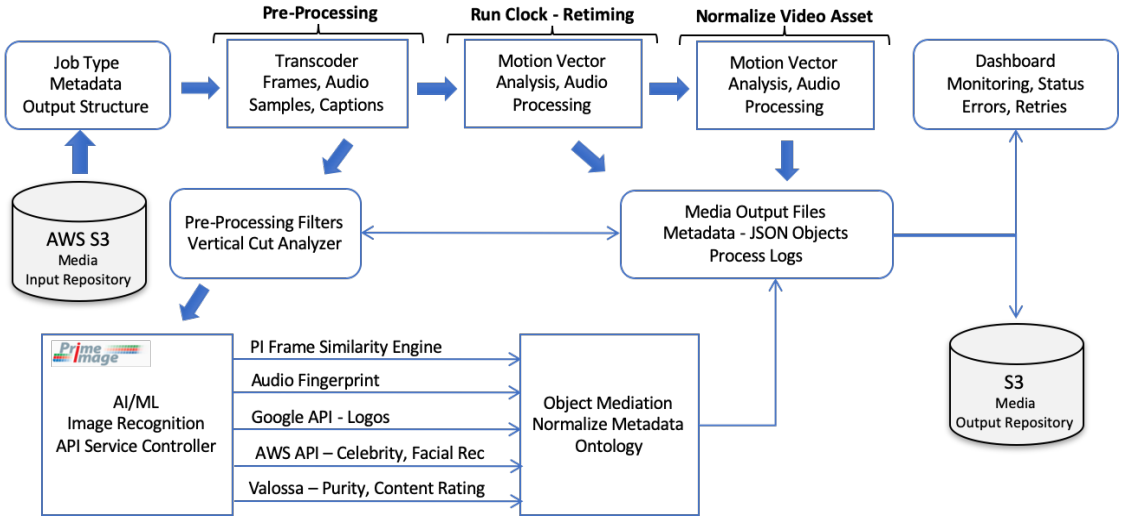
Prime Image's frame similarity work process provides a unique capability to quickly create actionable hotspots in media assets, thereby avoiding the more traditional model-based training approach. The technology enables content creators to develop an immersive user experience by targeting interactive hot spots or deleting undesirable content, including deep fake detection from media assets. The process uses two discrete methods to produce probabilistic results to meet customer objectives. The first method uses a frame matching process where like frames or images provided by customers are processed and detected by the AI pipeline. This advanced convolutional method of frame and image matching is used as a pre-filter to target and mask pixels within frames by transforming pixels into signals to measure intensity across a spatial domain. The frame similarity detector uses a multi-step iterative detection process to narrow down frames, images and/or TC that contain target images or frame content.

1. Step 1 uses a similarity score on every frame in the media asset. This score is done by processing symmetrical and non-symmetrical blocks of the image for similarities rather than the image as a whole. This filters out the most likely frames and derivative confidence scores using a proprietary algorithm.
2. Step 2 uses the same frame differencing algorithms from Prime Image's frame drop technology. This further narrows down the set of frames to only the scenes that match the source image.
3. Step 3 in the detection process identifies the source frame sequence by adding the Prime Image vertical cut detector, with the output metadata including both the frame counts and TC for viewer engagement.

The second method transforms the frame and image into the frequency domain. This is done using standard discrete Fourier transform (DFT) techniques to compute the frequency samples (complex numbers) at each row of the frame or image. The inverse DFT (IDFT) computes the same frequency samples from each row, but also includes the columns from the preceding results. This adds a second dimension to the Fourier analysis and derives both magnitude and

