Holographic Interface Management in the Age of Artificial Intelligence

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Summary
Digital holography provides the scheme to customize interface or system configuration with ease according to the sensitivity and ad-hocness of the ongoing scenario by just rearranging the photonic pattern or by photonic parameters reconfiguration and channelizing photons in different ways. Evolution and cognition are becoming critical consideration for contemporary and forthcoming complexities interrelated to procedures in rapidly changing diverse computing environment. Complexity management and massive computations are primary fragments of intelligent systems and holographic systems provide multi-dimensional view for better understanding of the data or information by utilizing the capabilities of different holographic technologies. Influential holographic techniques are emerging intermittently in parallel with fast and parallel hardware and because of diversity and complexity of holographic regime it is indeed hard to accomplish all computing procedures manually or by mere automation. The artificial intelligence has much more implementation in the computing regime which guide us to look into human like cognitive abilities to achieve more reliable and effective computing abilities. The computing world has already considerably benefited from various artificial intelligence approaches and their capacity to acquire knowledge by specimen enable them very supple and powerful tool. Furthermore, there is no attraction to develop an algorithm to accomplish a definite job. They suit well for real time arrangements due to their quick rejoinder, computational time and parallel architecture. Emergence and blend of Digital Holography and Artificial Intelligence will provide adequate mechanism for automated manipulation of holographic information, mandatory for real time diverse scenarios.

Key Words:
Digital Holography, Photon, Artificial Intelligence, Cognition, User Interface, Evolution, Information.

1. Introduction

Denis Gabor devised holography in 1948 and nearly 1955 holography departed to a long torpidity. The stimulation arose unexpectedly and explosively in 1963, with the publication of first effective laser hologram by Emmett N. Denis Gabor welcomed his Nobel Prize in 1971 and the very year, a paper "Digital holography" was printed in Proceedings of IEEE by T. Huang. This paper manifest the succeeding phase in the expansion of holography, the practice of digital computers for restructuring, creating and simulating wave fields, and revised pioneer activities in this field. These activities provoked an explosion of exploration and publications in initial and mid-70s. Plentiful probable applications of digital holography such as manufacturing computer made diffractive optical essentials and spatial filters for optical information processing, 3-D holographic demonstrations and holographic television, holographic computer vision stirred a prodigious passion among investigators. However, inadequate speed and memory volume of computers offered at that time, nonappearance of electronic resources and media for detecting and recording optical holograms hindered employment of these capacities. In 1980 digital holography departed to a kind of torpidity likewise to what occurred to holography during 1950-1960. Through an arrival, in the termination of 1990 of the novel production of fast microprocessors, high resolution electronic optical devices and liquid crystal demonstrations, of a technology for producing micro lens and mirror arrays digital holography is receiving an innovative breeze. Digital holography errands that necessitated extensive duration of computer time in 1970 can now be resolved in nearly "real" time. Optical holograms can now be straightly detected by extensive resolution photo electronic devices and deposited into computers in "real" time. The information nature of optics and holography is particularly and distinctly seen in digital holography. Due to digital holography and with integrating digital computers into visual information arrangements, information vision has touched its adulthood. The utmost gain of digital computers as equated with analog electronic and visual information dealing devices is that no hardware alterations are essential for resolving dissimilar errands. This superiority enables digital computers also a perfect tool for dealing visual signals adaptively since, they can adjust quickly and effortlessly to fluctuating indications, errands and user necessities. Also, obtaining and processing numerical data confined in visual signals, thanks to its universal feature, the digital signal is a superlative source for assimilating dissimilar informational systems [1].

1.1 Evolution & Future Perspective of Digital Holography

Topical past of visual media is specified by a quick expansion of 3D imagery, visualization and demonstration. It comprises stereoscopic and autostereoscopic schemes,

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head mounted displays, integral photography and digital holography. The technology which could possibly deliver more contented and genuine 3D capture and exhibition is digital holography (DH). This imagery procedure permits the complete wave field information; amplitude and phase to be stored. Through this evidence, it is probable, via devices recognized as spatial light modulators (SLM), to rebuild the visual wave field in alternative location and at alternative time. The complication of the holographic data dispensation sturdily be contingent on the type of an entity/scene. It may mention as stationary (image) or fluctuating in time entity/scene (video) and hence. The stationary recording scheme is built on a solo camera and an entity positioned at rotating stage, whereas the dynamic recording scheme necessitates numerous cameras positioned around an entity/scene [2].

