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(54) SYSTEM FOR PROGRAMMING CONTENT CHANNELS

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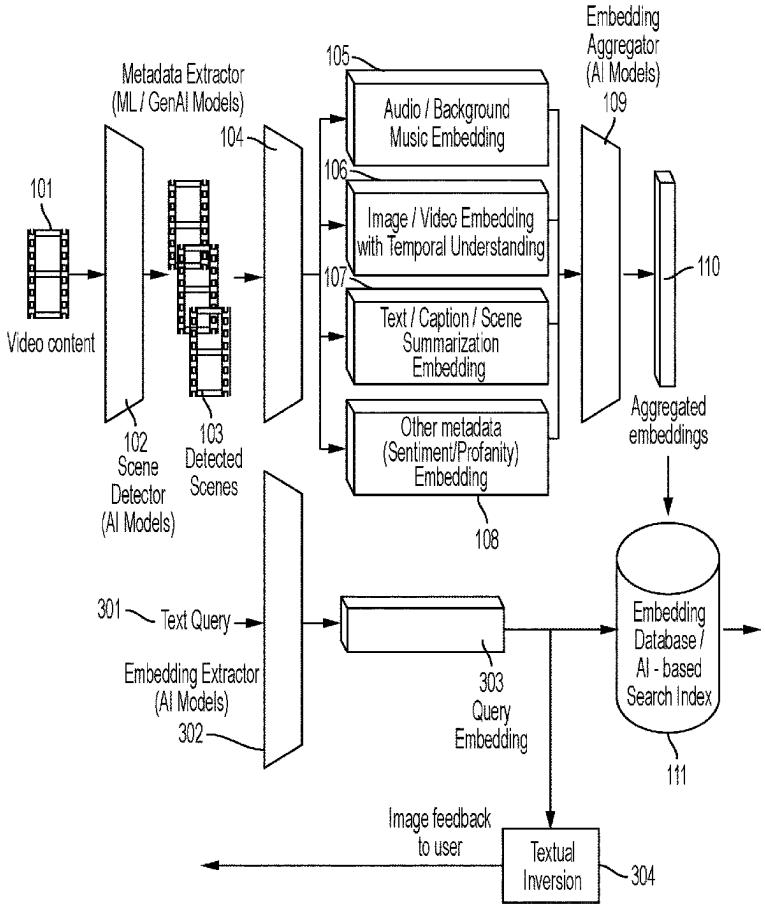
(57) **ABSTRACT**

A system for programming content channels based on multimodal extraction of metadata from content, wherein the metadata is extracted by processing one or more scenes in the content to extract metadata corresponding to multiple extraction modes, and an embedding model for each extraction mode wherein an aggregated embedding model responsive to the extracted metadata for each mode formulates an aggregated embedding. The system includes a consumer information database containing information regarding consumer consumption of content including at least an identification of content consumed. Programming logic based at least in part on comparing an embedding of metadata extracted by multimodal extraction of content consumed by the consumer to the aggregated embeddings including a vector comparison processor for determining the distance between the embedding generated based upon content consumed and the aggregated embedding is provided. The programming logic may use the distance between the embedding generated based on content consumed and the aggregated embedding to generate a program guide tailored to viewer preferences.



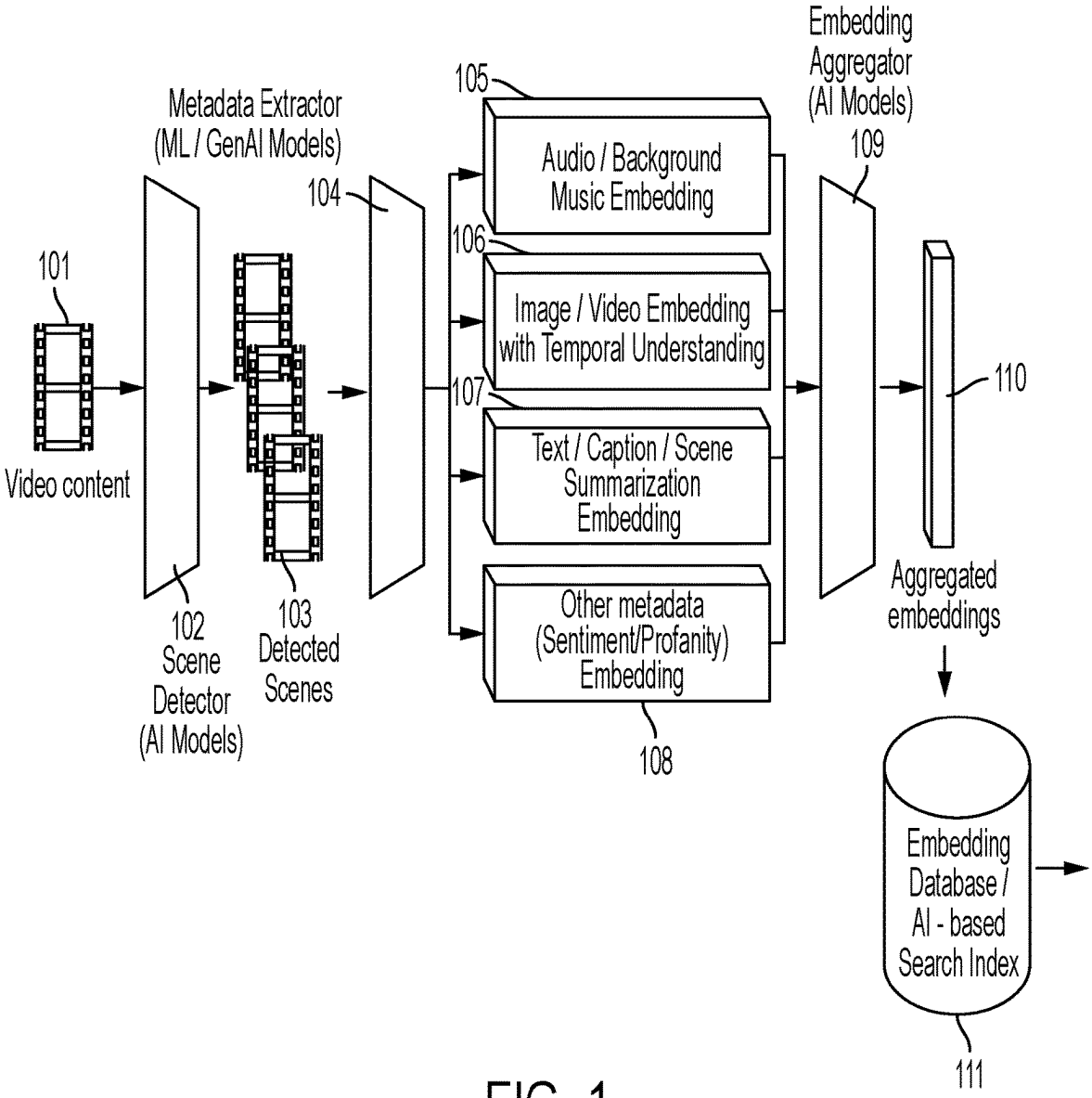

Video content
101
Metadata Extractor
(ML / GenAI Models)
Scene
Detector
(AI Models)
102
Detected
Scenes
103
104
105
Audio / Background
Music Embedding
106
Image / Video Embedding
with Temporal Understanding
107
Text / Caption / Scene
Summarization
Embedding
Other metadata
(Sentiment/Profanity)
Embedding
108
Embedding
Aggregator
(AI Models)
109
110
Aggregated
embeddings
Embedding
Database /
AI - based
Search Index
111

FIG. 1

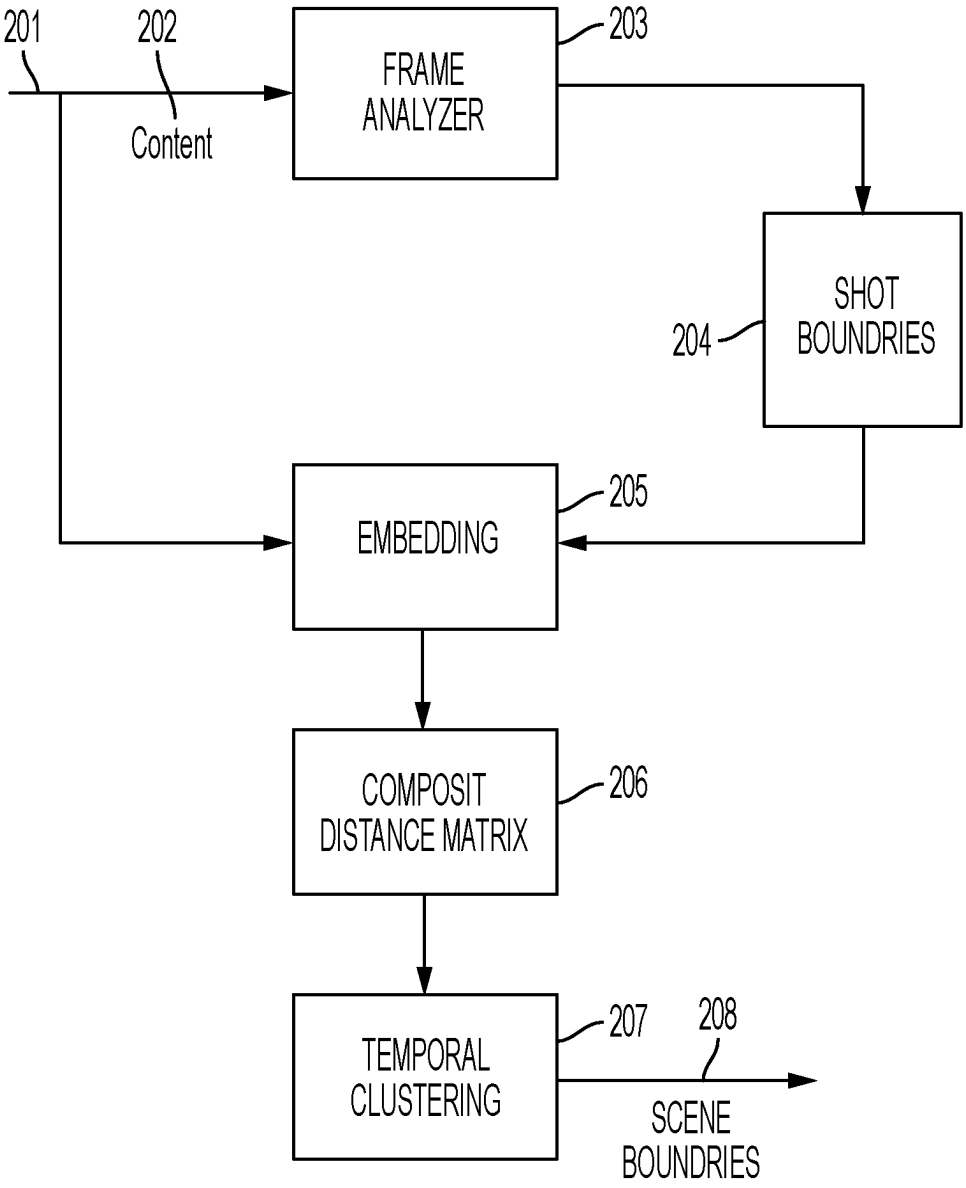

201
202
Content
FRAME ANALYZER
203
SHOT BOUNDRIES
204
EMBEDDING
205
COMPOSIT DISTANCE MATRIX
206
TEMPORAL CLUSTERING
207
208
SCENE BOUNDRIES