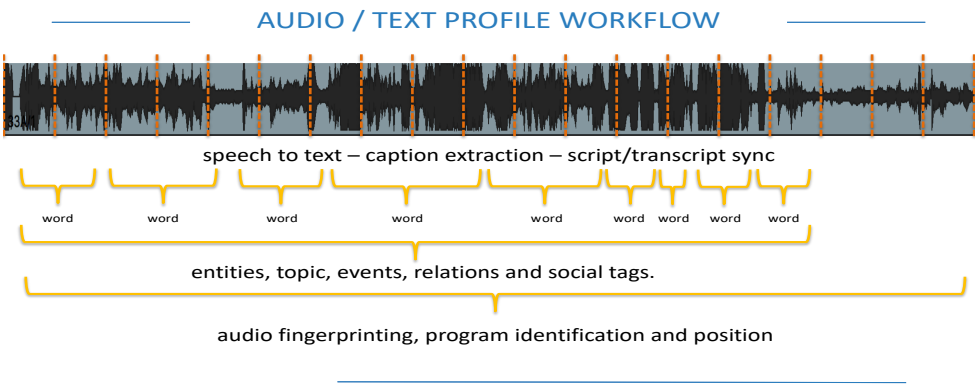
phase for the sampled frequencies or sine waves. The use of low and high pass filters will create a convolutional mask across the frequency spectrum to detect changes or anomalies (rate of change, phase shifts, and other synthetic intrusions) from both left and right edges of the image towards the center point, or from the center point out to left and right edges. The detection agent will track probabilistic scores using standard change detection rules or pattern detections prescribed by customers. These rules can be applied to deep fake or synthetic images inserted into frame sequences within media assets.

The image below provides an overview of the pipeline data services:



Prime Image's audio fingerprinting service operates by extending a virtual access layer of time-aligned metadata and assets staged for engagement to any application or device. The automated character recognition (ACR) and API engagement stack exposes any curated event at accuracy thresholds up to a sample rate level. This service is often used to enhance contextual metadata from the audio stream and serve as a surrogate to further triangulate image recognition accuracies. Third-party speech recognition, speech-to-text and ACR services can be seamlessly integrated into the existing pipeline work process.

The image below provides a high-level overview of the audio fingerprinting service:



AI Pipeline Scalability

The AI pipeline processes today operate within the CPU and utilize cores and processor clock speeds to drive throughput. To improve native performance and throughput, much of the processing is managed in memory using a complex buffering architecture. This approach eliminates disk I/O latency and generates quicker transcode times to and from the analysis engine. Throughput can vary by 50% depending on the type of job (detection vs. alteration). Standard AI operations using the video frame or audio sample analysis engine can take less than .5 of real-time of the processed asset. Other alteration or content moderation jobs where the process generates a new output file can take up to 1.1x of real-time of the processed asset. This process generates encoded mxf, mov and mp4 container files at the customers desired bit rate.

Prime Image's AI pipeline application runs in a standard Docker container. The container can run on any host (node, VM) or cluster using native cloud architectures and elastic services, e.g., Flexible App Engine, AWS EC2 Container Service (ECS). This service with an Elastic Load Balancer (ELB) enables the pipeline to elastically shape capacity with demand, while maintaining 100% utilization and price-performance from the job queue manager. Scale is a function of load as the pipeline is a serial process. Improvements could come from parallelization of audio and video splices (blocks of frames, audio samples) through a GPU process using the embedded EDL framework to concatenate altered parts of the video and audio back into a sequential video asset. These improvements are part of the Prime Image roadmap and will further enhance scalability across millions to 100s of million assets/day.

ACTIVE PATENTS

D&N Ref.	Title	No.	Date	No.	Date	Status
PII-2710	*Embedded Ancillary Packet Data Processing System and Method with Real Time Program Duration Alteration*	13/439,285	4-Apr-12	8,724,968	13-May-14	ISSUED. Expires 4/4/2032
PII-2911	*Controlling Digital Audio/Video Segment Duration with Remappped Code*	14/820,907	7-Aug-15			PENDING.
PII-3100	*Method and System for Detecting a Vertical Cut in a Video Signal for the Purpose of Time Alteration*	13/755,986	31-Jan-13	9,113,133	18-Aug-15	ISSUED. Expires 1/31/2033.
PII-3101	*Detecting a Vertical Cut in a Video Signal*	14/823,817	11-Aug-15	10,116,909	30-Oct-18	ISSUED. Expires 8/10/35. (Continuation of PII-3100)

About ACMX Technologies, LLC

ACMX Technologies, LLC has a license to apply the Prime Image's Automated Content Intelligence Pipeline to the content moderation market. ACMX Technologies is a wholly owned subsidiary to Prime Image AI Corporation.