Digital holography is a procedure that authorize digital recording of holograms and successive dispensation on a digital computer. By digitally uniting these interference patterns suitably, it is probable to improve the multifaceted wave amplitude of the single entity beam. The principal application comprises of simulating the inverse proliferation of the light via computer to digitally recreate the innovative 3-D entity. Also, digital holograms can be digitally conveyed and the 3-D body can be remotely rebuilt. Furthermore, numerous kinds of dispensation can be performed to digital holograms such as compression to lessen storing volume and communication time, encryption can also be made to protect or validate data [3].

In digital holography (DH), an imaging device and computer store the hologram and image rebuilding is attained via digital dispensation practices to deliver high resolution digital imageries. In computer-generated holography (CGH), a hologram function can be created computationally and then demonstrated via digital production, photolithography or display-founded schemes [4].

Computer Generated Holography has been extensively investigated for the last few years. Holographic storage is evolving as an auspicious field of high volume data storage. Aircraft flyers utilize holographic visual essentials for steering. Holograms are used in credit and debit cards to deliver augmented safety to lessen forging. Holographic displays are becoming prevalent currently. CGH aids to generate holograms without utilizing extremely precise optical arrangements. Also, the holograms of items which do not bodily available can also be shaped. It will show the marvelous properties on all arenas of life comprising corporate, edification, science, art and healthcare. 3D holographic forecast is a swiftly rising technology. Due to nearly immeasurable holographic potentials, the frequent developments in 3D holographic projection has an optimistic future ahead [5].

The advent of solid state sensors in the 1970s opened the novel age of digital holography (DH). Holograms are digitally tested, directly and quickly, by CCD or CMOS matrix sensors in observable or even in infrared spectra. The rebuilding can be either accomplished arithmetically for a 2D screen or for presentation in 3D by a SLM. The fusion of lively 3D scenes can be beneficial in numerous arenas like for drill and replication of real-world setups like surgical procedure training, 3D entity design and conception, entity recognition for automation/soldierly tenacities, and so on. Definitely, the huge employment for entertainment for instance, video-games, simulated reality, 3D video cannot be underrated. Most striking attainments in holographic 3D exhibition that have been described were gained through the understanding of computer generated holograms (CGHs). CGHs have been broadly considered as they are tremendously supple pioneer to the more tough job of directly finding a digital hologram by visually recording a 3D passage. Because of CGHs it is conceivable to manufacture holograms not only of solo items but of complete passages with numerous lively stuffs [6].

Holographic technology and spectral imaging has infinite deployments beyond that the human mind can visualize. Holographic technology will convert into an essential fragment of humanities and societies in the upcoming era. Holographic information security and storing schemes utilizing collinear technologies anticipated by Optware Corporation and in which with the selfsame spatial light modulator the information and reference rays are modified coaxially. Through this exceptional arrangement, the visual pickup can be intended as tiny as the DVDs and can be positioned on one side of the storing disk. Holographic storage is an innovative optical storing technique that can accumulate one terabyte of figures in a quartz almost [7].

Three dimensional (3D) holographic display as one of most encouraging 3D display methods has pulled in lots of consideration for it gives all profundity cue of human beings. 3D items are recreated by ascertaining computer generated holograms (CGHs) and stacking them in plain display devices, for instance, spatial light modulators (SLMs). To acquire the CGHs, a few algorithms are introduced, for example, Gerchberg–Saxton (GS) calculation, Fienup calculation, Fidoc technique, Yang-Gu calculation, direct binary search, and simulated annealing calculation. Besides, 3D cycle calculations are introduced in light of emphasis calculation to modulate wavefront in 3D space, for example, Fresnel ping-pong calculation which is a sort of two-plane encoding strategy. GS calculation and some other enhanced calculations utilize

two dimensional Fourier change in the computation; assessment from it 3D Fourier transform is acquainted with iterations for combining 3D wave dissemination.