FIG. 2

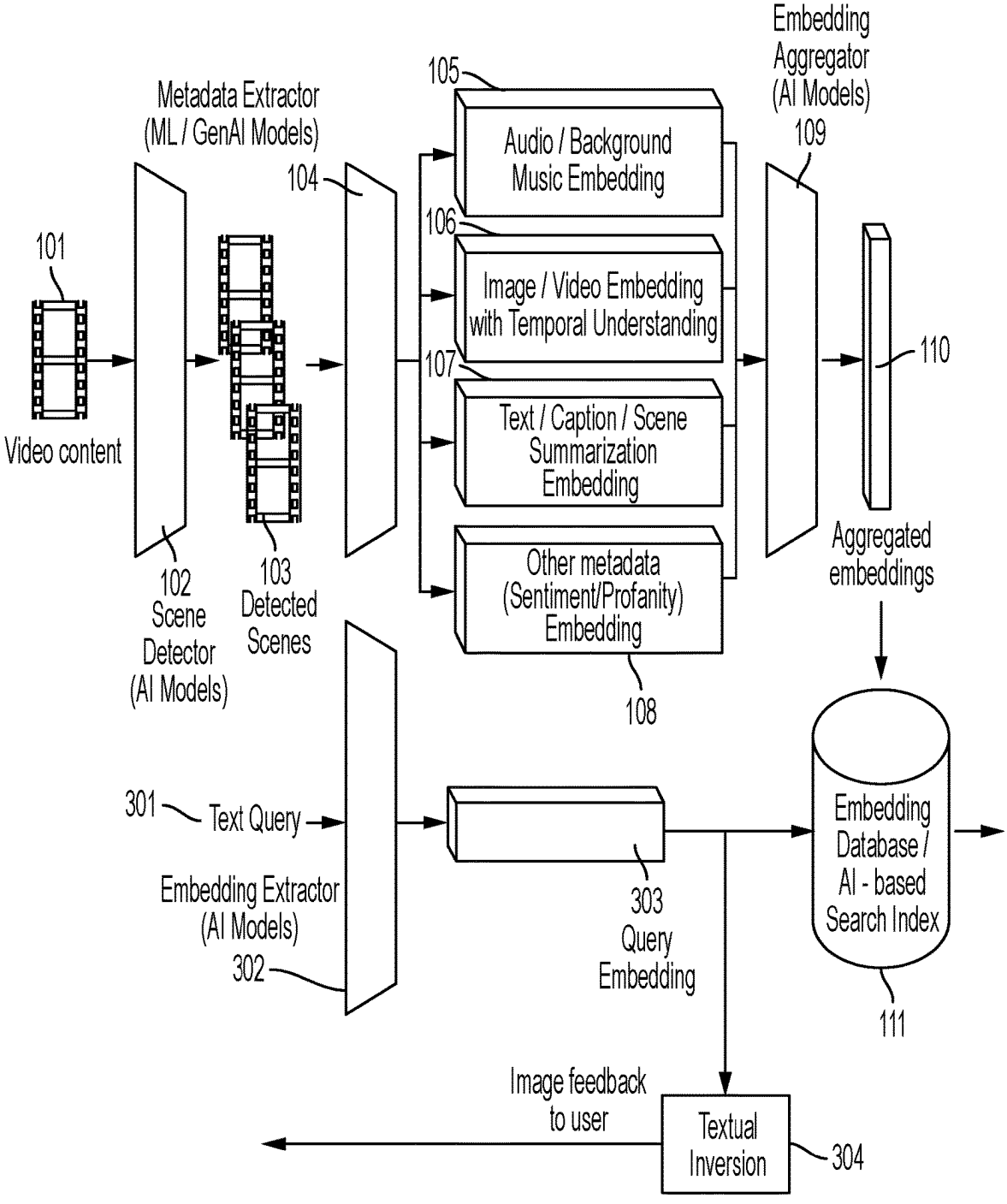
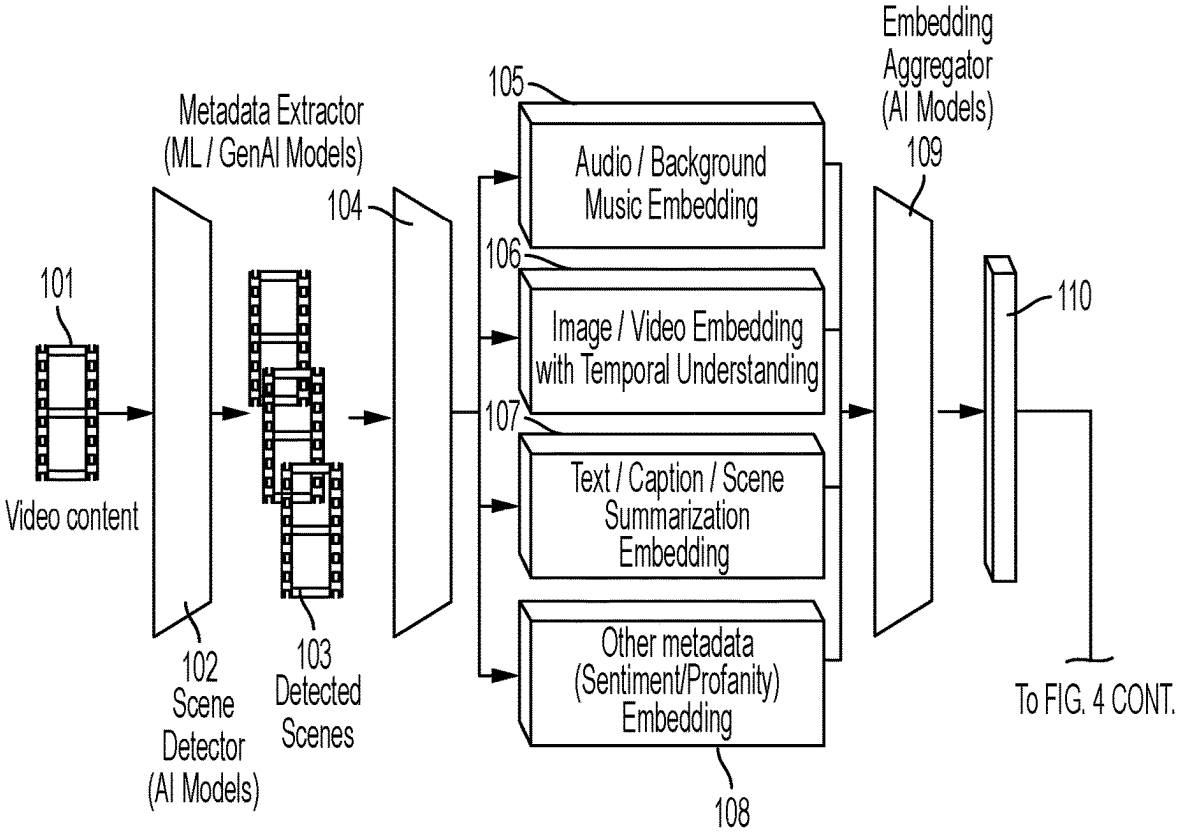

Embedding Aggregator (AI Models)
109
105
Metadata Extractor (ML / GenAI Models)
104
Audio / Background Music Embedding
106
Image / Video Embedding with Temporal Understanding
107
Text / Caption / Scene Summarization Embedding
Other metadata (Sentiment/Profanity) Embedding
108
101
Video content
102 Scene Detector (AI Models)
103 Detected Scenes
110
Aggregated embeddings
301 Text Query
Embedding Extractor (AI Models)
302
303 Query Embedding
Embedding Database / AI - based Search Index
111
Image feedback to user
Textual Inversion
304

FIG. 3


Embedding
Aggregator
(AI Models)
109
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Metadata Extractor
(ML / GenAI Models)
Audio / Background
Music Embedding
104
106
101
Image / Video Embedding
with Temporal Understanding
110
107
Text / Caption / Scene
Summarization
Embedding
Video content
Other metadata
(Sentiment/Profanity)
Embedding
102
Scene
Detector
(AI Models)
103
Detected
Scenes
To FIG. 4 CONT.
108

FIG. 4

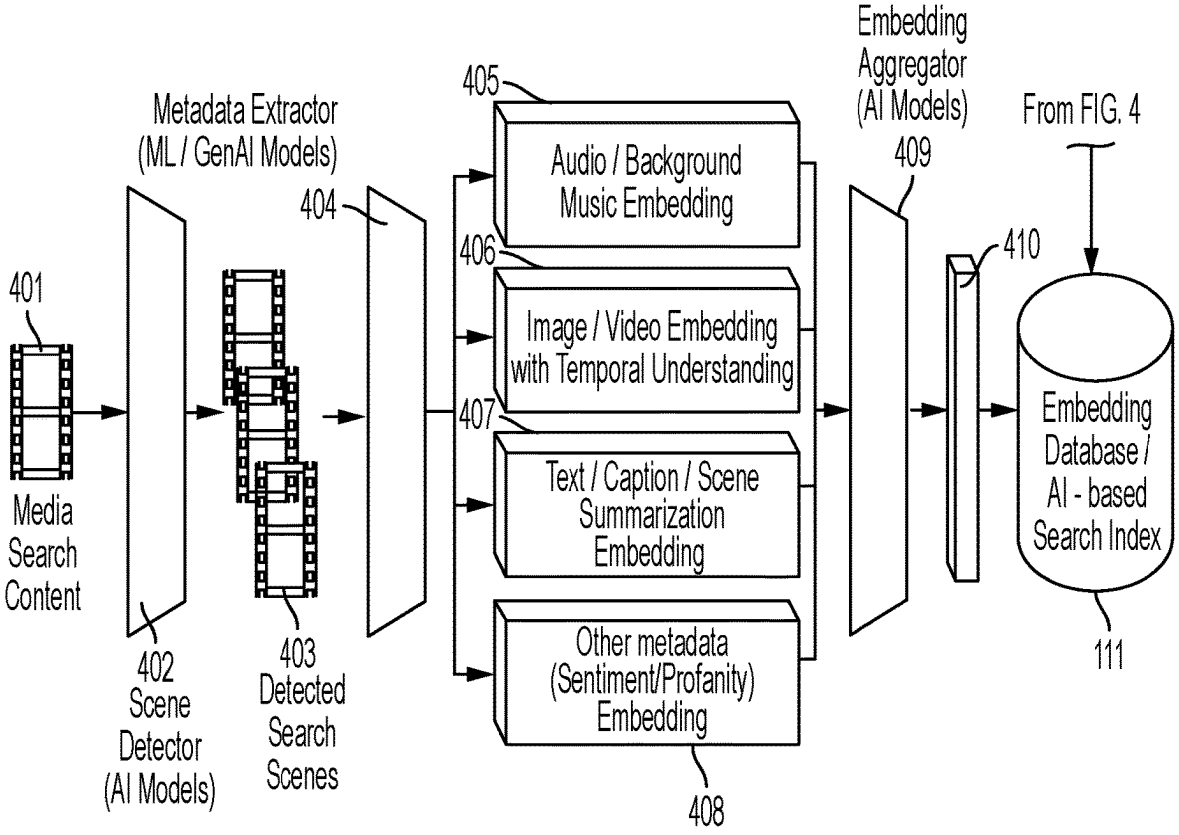
401
Media Search Content
Metadata Extractor (ML / GenAI Models)
402 Scene Detector (AI Models)
403 Detected Search Scenes
404
405
Audio / Background Music Embedding
406
Image / Video Embedding with Temporal Understanding
407
Text / Caption / Scene Summarization Embedding
Other metadata (Sentiment/Profanity) Embedding
408
Embedding Aggregator (AI Models)
409
410
From FIG. 4
Embedding Database / AI - based Search Index
111

FIG. 4 CONT.