Holographic presentations are capable for deployments, for example, therapeutic imaging and amusement because of their capacity to introduce a real environment into a three - dimensional (3D) scene, in this way holding the qualities of genuine items. Computer Generated Holograms (CGHs) can be ascertained to modulate the wavefronts by mimicking the optical transmission process from the 3D scene to the hologram plane, permitting full-depth signs to be losslessly caught and totally reproduced. The real-time execution of holographic displays confronts the challenge of tending to the gigantic volume of information that must be recorded and prepared in rendering and reproduction of high-resolution 3D pictures. Volume holographic polymers, which offer high stockpiling thickness, updatable recording and better multiplexing possessions contrasted and planar holographic materials, can give a way toward high-resolution holographic display in practical usage [8].

AR is an intuitive innovation that changes physical surroundings with superimposed virtual components. This virtual layer, set between the physical situations and the client, can include literary data, pictures, recordings or other virtual things to the individual's review of physical environment. The gadgets that empower such superimposition can be cell phones or tablets, wearables (head-mounted presentations), interactive intelligent screens or projectors. AR innovation has been to a great extent explored in the zones of computer innovation and human–computer interaction, where additionally the most pertinent definitions have been created. Mixed reality (MR), some of the time alluded to as hybrid reality, is the converging of real and virtual universes to create new situations and perceptions where physical and computerized objects coincide and connect continuously [9].

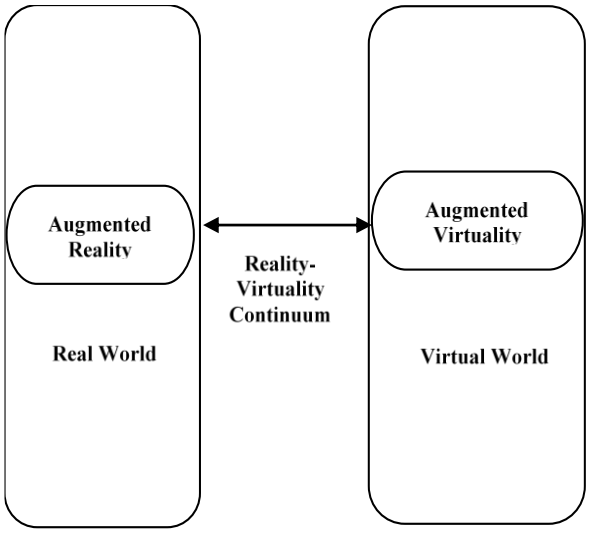

Fig. 1 Mixed Reality

1.2 Implementations of Artificial Intelligence

Noteworthy illustrations of artificial intelligence are expert systems. The expert systems procedure attempts to prototype the field knowledge of experts in their certain ranges of specialty like finding, scheduling, projecting etc. Expert systems are computer created deployments that determine multifaceted glitches or else they would necessitate comprehensive human acquaintance [10]. Expert systems typically encompass three vital segments: database, knowledge-base and lastly interpretation engine. It also accounts statistics carried by the handler attached with the task and the evidences inferred by the scheme.

Control systems are computer-based schemes that supervise and regulate physical procedures. For rapid acknowledgement to the settings in a situation artificial intelligence is indispensable. To designate, scrutinize procedures and to make obligatory verdicts it is mandatory to accomplish massive volume of information swiftly. Even so, it is stimulating to produce software with usual stationary algorithms for proficiently shielding against the bouts in cyber space, as fresh coercions originated recurrently [11].

In artificial intelligence, machine learning embraces the ability to predict some invisible structures of an object originated on some consequences in administered learning, or the talent to determine some edifice veiled inside data in unsupervised learning [12]. Artificial intelligence strategies, for example, information mining, artificial neural systems, genetic algorithm, fuzzy logic and expert systems can be coordinated with conventional ritual and measurable techniques to dissect the gathered information by sensors, perceive observation pattern, filter and

associate proceedings to bolster manipulation event administration and aversion of interruptions. These methods enhance the capacity of manipulation administration frameworks to correspond events produced by a differentiated suite of present day devices.