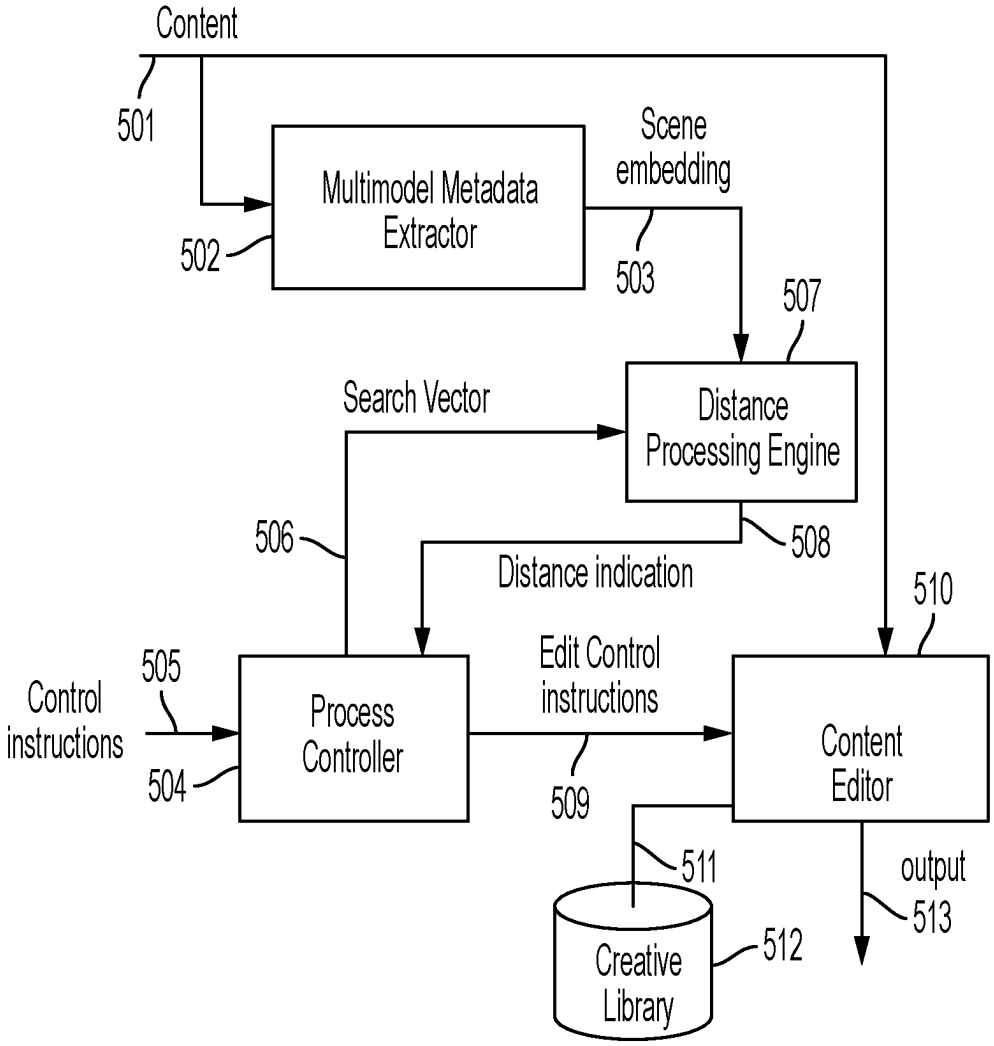
Content
501
Multimodel Metadata Extractor
502
Scene embedding
503
507
Distance Processing Engine
Search Vector
506
508
Distance indication
510
Control instructions
505
504
Process Controller
Edit Control instructions
509
Content Editor
511
output
513
Creative Library
512

FIG. 5

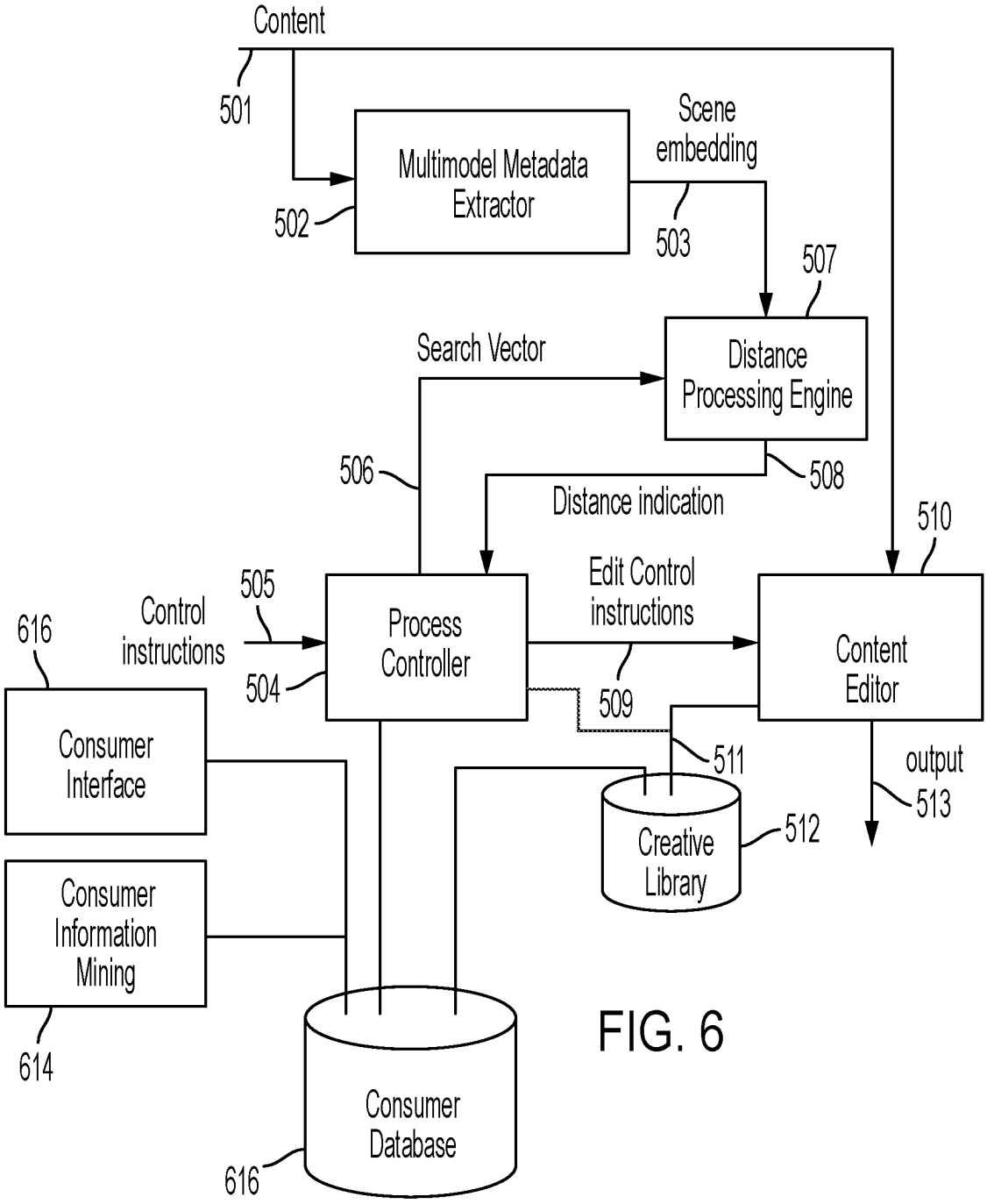
Content
501
Multimodel Metadata Extractor
502
Scene embedding
503
507
Distance Processing Engine
Search Vector
506
508
Distance indication
510
505
Control instructions
504
Process Controller
Edit Control instructions
509
Content Editor
616
Consumer Interface
511
output
513
Creative Library
512
Consumer Information Mining
614
Consumer Database
616

FIG. 6

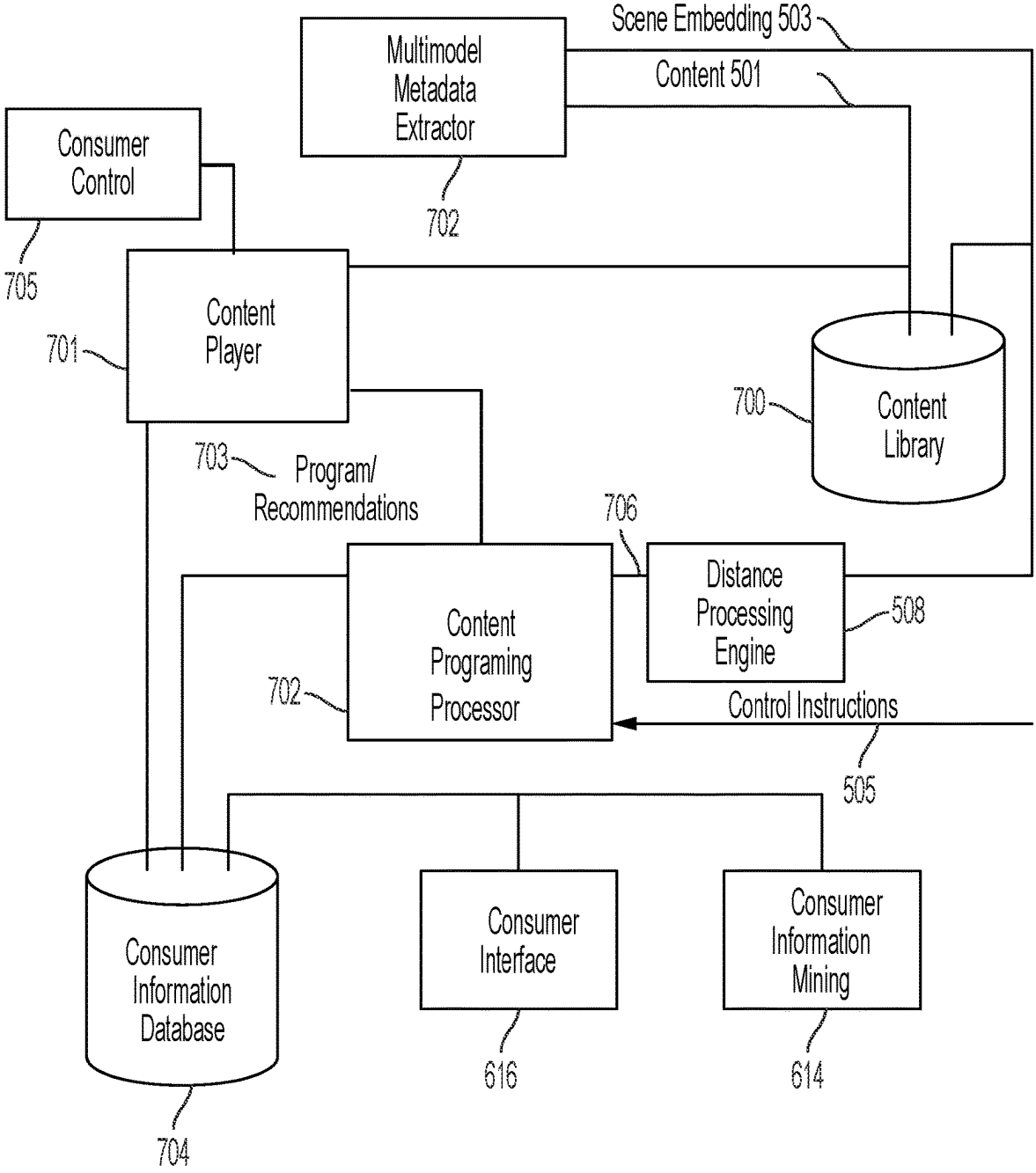
Scene Embedding 503
Multimodel Metadata Extractor
Content 501
Consumer Control
702
705
Content Player
701
700
Content Library
703
Program/ Recommendations
706
Distance Processing Engine
508
Content Programing Processor
702
Control Instructions
505
Consumer Information Database
704
Consumer Interface
616
Consumer Information Mining
614

FIG. 7

SYSTEM FOR PROGRAMMING CONTENT CHANNELS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is related to US Application No. _____ filed on _____, 2023, attorney docket no. 169003; US Application No. _____ filed on _____, 2023, attorney docket no. 169004; US Application No. _____ filed on _____, 2023, attorney docket no. 169005; US Application No. _____ filed on _____, 2023, attorney docket no. 169006; US Application No. _____ filed on _____, 2023, attorney docket no. 169007; US Application No. _____ filed on _____, 2023, attorney docket no. 169008; and US Application No. _____ filed on _____, 2023, attorney docket no. 16909; the disclosures of all of which are incorporated by reference herein.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The invention relates to a video content processing system and more particularly to a content-based search of contextual data representing video content.

2. Description of the Related Technology

[0003] Online advertising is a form of marketing and advertising that uses the Internet to promote products and services to audiences and platform users. Advertisements are increasingly being delivered via automated software systems operating across multiple websites, media services, and platforms, known as programmatic advertising.

[0004] Online advertising often involves a publisher, who integrates advertisements into its online content, and an advertiser, who provides the advertisements to be displayed on the publisher's content. Other potential participants include advertising agencies that help generate and place the ad copy, and an ad server that delivers and tracks the advertising activity.

[0005] Many common online advertising practices are controversial and, as a result, have become increasingly subject to regulation. Many internet users also find online advertising disruptive and have increasingly turned to ad blocking for a variety of reasons. Online ad revenues also may not adequately replace other publishers' revenue streams.

[0006] Display advertising conveys its advertising message visually using text, logos, animations, videos, photographs, or other graphics. The goal of display advertising is to obtain more traffic, clicks, or popularity for the advertising brand or organization. Display advertisers frequently target users to increase the ads' effect. Web banners or banner ads typically are graphical ads displayed within a web page. Many banner ads are delivered by a central ad server.

[0007] The online advertising process may involve many parties. In the simplest case, the website publisher selects and serves the ads. Publishers that operate their advertising departments may use this method. Alternatively, ads may be outsourced to an advertising agency, and served from the advertising agency's servers or ad space may be offered for sale in a bidding market using an ad exchange and real-time bidding, known as programmatic advertising.