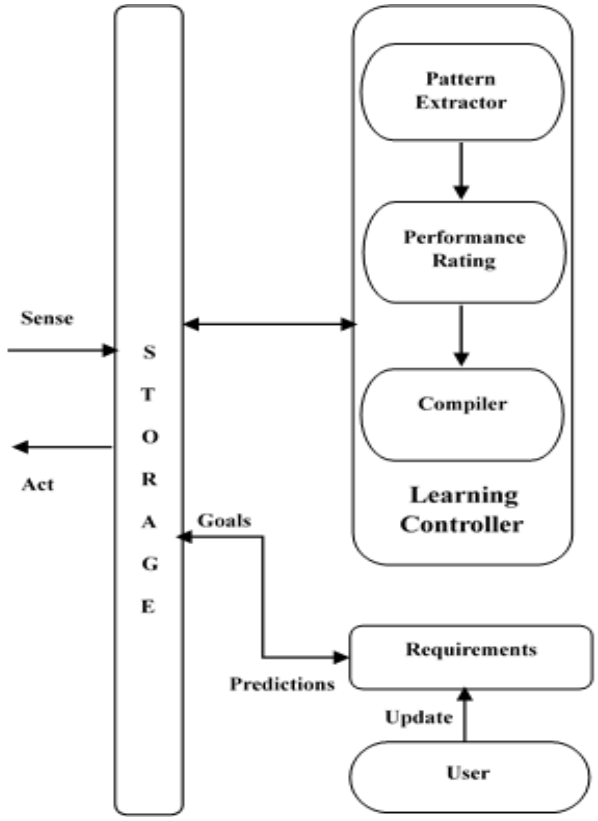

Fig. 2 Artificial Intelligence Decision Making Model

Artificial intelligence is rising to bolster manipulation management and these strategies upgrade agent capacities. Intelligent agents and multi-agent frameworks are among the most quickly developing regions of innovative work. A multi-agent framework is formed and actualized as a few cooperating agents. Multi-agent frameworks are in a preferably suited to demonstrative issues that have numerous critical thinking strategies and different viewpoints. Intelligent agents step up where apposite, socially cooperate with other artificial agents and people in order to accomplish the goal to their own particular critical thinking and to help other people with their activities [13].

1.3 Problem Statement

The key problem in this age of cognitive paradigms is that the existing holographic interface management systems are either of static nature and working rendering to some predetermined measures. There is deficiency of intelligence, evolution and autonomy in the existing mechanism of holographic interface. Due to which, these holographic interface management systems are not competent to present more, provide higher dimensions of viewpoint or to make their decisions on their own about hologram manipulation according to the user requirement or situation.

1.4 Hypothesis

Inference of Digital Holography and Artificial General Intelligence will provide adequate mechanism for modification in the photonic patterns rendering to the requirements of holographic interface or system configuration. With the passage of time learning, evolution and autonomy on the root of experience will facilitate and automate the reconfiguration of the holographic interface.

2. Literature Review

Since 1968, continuous efforts have been made to explore 3D displays that have planar surfaces, and several methods have been developed to provide stereopsis for binocular vision. The technologies that employ glasses to achieve this are based on such as anaglyphs, time-division, and polarization. On the other hand, those technologies that do not rely on glasses are based on such as parallax barrier and lenticular lens array. Although these methods can offer effective 3D images, they require calculation and generation of precise images for multiple viewpoints, and users have to stay within a limited view angle. A different approach to realize advanced 3D displays is using a physical 3D space to render graphics instead of a planar surface and forming a visual representation of an object in three physical dimensions, as opposed to the planar image of traditional screens that simulate depth through various visual effects. These 3D displays, which are called volumetric displays, allow users to view the displayed images from any angle [14].

Volumetric displays provide interesting opportunities and challenges for 3D interaction and visualization, particularly when used in a highly interactive manner. We explore this area through the design and implementation of techniques for interactive direct manipulation of objects with a 3D volumetric display. Motion tracking of the user's fingers provides for direct gestural interaction with the virtual objects, through manipulations on and around the display's hemispheric enclosure. Our techniques leverage the unique features of volumetric displays, including a 360° viewing volume that enables manipulation from any viewpoint around the display, as well as natural and accurate perception of true depth information in the displayed 3D scene. These displays

typically have a 360° field of view, and the user does not have to wear hardware such as shutter glasses or head-trackers [15].