[0008] Programmatic advertising involves automating the sale and delivery of digital advertising on websites and platforms via software rather than direct human decision-making. Advertisements are selected and targeted to audiences via ad servers which often use cookies, which are unique identifiers of specific computers, to decide which ads to serve to a particular consumer. Cookies can track whether a user left a page without buying anything, so the advertiser can later retarget the user with ads from the site the user visited.

[0009] As advertisers collect data across multiple external websites about a user's online activity, they can create a detailed profile of the user's interests to deliver even more targeted advertising. This aggregation of data is called behavioral targeting. Advertisers also target their audience by using contextual cues to deliver ads related to the content of the web page where the ads appear. Retargeting, behavioral targeting, and contextual advertising all are designed to increase an advertiser's return on investment over untargeted ads.

[0010] Customer information is combined and returned to the supply-side platform creates and provides ad offers to an ad exchange. The ad exchange puts the offer out for bid to demand-side platforms. Demand-side platforms act on behalf of ad agencies that sell ads. Demand-side platforms have ads ready to display and are searching for users to view them. Bidders get the information about the user ready to view the ad and decide, based on that information, how much to offer to buy the ad space. An ad exchange picks the winning bid and informs both parties. The ad exchange then passes the link to the ad back through the supply side platform and the publisher's ad server to the user's browser, which then requests the ad content from the agency's ad server.

[0011] Interstitial ads: An interstitial ad displays before a user can access requested content, sometimes while the user is waiting for the content to load. Interstitial ads are a form of interruption marketing.

[0012] Content marketing is any marketing that involves the creation and sharing of media and publishing content to acquire and retain customers. This information can be presented in a variety of formats, including blogs, news, videos, white papers, e-books, infographics, case studies, how-to guides, and more.

[0013] Ad blocking, or ad filtering is a technology that may be used to block advertising.

[0014] An online advertising network or ad network is a company that connects advertisers to websites that want to host advertisements. The key function of an ad network is an aggregation of ad supply from publishers and matching it with the advertiser's demand. The phrase "ad network" by itself is media-neutral in the sense that there can be a "Television Ad Network" or a "Print Ad Network" but is increasingly used to mean "online ad network" as the effect of aggregation of publisher ad space and sale to advertisers is common in the online space. The fundamental difference between traditional media ad networks and online ad networks is that online ad networks use a central ad server to deliver advertisements to consumers (ad serving), which enables targeting, tracking, and reporting of impressions in ways not possible with analog media alternatives.

[0015] Targeted networks focus on specific targeting technologies such as behavioral or contextual, that have been built into an ad server. Targeted networks specialize in using

consumer clickstream data to enhance the value of the inventory they purchase. Further specialized targeted networks include social graph technologies which attempt to enhance the value of inventory using connections in social networks. Significant targeting methods include behavioral targeting, contextual targeting, and creative optimization by using experimental or predictive methods to explore the optimum creative for a given ad placement and exploiting that determination in further impressions.

[0016] Artificial intelligence (AI) is the intelligence of machines or software, as opposed to the intelligence of human beings or animals.

[0017] Machine learning is the study of programs that can improve their performance on a given task automatically. It has been a part of AI from the beginning.

[0018] There are several kinds of machine learning. Unsupervised learning analyzes a stream of data, finds patterns, and makes predictions without any other guidance. Supervised learning requires a human to label the input data first and comes in two main varieties: classification (where the program must learn to predict what category the input belongs in) and regression (where the program must deduce a numeric function based on numeric input). In reinforcement learning the agent is rewarded for good responses and punished for bad ones. The agent learns to choose responses that are classified as "good". Transfer learning is when the knowledge gained from one problem is applied to a new problem. Deep learning uses artificial neural networks for these types of learning.

[0019] Natural language processing (NLP) allows programs to read, write, and communicate in human languages such as English. Specific problems include speech recognition, speech synthesis, machine translation, information extraction, information retrieval, and question answering.

[0020] Modern deep learning techniques for NLP include word embedding (how often one word appears near another), transformers (which finds patterns in text), and others. Feature detection helps AI compose informative abstract structures out of raw data.

[0021] Machine perception is the ability to use input from sensors (such as cameras, microphones, wireless signals, active lidar, sonar, radar, and tactile sensors) to deduce aspects of the world. Computer vision is the ability to analyze visual input. The field includes speech recognition, image classification, facial recognition, object recognition, and robotic perception.

[0022] Deep learning uses several layers of neurons between the network's inputs and outputs. The multiple layers can progressively extract higher-level features from the raw input. For example, in image processing, lower layers may identify edges, while higher layers may identify the concepts relevant to a human such as digits, letters, or faces.

[0023] Generative artificial intelligence (AI) is artificial intelligence capable of generating text, images, or other media, using generative models. Generative AI models learn the patterns and structure of their input training data and then generate new data that has similar characteristics. A generative AI system is constructed by applying unsupervised or self-supervised machine learning to a data set. The capabilities of a generative AI system depend on the modality or type of the data set used.

[0024] A foundation model (also called base model) is a large machine learning (ML) model trained on a vast quantity of data at scale (often by self-supervised learning or semi-supervised learning) such that it can be adapted to a wide range of downstream tasks. Foundation models can in turn be used for task and/or domain-specific models using targeted datasets of various kinds. Beyond text, several visual and multimodal foundation models have been produced-including DALL-E, Flamingo, Florence, and NOOR. Visual foundation models (VFMs) have been combined with text-based LLMs to develop sophisticated task-specific models. There is also Segment Anything by Meta AI for general image segmentation. For reinforcement learning agents, there is GATO by Google DeepMind.

[0025] Foundation models may be further developed through additional training. A foundation model is a "paradigm for building AI systems" in which a model trained on a large amount of unlabeled data can be adapted to many applications. Foundation models are "designed to be adapted (e.g., finetuned) to various downstream cognitive tasks by pre-training on broad data at scale".

[0026] Key characteristics of foundation models are emergence and homogenization. Because training data is not labeled by humans, the model emerges rather than being explicitly encoded. Properties that were not anticipated can appear. For example, a model trained on a large language dataset might learn to generate stories of its own or to do arithmetic, without being explicitly programmed to do so. Furthermore, these properties can sometimes be hard to predict beforehand due to breaks in downstream scaling laws. Homogenization means that the same method is used in many domains, which allows for powerful advances but also the possibility of "single points of failure".

SUMMARY OF THE INVENTION

[0027] It is an object to provide a system that is computationally efficient yet allows for a deep understanding of content, including video and/or other content.

[0028] It is an object to provide a versatile system that may be used in different applications where machine understanding of content, including video and/or other content, is useful or required.

[0029] It is an object to provide a system capable of indexing content, including video and/or other content, according to multiple domains. It is a further object to provide a system where the indexing of video may be on a scene-by-scene basis and/or a frame-by-frame basis.

[0030] It is an object to provide a system that utilizes a deep understanding of video content to provide contextual advertising. Contextual advertising is more relevant to the content and thus likely to be more relevant to a user who elects to view the content. Contextual advertising is more effective than advertising untethered to the content and thus more valuable to the advertiser. A system that can enrich content, using rich metadata, may provide the viewer with an enhanced viewing experience. This increases engagement. The ability to understand the content being consumed by a viewer enables recommendations of similar content and enables superior advertiser value propositions for increased monetization. This can provide better fill rates and higher CPMs for advertisement placements.

[0031] An example of utilizing the system for contextual advertising:

[0032] Consider a user who is watching content with a high-speed car chase. The advertising provided immediately following the car chase scene can be selected to be consis-

tent with the scene. For example, an advertisement may be presented for a sports car immediately following a high-speed chase. The selection of a Porsche advertisement immediately for placement after a high-speed car scene involving a Porsche is even more relevant.

[0033] The enriched metadata may also indicate that the high-speed chase involving a Porsche ends in a fiery crash in which case it may be better for an agency placing Porsche advertisements to know that would be an inopportune moment to place a Porsche advertisement. Instead, it may be more opportune to provide a message relating to car safety.

[0034] For another example, when the content viewed relates to an infant, it may be appropriate to show an advertisement for relevant products such as car seats, diapers, baby formula, or other baby-related items.

[0035] For another example, restaurant advertisements may be served following content showing people dining in a restaurant. Similarly, insurance ads may be served following content showing natural disasters or other types of destruction.

[0036] The foregoing examples involve the presentation of an advertisement during a pre-established commercial break in the content provided or by interrupting the content at an appropriate juncture during the consumption of content. The system may use a deep understanding of the content reflected in the rich metadata to determine the point in the presentation of content to present an advertisement. For example, at the conclusion of a scene or the conclusion of a shot. The system also has the ability to understand the frequency and timing of commercial breaks and override scheduling based on determined conditions. For example, the system may accommodate logic to override an advertisement opportunity determined based on the content but is otherwise inappropriate or undesirable, for example, based on time constraints such as the opportunity following too closely after another opportunity.

[0037] Another modality for the use of the system is to modify the content by superimposing relevant messages in an automated fashion based on a deep understanding of the content reflective of the metadata which, in turn, is reflective of the scene. For example, during a scene that includes a baby smiling or otherwise expressing joy, an overlay may be provided to the content with a consistent advertising message. For example, "This happy baby moment is brought to you by Huggies". According to another example where content shows a relaxing moment with folks sitting around a fire, a pool, or in a lounge, the message may be "This moment is brought to you by Bud Light".

[0038] A deep understanding of the content can facilitate the presentation of the overlay. This can be accomplished by deciding if there is a suitable position on the screen during a shot for presenting the overlay. This involves a determination of a sufficiently sized area with a relatively low level of variations for a sufficient period of time during or near the relevant portion of the content. The rich metadata can also assist in selecting the color of the superimposed message. For example, the superimposed message should not be presented over content having similar coloring as the backdrop. The system may use AI techniques to alter the coloring of the superimposed image or to select an image to superimpose that has contrasting coloring to the backdrop. The system may also interface with an ad server and include in the identification of an ad opportunity, the particulars (size shape, background color, duration, and information describing the content) as part of a bid package, and the ad server may place advertisements through a competitive bid process where the advertiser/agency controls the bids and advertisement selection based on the particulars. The advertiser may thereby elect to limit the superimposition based on the particular colors. For example, Coca-Cola may have superimposed content in two versions: according to one version the superimposition is in red, and according to another version, the superimposition is white. Each may be suitable only for a limited range of background colors and the background color will inform the decision to place a particular advertisement superimposed on the content.

[0039] According to an advantageous feature, a multimodal metadata extraction system may be provided with a scene detector having a video content input and an output representing scene boundaries. The metadata extractor may be responsive to the content of a scene as identified by the scene boundaries to extract metadata corresponding to several, plural, or multiple extraction modes. A metadata embedding may be used for each of the modes.

[0040] An embedding aggregator response to the embedding operates to formulate an aggregated embedding for each scene thereby indexing the content of the scene. The output representing the identified scenes may be a set of video clips of each scene or an index to the video content corresponding to the identified scenes. The scene detector may include a frame analyzer for identifying consecutive frames having similar characteristics. A boundary detector may be provided to identify boundaries of consecutive frames having sufficiently similar characteristics that they likely belong to the same shot. An embedding system may be provided to formulate a composite distance matrix capturing the distance between shot embeddings. A temporal clustering system may be connected to the composite distance matrix. An output of the temporal clustering system identifies the scene boundaries of the content.

[0041] An embedding database may be connected to the embedding aggregator for storing the aggregated embedding for use as a search index for scenes identified in the content.

[0042] The multimodal metadata extraction system may be provided with extraction modes to adequately characterize the content. The particular extraction modes and several extraction modes may be by the application for which the metadata will be used. Extraction modes include at least one of audio (speech recognition, music recognition); image recognition (feature recognition with temporal understanding); text (caption, scene summarization, text recognition); and scene interpretation (sentiment, profanity, action level). Many other extraction modes may be implemented.

[0043] A system for contextual modification of content based on multimodal extraction of metadata from the content, wherein said metadata is extracted by processing one or more scenes in said content to extract metadata corresponding to multiple extraction modes, and an embedding model for each extraction mode wherein an aggregated embedding model responsive to said extracted metadata for each mode formulates an aggregated embedding including a process controller having an embedding extractor responsive to a control input wherein the control input specifies one or more features defining a content modification opportunity and wherein the embedding extractor includes an embedding model coordinated with the embedding model for one or more of the embedding modes to generate an opportunity embedding in the form of a vector. A vector comparison

processor for determining the distance between the opportunity embedding and the aggregated embedding to determine a content modification opportunity. Wherein the process controller is responsive to the vector comparison processor to generate edit control instructions indicating a modification of the content upon detection of the content modification opportunity. A content editor is responsive to the edit control instructions to modify the content and have a modified content output.

[0044] The edit control instructions may cause the content editor to add an overlay to the content. A creative library to store one or more content overlays and the edit control instructions may specify an overlay for use by said content editor.

[0045] The edit control instructions may include an identification of an overlay stored in the creative library and the content editor may be connected to the creative library. The edit control instructions may include the overlay and the process controller may be connected to the creative library. The edit control instructions may include instructions for placement of the overlay in the modified content output.

[0046] The edit control instructions may include instructions for modification of the overlay in the modified content. The process controller may be responsive to the vector comparison processor to identify an indication of the position and duration of a content modification opportunity and may further include a modification selection server responsive to the opportunity to select a modification to apply to said content. The modification selection server may be a competitive bid processor.

[0047] The edit control instructions may cause the content editor to interrupt the content and add a set of additional frames to the content during the interruption. A creative library may store one or more sets of additional frames and the edit control instructions may specify a set of additional frames for use by the content editor.

[0048] The edit control instructions may include an identification of a set of additional frames stored in the creative library and the content editor may be connected to the creative library. The edit control instructions may include the set of additional frames and the process controller may be connected to the creative library. The edit control instructions may include instructions for placement of the set of additional frames in the modified content output. The process controller may be responsive to the vector comparison processor to identify the time of insertion of the set of additional frames.

[0049] The process controller may be responsive to the vector comparison processor to identify the location of a content modification opportunity and a modification selection server responsive to the opportunity to select a modification to apply to said content. The modification selection server may be a competitive bid processor.

[0050] It is an object to provide a system that can provide dynamically customized contextual advertising and/or generated creatives using Gen AI techniques. It is a feature to modify creatives based on context. The context may include information relating to the viewer and information relating to the content. Where context includes viewer information, a viewer database may be provided which includes demographics, viewing history, and other information concerning the viewer or the viewer's household. The contextual information may be stored by cross-referencing a viewer identification with the scene embeddings **503** or content identification of content viewed. Having a deep understanding of the content a viewer has previously viewed allows the generation of creatives based on the user. For example, a creative may be generated featuring a San Francisco resident listening to NPR driving a Tesla on the Golden Gate Bridge, and drinking a certain Kombucha brand may be created on the fly to follow a scene with San Francisco in the background where the viewer information indicates the viewer is a Silicon Valley executive. Different creatives may be generated for different viewers or default creatives may be utilized where a viewer does not match the parameters of an identified advertising opportunity.

[0051] According to another feature, a creative may be modified based on the content being viewed. For example, if the rich metadata indicates that the scene is set in San Francisco, a creative may be presented during an advertising break showing San Francisco as the backdrop. If the content indicated that the scene was set in New York City, a creative may be generated using New York City as the backdrop. In this way, the main video content may be utilized to dynamically create or modify a creative for insertion as an advertisement.

[0052] A system for contextual modification of media content based on multimodal extraction of metadata from the media, wherein the metadata is extracted by processing one or more scenes in the media to extract metadata corresponding to multiple extraction modes, and an embedding model for each extraction mode wherein an aggregated embedding model responsive to the extracted metadata for each mode formulates an aggregated embedding including a process controller having an embedding extractor responsive to a control input wherein the control input specifies one or more features defining a media modification opportunity and wherein the embedding extractor includes an embedding model coordinated with the embedding model for one or more of the embedding modes to generate an opportunity embedding in the form of a vector. A vector comparison processor for determining the distance between the opportunity embedding and the aggregated embedding to determine a media modification opportunity wherein the process controller is responsive to the vector comparison processor to generate edit control instructions indicating a modification of the media upon detection of the media modification opportunity. A media content editor may be responsive to the edit control instructions to modify the media and have a modified media output wherein the media content editor uses generative AI techniques to modify the media content.

[0053] The system may include a creative library, wherein the creative library stores one or more template creatives, and the edit control instructions specify the generative AI techniques to the template creative retrieved from the creative library application for use by the media content editor. The edit control instructions may cause the media content editor to apply generative AI techniques based on triggering embeddings. The edit control instructions may include triggering embeddings. The triggering embeddings may be based in part on the aggregated embeddings. The triggering embeddings may be based in part on metadata concerning viewers, and further including a viewer database for viewer metadata. The edit control instructions may be dynamically generated based on the viewer database and scene content embeddings in the modified media content. A modification selection server may be responsive to the opportunity to

select a modification to apply to the media. The modification selection server may be a competitive bid processor.

[0054] It is an object to provide fully immersed advertising in video content. It is an object to use artificial intelligence techniques to allow an advertiser to identify an opportunity to provide artificial product placement in a scene. A user may specify advertising opportunities by providing instructions reflective of the opportunity that they are looking for. For example, the user may designate the occurrence of an actor holding a beverage as an opportunity. The system may establish a search vector to identify a scene, shot, or frame that includes an actor holding a beverage container. The distance between the search vector and content embedding indicates the presence of the opportunity in video content. Once a scene is identified, the system may utilize generative AI techniques to edit the content. For example, to replace a beverage container in the content with another object (or no object). One option is to replace a beverage container with a sponsored beverage container. Generative AI may be utilized to replace the beverage container with a branded container in order to establish artificially created product placements. The system is not limited to advertisements. For example, the system may specify a search for any kind of element and use generative AI techniques to replace such an element. The system may be instructed to locate occurrences of a protagonist smoking a cigarette and use generative AI techniques to eliminate the cigarette or to change the cigarette to something else, for example, a lollypop, and may be set to delete any smoke.

[0055] An alternative implementation may be to insert into the content, for example at the end of a scene some, extra frames essentially replicating the frames that have the beverage container except for using the generative AI techniques to artificially modify the frames to include the desired product placement. In this way, the content frames remain intact, but the system allows the insertion of an advertisement that appears seamlessly as part of the content. Generative AI techniques are available for performing such modifications. Another implementation is to edit the video content by inserting a creative immediately after the scene. The creative might be a sponsored advertisement suggested by the opportunity. In general, it is an object to provide a system that identifies scene modification opportunities. The scene modification opportunities are specified by a set of conditions and such conditions are utilized to establish a search vector. The conditions may be specified by media input or other instructions. The input may be generated by a user or may be driven by a content inventory.

[0056] One aspect of the content inventory may be an advertisement inventory. In this scenario, the advertisement inventory may be represented by a set of "creatives". The creatives might be any kind of content that the user wants incorporated into a video content. Consider the example where the inventory includes an advertisement for a London Fog brand overcoat. The advertisement includes a scene with a man on a rainy night walking under a streetlight. Another creative in the inventory might be a soft drink advertisement featuring teens frolicking at the beach. A third creative in the inventory might be for a brand of beer featuring people at a football stadium.

[0057] The inventory may be processed as search media to generate search vectors. The search vectors may be compared to scene embeddings generated from video content by a multimodal metadata extractor. If the video content includes a scene that is like a creative in the inventory, the corresponding creative may be inserted into the video content at the end of the identified scene. Similarity is indicated by the distance between a search vector generated from the creative and the scene embeddings generated by a multimodal metadata extractor.

[0058] A system for contextual modification of content based on multimodal extraction of metadata from the content, wherein the metadata is extracted by processing one or more scenes in the content to extract metadata corresponding to multiple extraction modes, and an embedding model for each extraction mode wherein an aggregated embedding model responsive to the extracted metadata for each mode formulates an aggregated embedding may include a process controller including an embedding extractor responsive to a control input wherein the control input may specify one or more features defining a media modification opportunity and wherein the embedding extractor may include an embedding model coordinated with the embedding model for one or more of the embedding modes to generate an opportunity embedding in the form of a vector. A vector comparison processor may be provided for determining the distance between the opportunity embedding and the aggregated embedding to determine a content modification opportunity. The process controller may be responsive to the vector comparison processor to generate edit control instructions indicating a modification of the content upon detection of the content modification opportunity. A content editor may respond to the edit control instructions for a content modification opportunity may modify the content and may have a modified content output wherein the content editor may use generative AI techniques to modify the content by replacing an element appearing within the content during the content modification opportunity with an element correlated with the element appearing in the content.

[0059] The element appearing during the content modification opportunity may represent an object that appears in one or more frames of the content wherein the element correlated with an element of the content may represent an alternative object and the generative AI technique may excise at least an area of one or more frames corresponding to the element and inserting the element correlated with the element appearing in the content in the one or more frames. The generative AI techniques may operate to fill any gaps between the element appearing within the content during the content modification opportunity and the element correlated with the element appearing in the content.

[0060] A creative library may be provided with one or more creative templates and the edit control instructions may specify the generative AI techniques to the creative template retrieved from the creative library application for use by the content editor. The edit control instructions may cause the media content editor to apply generative AI techniques based on triggering embeddings.

[0061] The edit control instructions may include triggering embeddings. The triggering embeddings may be based in part on the aggregated embeddings. The triggering embeddings may be based in part on metadata concerning viewers, and further include a viewer database for viewer metadata. The edit control instructions may be dynamically generated based on the viewer database and scene content embeddings in the modified content. The system may include a modification selection server responsive to the content modification opportunity to select a modification to apply to the

content. The modification selection server may be a competitive bid processor. The element appearing during the content modification opportunity may represent an object that appears in one or more frames of the content and the element correlated with an element of the content may represent an alternative object and the generative AI techniques may insert one or more frames of modified content into the content at the content modification opportunity.

[0062] A system for replacing elements in content using multimodal extraction of metadata from the content, wherein the metadata is extracted by processing one or more segments of the content to extract metadata corresponding to multiple extraction modes, and an embedding model for each extraction mode wherein an aggregated embedding model responsive to the extracted metadata for each mode formulates an aggregated embedding may include a process controller including an embedding extractor responsive to a control input wherein the control input specifies one or more features defining a content modification opportunity and wherein the embedding extractor includes an embedding model coordinated with the embedding model for one or more of the embedding modes to generate an opportunity embedding in the form of a vector and a distance processing engine for determining the distance between the opportunity embedding and the aggregated embedding to determine a content modification opportunity. The process controller may be responsive to the vector comparison processor to generate edit control instructions indicating a modification of the content upon detection of the content modification opportunity. A preference database may contain content modification preferences for a subset of content consumers wherein the process controller may be connected to the preference database to obtain content modification preferences for the subset of content consumers and the control instructions may include an identification of the subset of the consumers and the content modification preferences for the subset of content consumers are connected to the embedding extractor. A content editor may be provided responsive to the edit control instructions for a content modification opportunity to modify the content and modified content output. The content editor may use generative AI techniques to modify the content by replacing an element appearing within the content during the content modification opportunity with an element correlated with the element appearing in the content.

[0063] The element correlated with an element of the content may represent an alternative object and the generative AI techniques may exercise at least an area of the one or more frames corresponding to the element and insert the element correlated with the element appearing in the content in the one or more frames. The generative AI techniques may fill any gaps between the element appearing within the content during the content modification opportunity and the element correlated with the element appearing in the content.

[0064] The system may include a creative library that stores one or more templates and the edit control instructions may specify the generative AI techniques to the template retrieved from the creative library application for use by the content editor. The edit control instructions may cause the content editor to apply generative AI techniques based on triggering embeddings. The subset of consumers may be a set of consumers having similar demographics in at least one respect. The subset of consumers may be a set of consumers in a single household. The subset of consumers may be a single consumer. The system may include a consumer interface and preferences specified through the consumer interface may be stored in the consumer database. The system may include a consumer mining system connected to the consumer database and at least some information from the consumer information mining system may be stored in the consumer information database.