Holographic optical tweezers (HOT) systems use a programmable spatial light modulator (SLM) to split, steer and shape the laser beam resulting in multiple traps which can be independently controlled in 3D. SLMs are an increasingly popular tool for controlling and shaping light beams, used in many areas of physics such as laser marking, two-photon polymerisation and HOT. Most currently available SLMs use a nematic liquid crystal layer to alter the optical path length of light reflected from the device. Modulating the phase of an incident laser beam provides an unprecedented degree of control over optical fields. The massively parallel architecture of graphics processing units (GPUs) has been exploited to speed up the calculation of holograms by several orders of magnitude [16].

Rendering to the holographic philosophy of human memory, a material's term subsists in a vibrant scattered illustration termed as hologram. The contemporary illustration of explicit term in the hologram and all allied terms altered alike in the course of learning or recollecting a term. The holograms are being used to retain data connecting simple open commemoration, learning in several open trial commemorations, simple serial commemoration, and learning in several trial serial commemorations. The prototypical attains accuracy and order of report in both open and serial commemoration with determination of learning and sovereign arrangement in multiple trial open commemoration [17].

To mimic the quality of everyday human interaction with surrounding, future computer interfaces must combine the benefits of high visual fidelity with intelligence and—above all—the ability to modulate the emotions of their users. To achieve this goal, researchers eventually replaced pre-crafted animated actions with intelligent behavior modules that could control speech, locomotion, gaze, blinks, gestures (including various postures), and interaction with the environment [18].

The notion of self-directed quantum computation arrangement is awarded in favors to quantum AI and applied to QNN. Quantum cybernetics offers an arrangement on the behalf of QNN networks as an ordinary scheme for tackling multifaceted quantum structures that perform grid centered quantum computing. Though, if we desire to handle quantum artificial intelligence it should be allowed for self-directed quantum computation describing an AQCS, so that the quantum computing structure must be capable in adjusting to diverse environmental variations and react accordingly like QuANNs which have extremely tangled states [19].

In multi-agents' organization machine learning processes used to estimate information inclination. This scheme is installed to a commercial information controlling structure. In the CoMMA venture the principal aim is to convey the rationality of machine learning and it also attempts to regulate the ruptures and restrictions of semantic centered information recovery systems. This choice not only provides fast results but also permits an investigational confirmation through opinion from the user [20].

An innovative task and learning model was suggested that resembles to perform machine learning techniques in the domain of quantum mechanics in which information behaves accordingly - which is, absolutely, the realistic domain. Usage of quantum evidence has phenomenal effects in learning procedure and various traditional machine learning understandings are being tested in this domain [21].

3. METHODOLOGY

The proposed framework can be categorized into four major segments,The Data Detection and Verification segment, Digital to Hologram Conversion Segment, Holographic Interface and finally Evolvable Memory segment.