[0065] It is an object to permit content consumers the opportunity to control aspects of the content. It is believed that consumers will be more engaged with content if they are able to control aspects of the presentation of the content and, personalize aspects of the content. The personalization of aspects of the presentation of content may apply to the entirety of the content or only portions of the content. It is a feature to provide an interface for a viewer to input the information. The interface may be a browser-based interface that allows a user to input preferences and content to the system. According to a feature, a viewer may log into an account, the system may then make a connection between the viewer and the destination of a content stream, for example, the IP address to which content is delivered. The preferences may be the selection of an avatar to be used for one or more characters in the content and/or images to be utilized. For example, the images may be pictures of the user, friends, family members, or any other pictures intended to be used by the system in modifying content. Images of a household pet may be utilized to represent a pet or character that the viewer prefers to be included in the video content. The preferences may be set for any aspect of the video content supported by the system. The multimodal metadata extraction facilitates a deep understanding of the content and any aspect of the content that is understood may be selected by a consumer. The system also allows the consumer to select or provide the basis for a modification of the content. Other examples are vehicles appearing in the content, cities appearing in the content, music contained in the content, voice, and accent used. For example, a consumer may specify certain compositions or styles of compositions to be used as background music. The consumer may set a preference that one or more of the characters look like the consumer and that any vehicles driven by the character look like the viewer's vehicle or a specified vehicle. There exists technology to collect information regarding a consumer in an automated fashion and technology for collecting data privacy preferences for a user. It is an object of the invention to extend those capabilities to include the collection of consumer preferences for inclusion in a content stream presented to the consumer. The preferences may be incorporated in a portion of the content presented to the consumer, for example, by customizing aspects of supplemental content such as advertisements, but not the base content. It is an object to limit the use of the identified preferences to aspects of content authorized by a content provider or system administrator. For example, a consumer may indicate a preference for some lead character in the content to be replaced by images modified to look like a consumer's preferred character or avatar. For another example, the consumer selects a preference for all beverages consumed by characters in the content to be replaced with a martini. It is an object to allow the system to ignore the consumer's preference in certain circumstances. For example, in an advertisement for a particular soft drink, the system may be configured to show images of the soft drink selected by a

system operator and not utilize a beverage preference expressed by a consumer. Similarly, where a consumer specifies a preference for a vehicle, such preference need not be honored for vehicle advertisements. It is a further object to allow the system to mine consumer information for the identification of elements to be incorporated into a content stream. For example, the consumer information accessed by the system may include an identification of content consumed or selected by the consumer or other information collected about the consumer. For example, technology exists to record online advertisements delivered by an ad server to a consumer. For example, a vehicle manufacturer may have bid on and/or successfully placed advertisements for a particular vehicle to a consumer. That vehicle manufacturer may wish to reinforce those online advertisements by modifying the vehicle that appears in content consumed by the consumer. For example, the consumer information available to the system may reflect that the consumer has been exposed to advertisements or other content depicting a certain class of vehicles, for example, pick-up trucks. Having access to such information, for example, Ford Motor Company may elect to modify a content stream or portion of a video content stream to show one or more characters driving a Ford F-150 pick-up truck. It is an object to use generative AI techniques to modify the content stream in the desired fashion.

[0066] It is an object to provide a system for programming content channels. It is a further object to provide a system for generating content channel lineups based on a deep understanding of consumer preferences and/or content consumed by a consumer or class of consumers. The program content channels may be dynamically generated based on a population of consumers where the population is at one or more consumers. The population may be established by evaluating consumer information to assess the similarity between consumers. The similarities may be demographic-based on content consumption or based on other available consumer information. It is an object to utilize a deep understanding of the content consumed by a consumer to at least in part program a content channel or make content recommendations to the relevant population. Consumer information may include any information collected regarding an individual consumer or population of consumers. For example, information concerning a vehicle purchased by a consumer may be utilized as part of the program formulation. The available content for programming may be a library of content. It is an object to take advantage of a deep understanding of content in the library. A deep understanding of content coupled with content consumption history and patterns allows for the formulation of a program or recommendation for a population. The programming recommendations may be dynamically generated for a population. For example, the viewership information coupled with a deep understanding of the content may indicate sufficient characteristics of the consumed content to formulate search vectors. The distance between the search vectors and content embeddings, for example, generated from multimodal metadata extraction may be utilized to establish and program one or more content channels and/or establish content recommendations for genres or micro-genres. It is an object to utilize a deep understanding to facilitate the definition of highly specified genres, referred to herein as microgenres. For example, a consumer may have consumed multiple content presentations which can be ascertained as science fiction, action, adventure, post-apocalyptic, and including scenes set in cities having diverse populations. Such information may, for example, be derived from a deep understanding of the content of the films Blade Runner, The Fifth Element, and Total Recall. Based on that information and a deep understanding of other available content, the system may recommend or program a channel that includes films such as The Matrix franchise movies, I Am Legend, I Robot, The Expanse series, and other content. The system may be dynamically updated so that the more content consumed by the population may refine the criteria and thereby refine the program or recommendations.

[0067] Conventional programming and recommendations are essentially static and may be supplemented by trending information among a population. The deep understanding of content consumed presently and historically allows AI algorithms to take a consumer's taste and preferences, demographics, geographical location, time of day, etc. into account for personalization of the programming and/or recommendations. A program channel for a consumer population may be weighted based on recency or other factors.

[0068] It is an object to facilitate content programming or recommendations having vertical personalization. Vertical personalization may include a list of channels curated and ranked for each user dynamically. For example, if consumer A has watched Bollywood content and consumer B has watched Spanish language content, those channels may be presented on a consumer-by-consumer basis. For example, if consumer A has recently been binging on Korean thriller series, a Korean thriller channel may be presented to the consumer. In addition, may be positioned in a list of channels based on frequency. For example, the most recently viewed content may trigger channels based on that content to be listed higher in sequential order, and channels based on historically viewed content may be presented in a lower position in a sequence of channels.

[0069] It is a further object to allow for horizontal personalization, even within a channel. The content lists may be curated for a consumer dynamically for a particular consumer or population. For example, consumer A may have consumed slapstick comedies in the consumer's recent history, while consumer B may have more recently consumed dark comedies. The horizontal personalization of a comedy channel for consumer B may elevate dark comedies within the lists of comedies and the sequence of programming or recommendations and the horizontal personalization of a comedy channel for consumer A may elevate or prioritize slapstick comedies in a comedy collection. A system for programming content channels may be based on multimodal extraction of metadata from content, wherein the metadata is extracted by processing one or more scenes in the content to extract metadata corresponding to multiple extraction modes, and an embedding model for each extraction mode wherein an aggregated embedding model responsive to the extracted metadata for each mode formulates an aggregated embedding including a consumer information database containing information regarding consumer consumption of content including at least an identification of content consumed, programming logic based at least in part on comparing an embedding of metadata extracted by multimodal extraction of content consumed by the consumer to the aggregated embeddings including a vector comparison processor for determining the distance between the embedding generated based upon content consumed and the aggregated

embedding, and wherein the programming logic uses the distance between the embedding generated based on content consumed and the aggregated embedding to generate a program guide tailored to viewer preferences. A content identification may be stored in the consumer information database identifying content consumed by the consumer and the embedding generated based upon content consumed may be stored in the content library. The programming logic may include an embedding aggregator to aggregate embeddings generated from multimodal metadata extraction of consumed content with embeddings of content previously selected for consumption.

[0070] The embedding aggregator may weigh embeddings supplied to the embeddings aggregator. The weight may be based, at least in part on recency. The weight may be based on time of day, frequency, or consumer input. The programming guide may include multiple content channels. The programming logic may order the content channels in the programming guide based on user preferences. The programming logic may order the content channels in the programming guide by genre based on user preferences. The programming logic may order the content channels in the programming guide by vertical personalization based on user preferences, by horizontal personalization based on user preferences, or otherwise.

[0071] Various other objects, features, aspects, and advantages of the disclosed system will become more apparent from the following detailed description of preferred embodiments of the invention, along with the accompanying drawings in which the same numerals represent the same components across more than one figure.

[0072] Moreover, the above objects and advantages are illustrative, and not exhaustive, of those that can be achieved by the or with the system. Thus, these and other objects and advantages will be apparent from the description herein, both as embodied herein and as modified because of any variations that will be apparent to those skilled in the art.

BRIEF DESCRIPTION OF THE DRAWINGS

[0073] FIG. **1** shows a multimedia metadata extraction system.

[0074] FIG. **2** shows the operation of a scene detector.

[0075] FIG. **3** shows a text-based query system.

[0076] FIG. **4**. shows an embodiment using video content to search metadata extracted from video content using a multimodal metadata extractor.

[0077] FIG. **5** shows a system architecture for taking advantage of a deep understanding of content.

[0078] FIG. **6** shows a system that may be utilized to generate contextual advertising with dynamically customized and/or generated creatives using Generative AI.

[0079] FIG. **7** shows a system for programming media channels.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0080] Before the present invention is described in further detail, it is to be understood that the invention is not limited to the embodiments described, as such may, of course, vary. It is also to be understood that the terminology used herein is for the purpose of describing embodiments only, and is not intended to be limiting, since the scope of the present invention will be limited only by the appended claims.

[0081] Where a range of values is provided, it is understood that each intervening value, to the tenth of the unit of the lower limit unless the context clearly dictates otherwise, between the upper and lower limit of that range and any other stated or intervening value in that stated range is encompassed within the invention. The upper and lower limits of these smaller ranges may independently be included in the smaller ranges are also encompassed within the invention, subject to any specifically excluded limit in the stated range. Where the stated range includes one or both of the limits, ranges excluding either or both of those included limits are also included in the invention.

[0082] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Although any methods and materials similar or equivalent to those described herein can also be used in the practice or testing of the present invention, a limited number of exemplary methods and materials are described herein.

[0083] It must be noted that as used herein and in the appended claims, the singular forms "a", "an", and "the" include plural referents unless the context dictates otherwise.

[0084] All publications mentioned herein are incorporated herein by reference to disclose and describe the methods and/or materials in connection with which the publications are cited. The publications discussed herein are provided solely for their disclosure before the filing date of the present application. Nothing herein is to be construed as an admission that the present invention is not entitled to antedate such publication by prior invention. Further, the dates of publication provided may be different from the actual publication dates, which may need to be independently confirmed.

[0085] A system is provided for processing video content to gain a rich understanding of the video content. To effectively process the content and achieve sufficient computational efficiency, even using artificial intelligence (AI) techniques, a content stream may be divided into scenes made up of one or more segments of the content. Each segment is likely to correspond to a shot and is made up of one or more sequential frames having a high level of commonality. Two or more segments having a high level of commonality may be grouped together and processed as a single scene.

[0086] In content production, a "shot" is typically considered to be a continuous view captured by a single camera without interruption. A processor can identify continuous frames that are likely to be in the same groups of frames in a shot by examining local color distribution. These shots are identified as a segment of content. Similar shots (or segments) may be grouped into scenes. Similar shots are taken to be part of a scene. Shots having sufficient similarity in a scene are assumed to convey a homogeneous storyline or concept.

[0087] FIG. **1** shows a multimodal metadata extraction system with a video content input **101**. The content input **101** is provided to a scene detector **102**. The scene detector **102** operates to break a video content stream to smaller (or shorter) scenes. A video stream is made up of a series of frames. Frames of content can be grouped into segments based on commonality. Segments can also be grouped into scenes based on commonality.

[0088] FIG. **2** shows the operation of scene detector **102**. A content stream is provided to a stream analyzer for performing a frame-by-frame analysis to identify boundary frames for a series of consecutive frames having a high level of similarity. The frame-by-frame analysis may be performed by using significant average color distribution differences between consecutive frames. The shot boundaries may be stored in boundary table **204** and used to access the frames of a shot. The video content may be in content storage **206**. Alternatively, the frames of a shot may be processed in a stream.

[0089] The frames of the shots are provided to embedding system **205**. The embedding system may be implemented using a convolutional neural network or a Vision Transformer based on a Deep Learning image featurizer. The embedding system may generate a composite distance matrix **206** by capturing the distance between shot embedding based on a distance metric and potentially the temporal distance between shots.

[0090] Temporal clustering **207** based on dynamic programming is applied on the composite distance matrix **206** to group similar, shots together to obtain scene boundaries **208**.

[0091] Scene boundaries **208** define the detected scenes **103**. The detected scenes **103** are provided to a metadata extractor **104**. The metadata extractor **104** considers the content of the scenes individually according to selected aspects anticipated to be potentially present in the content. FIG. **1** illustrates four aspects for processing and embedding. The aspects illustrated in FIG. **1** are examples, Audio/Background Music embedding **105**, Image/Video embedding with temporal understanding **106**, Text/Caption/Scene Summation embedding **107**, and other metadata (sentiment profanity) **108**. In practice, many more modes are contemplated. For example, location, time of day, weather, genre, etc.

[0092] The extraction frame level detail may include objects, logos, locations, sentiment, action detection, scene summarizer, etc. All the information is then encoded using an embedding model for every scene and a vector search index for each scene is then built. This allows for free-form, contextual, and detailed video indexing/searches for example the metadata for "a romantic scene with a glass of wine by a lake" can be easily identified.

[0093] The embeddings are provided to an embedding aggregator **109** to generate aggregated embeddings **110**. The aggregated embeddings may be stored in an embedding database **111**.

[0094] FIG. **3** shows a text-based query system for searching a database of video content metadata. As shown in FIG. **3**, the metadata obtained by multimodal extraction, as shown in FIGS. **1** and **2**, may be generated in advance and stored in a database. Alternatively, the query may be formulated as described herein and applied against a stream of multimodal extracted metadata in real-time or near real-time.

[0095] A text query **301** is encoded by embedding extractor **302**. The query mode must correspond to one of the mode embeddings used to extract metadata. While the contemplated search is presented as text, the text can be used to search text-compatible modal extractions.

[0096] In its simplest form, the text query can search for corresponding text appearing in the content. The query embedding **303** (SG: The following description is of the text query searching across multiple embedding modes. Please let me know how this is done (or if something different is happening.)) creates a search vector across text-compatible modes. For another example, the location mode may be based on image recognition and if successful may recognize a city. Many cities have unique landmarks that may appear in the content and be recognizable. For example, landmarks like the Arc de Triomphe, the Louvre, or Eiffel Tower signify Paris France; the Empire State Building, UN, or Radio City signify New York.

[0097] The query embedding **303** is used to generate a search vector to be applied against the extractions used to index the content in order to find similar embeddings and the relevant scenes are returned (or identified). This allows for free-form, contextual, and detailed video searches, for example, "a romantic scene with a glass of wine by a lake" can be easily searched. Such searches can be used to identify occurrences in the video content, stored or streamed.

[0098] FIG. **4** shows an embodiment of a system that includes a multimodal metadata extractor for video content and a structure for searching and/or identifying content using video, image, audio and/or text queries. This system allows a user to identify video content that is close to or compatible with other creative content rather than requiring a text-based search as shown in FIG. **3**. The system includes sub-system **400** for establishing a search vector **10**. The search vector may be applied against an index database for a library of video content. The same search vector may be applied against a stream of video content.

[0099] The application may be useful for a system that intends to identify conditions that may present themselves in a live video stream. For example, in a security system, a user may wish to search for a particular occurrence, for example, a person or vehicle entering a gate or checkpoint and proceeding to a location other than a security office. The search content may be a staged video of a person or vehicle entering through a checkpoint and proceeding to unauthorized locations rather than a security office. The search may also be conducted by using video content of expected behaviors and searching for sequences that do not correlate to the expected behaviors.

[0100] Using or formulating explicit text queries to search for suitable shots in content, the system allows for free-form text, audio, video/image, music, and other inputs as queries. Another use case might be in the situation where an advertiser could use its own creative to select the best place in content to serve it. For example, during a TV program or movie that is streaming or broadcast, the advertiser could identify the correct time to insert its ad. There is no need for formulating explicit textual prompts or queries to find suitable shots for placing ads.

[0101] The search vector may be formulated using different modalities embedded using the same foundational models used to index the content stream. These embeddings can then be used to search the content for the highest similarities. The results can be aggregated post or pre-searched. The embeddings for different modalities can also be used to get a single representation using contrastive learning frameworks.

[0102] The search content input **401** is provided to a scene detector **402** operating in the same fashion as scene detector **102**. Scene detector **402** may however be simplified to the extent that the application permits restricting video content search terms to a single shot or at least to an appropriately limited duration or complexity.

[0103] To the extent that the application permits multiple scenes in a video search, the scene detector may be considered to create multiple search terms. The system may be configured to cause a multi-scene search to look for content that includes each of the scenes, any of the scenes, or two or more of the scenes within a temporal limit. The scene boundaries define the detected scene **403**. The detected scenes **403** are provided to a metadata extractor **404**. The metadata extractor **404** may consider the content of the scenes individually according to one or more of the selected aspects anticipated to be potentially present in the content. FIG. **4** illustrates four aspects of search content processing and embedding. The aspects illustrated in FIG. **4** are examples. Audio/Background Music embedding **405**, Image/Video embedding with temporal understanding **406**, Text/Caption/Scene Summation embedding **407**, and other metadata (sentiment profanity) **408**. Many more modes are possible, however, they may not be needed for a video content search application, depending on the objective of the contemplated search. The search term embeddings may be provided to an embedding aggregator **409** to generate aggregated search embeddings **410** for use as a search vector against content embeddings.

[0104] As shown in FIG. **4**, the metadata obtained by multimodal extraction, as shown in FIGS. **1** and **2**, may be generated in advance and stored in a database. Alternatively, the query may be formulated as described herein and applied against a stream of multimodal extracted metadata in real-time or near real-time. This system allows a user to identify video content that is close to or compatible with other creative content rather than requiring a text-based search as shown in U.S. patent application Ser. No. _____, Attorney Docket No. 169004, and as illustrated in FIG. **3**. The system includes a sub-system **400** for establishing a search vector **410**. The search vector may be applied against an index database for a library of video content. The same search vector may be applied against a stream of video content.

[0105] FIG. **5** shows a system architecture for taking advantage of a deep understanding of content, including video and/or other content. Video content of **501** is provided to the system. Depending on the application, architecture, and demands in terms of computational complexity and timing, all data processed through the system may be in the form of a data stream or may be stored, accessed, and used by the system as needed. The system may be implemented in a hybrid approach whereby processing is performed as demanded with results stored in buffers. In this manner, processing need not be synchronized with content output requirements. The system may utilize libraries and databases to preprocess and store content, including subject video content, operational parameters, and creatives, which are used to modify video content processed by the system. The video content **501** may originate from a database or content library or be a video stream.

[0106] The multimodal metadata extractor develops data serving as an index representing a deep understanding of the video content. An embodiment of the multimodal metadata extractor **502** is illustrated in FIG. **1** and described in connection therewith. The multimodal metadata extractor **502** outputs scene embeddings **503** generated by artificial intelligence processing techniques. The scene embeddings **503** are associated with the video content **501** processed by the multimodal metadata extractor **502**. The association may, for example, be affected by video content **501** time-stamps indexed against or incorporated into the scene embeddings **502**. Alternatively, the scene embeddings **503** may be combined with the video content **501**. The process controller **504** is illustrated schematically in FIG. **5**. The process controller **504** may have different configurations depending on the intended application of the system. Embodiments of the process controller **504** are described hereinafter. In addition, aspects of the embodiments illustrated in FIGS. **3** and **4** include aspects of embodiments of process controller **504**. Process control instructions **505** are provided to process controller **504**. The process control instructions **505** may be generated manually or, particularly in a production environment, generated in an automated fashion. The process controller **504** may have a search vector output **506**. The search vector output **506** may be generated based in part on process control instructions **505**. The process controller **504** may be configured with inputs in the form of text queries and may have an embedding extractor **302**, query embedding **303**, and optionally textual inversion **304**, as shown in FIG. **3**. Alternatively, or in addition, the process controller may be configured with inputs in the form of media content queries **401** and having a metadata extractor **404**, one or more embeddings **405**, **406**, **407**, **408**. If more than one embedding is extracted, an embedding aggregator **409** may be included to generate an aggregated search vector **410** as shown in FIG. **4**. The system may be configured to permit search content composed of multiple scenes, in which case, a scene detector **402** may be included to break video search content **401** into multiple detected search scenes **403** and the multiple scenes may be logically combined as search terms according to control instructions **505**. The search content may be any media content. In addition to video search content, the search content may be audio content, images, text, or other metadata concerning content.

[0107] The process controller **504** may generate an output of one or more search vectors **506**. The search vector(s) **506** is provided to distance processing engine **507**. The distance processing engine **507** may determine the distance between the search vector **506** and relevant portions of the scene embeddings **503**. In many applications, an identical match between a search vector **506** and scene embeddings **503** is not necessary, and indeed is not expected. A match is indicated when the distance between the search vector **506** and the relevant aspects of scene embeddings **503** falls below a threshold. The threshold may be set to a default level or may be provided and/or modified as part of the control instructions **505**.

[0108] The distance processing engine **507** has an output **508** connected to the process controller **504**. The output **508** of the distance processing engine may represent a distance between a search vector **506** and scene embeddings **503**. In this case, the process controller **504** may make a determination if a threshold distance is satisfied. Alternatively, the distance processing engine **507** may compare the distance to a threshold and issue a determination indicating whether the threshold is satisfied at output **508** to process controller **504**. Depending on the control instructions **505** and the distance processing engine output **508**, the process controller **504** provides edit control instructions **509** to a video content editor **510**. The video content editor **510** may alter the video content in accordance with the content instructions **509**.

[0109] Embodiments of the video content editor **510** are described hereafter. According to one embodiment, the edit

control instructions **509** may include creative material or include instructions to retrieve creative content **511** from a creative library **512**. The creative content **511** may be supplemental information for the purpose of modifying the video content **501** by the video content editor **510** to generate a video output **513**. The output **513** may be streamed for consumption or stored for later consumption. According to According to one embodiment, the edit control instructions **509** may include creative material or include instructions to retrieve creative content **511** from a creative library **512**. The creative content **511** may be supplemental information for the purpose of modifying the video content **501** by the video content editor **510** to generate a video output **513**. The output **513** may be streamed for consumption or stored for later consumption. According to a hybrid approach, the video content editor **510** does not modify the video content **501** strictly in sequential order. Such a situation may occur if temporal clustering is utilized and all similar shots are modified together thereby causing the remaining shots to be processed out of sequential order. In such situations, the processed video may be accumulated in a buffer and output from the buffer in sequential order. Such an operation may result in computational efficiencies.

[0110] According to one embodiment, the edit control instructions **509** may include creative material or include instructions to retrieve creative content **511** from a creative library **512**. The creative content **511** may be supplemental information for the purpose of modifying the video content **501** by the video content editor **510** to generate a video output **513**. The output **513** may be streamed for consumption or stored for later consumption.

[0111] An example of the aforementioned hybrid approach may be a system where the video content editor **510** does not modify the video content **501** strictly in sequential order. Such a situation may occur if temporal clustering is utilized and all similar scenes by modification are modified together thereby causing the remaining scenes to be processed out of sequential order. In such situations, the processed video may be accumulated in a buffer and output from the buffer in sequential order. Such an operation may result in computational efficiencies.

[0112] The insertion of contextual advertising may be accomplished by an embodiment in accordance with FIG. **5**. An advertiser or agency may submit control instructions **505** to the process controller **504**. The process controller **504** may formulate a search vector **506** on the basis of the control instructions. For example, the search vector may be designed to identify a commercial break in content suitable for the insertion of a Porsche advertisement. In this case, the control instructions would be to formulate a search vector representation of a high-speed chase involving a Porsche having a positive result for the Porsche (escape or first-place finish and not ending in a crash of the Porsche). The search vector **506** is compared to scene embeddings **503** by the distance processing engine **507**. If the distance is below a threshold level, a threshold match indication **508** may be provided to the process controller **504** which then issues edit control instructions **509** to the video content editor **510**. The video content editor **510** may retrieve a selected advertisement **511** from the creative library. The video content editor **510** may then insert the Porsche advertisement **511** retrieved from the creative library **512** into the video content **501** to be included in the commercial break in the video content **501** and incorporated into output stream **513**. Generally, this example identifies a suitable advertising opportunity and then modifies the video content to include additional creative materials i.e., the advertisement in the video stream.

[0113] The above-described process for overlaying an ad or sponsorship into video content is performed in essentially the same manner except that the creative **511** retrieved from the creative library **512** is superimposed over the video content **501** by video content editor **510** and incorporated into the video content output stream **513** when the advertising opportunity consistent with control instructions **505** is identified.

[0114] The system according to FIG. **6** may be utilized to generate contextual advertising with dynamically customized and/or generated creatives using Generative AI. The video content editor **510** may use Generative AI techniques to edit the content. The Generative AI techniques may rely on templates retrieved from creative library **512**. Instructions to the video content editor **510** may be the edit control instructions **509** generated by the process controller **504**. The process controller **504** utilizes the scene embeddings **503** to provide edit control instructions **509** which are consistent with the content. The process controller **504** may also rely on viewer information **614** stored in viewer database **615** to generate edit control instructions **509** for the video content editor **510**. The video content editor **510** may then utilize Generative AI techniques with the information contained in the creative library **512** to generate an appropriate output **513** which may be dynamically based on the content or viewer information.

[0115] The system systemically illustrated in FIG. **6** may be configured to replace aspects of a content stream dynamically based on consumer information and/or consumer preferences using generative AI techniques. The system may store information regarding a consumer in consumer database **615**. The information in the consumer database **615** may be collected directly from the consumer, for example, to include consumer-provided preferences. The consumer-provided preferences may be input by a consumer through consumer interface **616**. The consumer interface **616** may use a consumer ID to coordinate consumer information. The consumer information may include an IP address. The IP address may be utilized to identify various screens or other players utilized by a consumer such as a computer monitor, a set-top box/television, or a tablet all receiving data through a WI-FI router IP address. The process controller **504** may be connected to consumer database **615** and the multimodal metadata extractor **502**. The controller instructions **505** to the process controller **504** may be configured to identify elements of consumer information dynamically to incorporate into a search vector to identify opportunities for content modification as described above. Alternatively, or in addition, the consumer information, images, audio, and/or video identified by a user may be stored in the creative library **512** for use by the system. The process controller **504** formulates a search vector **506** utilizing control instructions **505** and optionally consumer information. The search vector **506** is provided to distance processing engine **507**. Upon identification of a suitable opportunity under control instructions **505**, the process controller **504** issues edit control instructions **509** to a content editor **512**. The content editor **510** may utilize generative AI techniques to modify the content stream **501**. The content editor **510** may access creative library **512** for any creative information needed to execute the edit control instructions **509**. The process control instruc-

tions are utilized to control the identification of an opportunity to modify the content stream and may be provided to limit aspects of preference-driven modifications.

[0116] The system shown in FIG. **5** may be implemented in a way to seamlessly stitch fully contextual short ads to content for immersive advertisement. The process controller **504** may receive control instructions **505** instructing it to identify opportunities in the video content for insertion of the desired material. Depending on the control instructions **505**, the opportunity may be the identification of a scene having the desired context and features which admits to using generative AI techniques for the modification within the video content stream **501** or by insertion of additional frames to the video content. The process control **504** formulates search vector **506** to be consistent with scene embeddings of **503** of the video content **501** generated by the multimodal metadata extractor **502**. The distance processing engine **507** may be configured to generate a representation of the distance at its output **508** thereby allowing process controller **504** to select the suitable opportunity within the video content. The process controller **504** may be configured to determine if the distance is within its margin for identifying an opportunity. Alternatively, the determination may be performed by the distance processing engine **507**, and the output **508** of the distance processing engine **507** indicates the identification of a suitable opportunity.

[0117] Creative library **512** may include creatives representing content inventory available for incorporation into the video content **501**. The process controller **504** may access the creatives for use as media queries to be processed to generate search vectors, for example, as described in connection with FIG. **4**.

[0118] The process controller may formulate edit control instructions **509** for video content editor **510** to make the desired edits in the video content **501**. The modified video content **513** is provided at the output of video content editor **510**. The video content editor of **510** may utilize generative AI techniques to modify the video content **501**.

[0119] The system systemically illustrated in FIG. **6** may be configured to replace aspects of a content stream dynamically based on consumer information and/or consumer preferences using generative AI techniques. The system may store information regarding a consumer in consumer database **615**. The information in the consumer database **615** may be collected directly from the consumer, for example, to include consumer-provided preferences. The consumer-provided preferences may be input by a consumer through consumer interface **616**. The consumer interface **616** may use a consumer ID to coordinate consumer information. The consumer information may include an IP address. The IP address may be utilized to identify various screens or other players utilized by a consumer such as a computer monitor, a set-top box/television, or a tablet all receiving data through a WI-FI router IP address. The process controller **504** may be connected to the consumer database **615** and the multimodal metadata extractor **502**. The controller instructions **505** to the process controller **504** may be configured to identify elements of consumer information dynamically to incorporate into a search vector to identify opportunities for content modification as described above. Alternatively, or in addition, the consumer information, images, audio, and/or video identified by a user may be stored in the creative library **512** for use by the system. The process controller **504** formulates a search vector **506** utilizing control instructions **505** and optionally consumer information. The search vector **506** is provided to distance processing engine **507**. Upon identification of a suitable opportunity in accordance with control instructions **505**, the process controller **504** issues edit control instructions **509** to a content editor **512**. The content editor **510** may utilize generative AI techniques to modify the content stream **501**. The content editor **510** may access creative library **512** for any creative information needed to execute the edit control instructions **509**. The process control instructions are utilized to control the identification of an opportunity to modify the content stream and may be provided to limit aspects of preference-driven modifications.

[0120] FIG. **7** shows a system for programming media channels. The programming may take the form of on-demand content recommendations, or a fixed content schedule. FIG. **7** utilizes reference numbers for components that have been described previously. A content library **700** may be provided to store multimedia content, for example, video content **501** and scene embeddings **503**. A multimodal metadata extractor **502** may obtain the content **501**, generate scene embeddings **503** for the content **501** and the content with embeddings may be stored in the content library **700**. A consumer will have access to a content player **701**. The content player **701** may be in the form of a set-top box, incorporated into a gym display such as a Smart TV, or incorporated into a computing device for helping content to a display and/or speaker system. The display and/or speaker system may be associated with a computer or a mobile device such as a telephone or tablet. The content player presents selected content to the consumer and presents the programming, for example, in the form of an electronic programming guide or other form of recommendations. The consumer control allows a consumer to select and control content for output to the player. In the case of a set-top box, the consumer control may be a handheld remote or other interface, for example, an app may be running on a mobile device configured to provide control to the content player **701**. The content programming system **702** may provide programming choices or recommendations **703** to the content player **701** for selection by a consumer. A viewer may utilize the viewer control **705** to instruct the media player to retrieve the selected content from the content library **700**.

[0121] The content programming processor may be configured to generate criteria for the selection of content to be included in programming or recommendations **703** to be provided to a viewer through media player **701**. Distance processing engine **508** may evaluate the criteria against the content to facilitate the selection of content for programming or recommendations. The criteria may be in the form of a search vector **706** provided to the distance processing engine **508**. The distance processing engine **508** has access to scene embeddings contained in content library **700**. The distance processing engine **508** may determine the distance between the search vector **706** and the scene embeddings **503** to identify video content as a candidate for incorporation into programming or recommendations. As described previously, the creation of scene embeddings **503** and the search vector **706** involved the utilization of artificial intelligence techniques. The programming engine **702** may be implemented utilizing hardware and software suitable for executing artificial intelligence techniques such as creation of the scene embeddings and search vectors. The distance processing engine **508** may be integrated with or implemented by

separate hardware and software from the content programming engine **702**. The hardware and software utilized in the distance processing engine **508** must be suitable for carrying out the described function, namely determination of the distance between the multimodal metadata represented by the scene embeddings **503** and the search vector **706**. The search content programming engine **702** may rely on other information and structures to formulate the content programming/recommendations **703**.

[0122] The content programming engine **702** will have access to viewer information in the viewer information database **704**. The viewer information database will include at least the identification of content consumed by the consumer. In addition, the content programming engine **702** may have access to other viewer information including information provided through the viewer interface **616**, previously described, and information obtained through the viewer information mining processes **614**. The content player **701** may provide the identification of consumed content to the viewer information database. The identification of consumed content may include information specifying the time of day and the date that the viewer consumed the content and the particulars of the consumption. The particulars may include the point in the content where the consumer began consumption, the point in the content where the consumer ended consumption, or an indication that the consumer watched the complete or substantially complete content. The content player **701** may also provide an indication identifying the screening used for the consumption.

[0123] The content programming engine **702** may also receive control instructions **505**. The control instructions **505** may be provided in a manual or automated fashion and may be static or dynamic depending on the application and choices of the system administrator. An example of a control instruction **505** may be an instruction to override the programming recommendations with alternative programming, to simply ignore certain content for programming or recommendations, or suppress certain content, otherwise selected for programming or recommendations. For example, an instruction may be provided to take into account a particular local rule or regulation. For example, a particular state may have a different regime for protection of minors than other states. The control instructions **505** may instruct the content programming engine **702** to take into account the current consumer location and consumer age. Another example of control instructions may include content controls based on consumer hardware or software, for example, the size of the screen or utilization of a VPN. Identification of program content or recommendations may be provided to a consumer over an interface displayed by the content player **701**. For example, the content player may be presented with a program guide formulated by the content programming engine **702** which permits a consumer to utilize the consumer control **705** to select content to be played.

[0124] A system for programming content channels may be based on multimodal extraction of metadata from content, wherein the metadata is extracted by processing one or more scenes in the content to extract metadata corresponding to multiple extraction modes, and an embedding model for each extraction mode wherein an aggregated embedding model responsive to the extracted metadata for each mode formulates an aggregated embedding including a consumer information database containing information regarding consumer consumption of content including at least an identification of content consumed, programming logic based at least in part on comparing an embedding of metadata extracted by multimodal extraction of content consumed by the consumer to the aggregated embeddings including a vector comparison processor for determining the distance between the embedding generated based upon content consumed and the aggregated embedding, and wherein the programming logic uses the distance between the embedding generated based on content consumed and the aggregated embedding to generate a program guide tailored to viewer preferences. A content identification may be stored in the consumer information database identifying content consumed by the consumer and the embedding generated based upon content consumed may be stored in the content library. The programming logic may include an embedding aggregator to aggregate embeddings generated from multimodal metadata extraction of consumed content with embeddings of content previously selected for consumption.

[0125] The embedding aggregator may weigh embeddings supplied to the embeddings aggregator. The weight may be based, at least in part on recency. The weight may be based on time of day, frequency, or consumer input. The programming guide may include multiple content channels. The programming logic may order the content channels in the programming guide based on user preferences. The programming logic may order the content channels in the programming guide by genre based on user preferences. The programming logic may order the content channels in the programming guide by vertical personalization based on user preferences, by horizontal personalization based on user preferences, or otherwise.

[0126] The techniques, processes, and apparatus described may be utilized to control the operation of any device and conserve the use of resources based on conditions detected or applicable to the device or otherwise made available for further processing.

[0127] The system is described in detail with respect to preferred embodiments, and it will now be apparent from the foregoing to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects, and the invention, therefore, as defined in the claims, is intended to cover all such changes and modifications that fall within the true spirit of the invention.

[0128] Thus, specific apparatus for and methods of metadata extraction have been disclosed. It should be apparent, however, to those skilled in the art that many more modifications besides those already described are possible without departing from the inventive concepts herein. The inventive subject matter, therefore, is not to be restricted except in the spirit of the disclosure. Moreover, in interpreting the disclosure, all terms should be interpreted in the broadest possible manner consistent with the context. In particular, the terms "comprises" and "comprising" should be interpreted as referring to elements, components, or steps in a non-exclusive manner, indicating that the referenced elements, components, or steps may be present, or utilized, or combined with other elements, components, or steps that are not expressly referenced.

1. A system for programming content channels based on multimodal extraction of metadata from content, wherein said metadata is extracted by processing one or more scenes in said content to extract metadata corresponding to multiple extraction modes, and an embedding model for each extrac-

tion mode wherein an aggregated embedding model responsive to said extracted metadata for each mode formulates an aggregated embedding comprising:

a consumer information database containing information regarding consumer consumption of content including at least an identification of content consumed;

programming logic based at least in part on comparing an embedding of metadata extracted by multimodal extraction of content consumed by said consumer to said aggregated embeddings including a vector comparison processor for determining the distance between said embedding generated based upon content consumed and said aggregated embedding;

wherein said programming logic uses said distance between said embedding generated based upon content consumed and said aggregated embedding to generate a program guide tailored to viewer preferences.

2. The system for programming content channels according to claim **1** wherein a content identification is stored in said consumer information database identifying content consumed by said consumer and said embedding generated based upon content consumed is stored in said content library.

3. The system for programming content channels according to claim **1** wherein said programming logic includes an embedding aggregator to aggregate embeddings generated from multimodal metadata extraction of consumed content with embeddings of content previously selected for consumption.

4. The system for programming content channels according to claim **3** wherein said embedding aggregator weights embeddings supplied to said embeddings aggregator.

5. The system for programming content channels according to claim **4** wherein said weight is based on recency.

6. The system for programming content channels according to claim **4** wherein said weight is based on time of day.

7. The system for programming content channels according to claim **4** is based on frequency.

8. The system for programming content channels according to claim **4** wherein said weight is based on consumer input.

9. The system for programming content channels according to claim **1** wherein said programming guide includes multiple content channels.

10. The system for programming content channels according to claim **9** wherein said programming logic orders said content channels in said programming guide based on user preferences.

11. The system for programming content channels according to claim **10** wherein said programming logic orders said content channels in said programming guide by genre based on user preferences.

12. The system for programming content channels according to claim **10** wherein said programming logic orders said content channels in said programming guide by vertical personalization based on user preferences.

13. The system for programming content channels according to claim **10** wherein said programming logic orders said content channels in said programming guide by horizontal personalization based on user preferences.

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