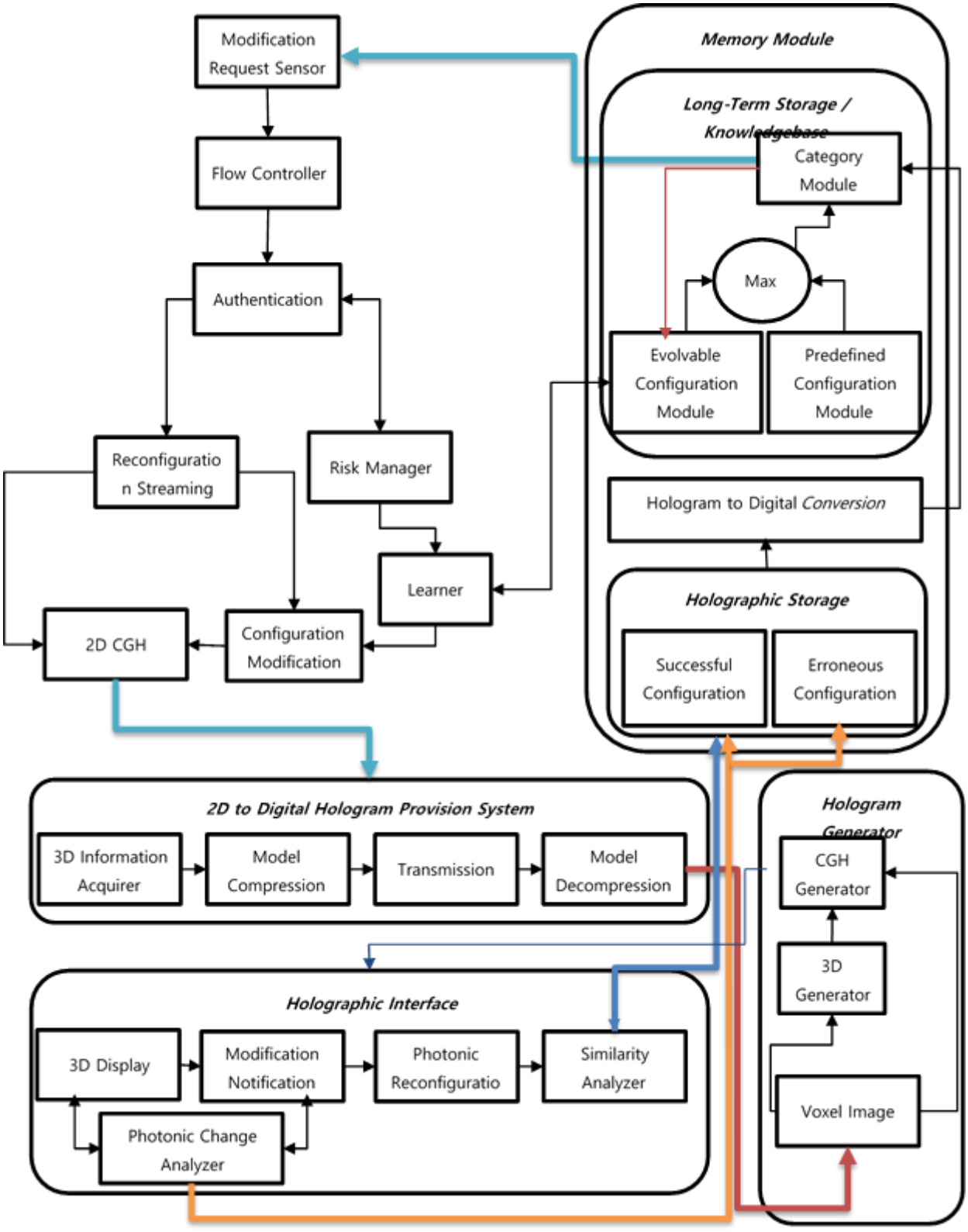

Fig 3. Cognitively Photonic Channelization Management Framework

1.1 Data Detection and Verification Segment

In the proposed framework Modification Request Sensor module, will sense the incoming/outgoing data through sensory memory. Sensory storage is the component of memory with least time span. It is the capacity to hold impressions of perceptible information after the unique provocations have finished. Modification Request Sensor module will be in charge of just information gathering regarding reconfiguration of the current setting and transmit it to the Flow Controller module as in the human cognitive framework.

Flow Controller module line up the forthcoming requests on the basis of three elementary experienced constraints:

- How much significant the processing of certain forthcoming request? It will be determined by the framework on the roots of prior experience or by human interference.
- How much time is necessitated by the request in framework? Any request which necessitate minimum time than all other request for processing has more likelihood to be accomplished earlier.
- How much association be present in framework about the job? If a definite job has more links in knowledge-base so it will also necessitate minimum time for learning and processing and if not, then it necessitates additional time for learning and processing.
- How much framework has cultured about the request? May be a request has been completed by this framework but its gratification level may be or may be not acceptable. It illustrates that it is also contingent on time.

Data Authentication component will be accountable for performing the subsequent subtasks on the roots of learning and prior knowledge which reside in the memory that would be necessary for the imminent requests. This module will sense the approaching request, authenticate the request and also forwards it to the digital to hologram conversion module. The imminent request necessitates the learning phenomena rendering to the knowledge and semantics warehoused in knowledge-base or storage about that specific request processing.

Similarly, suspected requests will be transferred to the Risk Manager module for inspection, investigation, verification and preventive measures. When suspected, request will approach to the Risk Manager module through Authentication Module for verification then risk management will take place in the anticipated framework. If the Risk Manager module has enough semantics in memory module for the approaching suspected request then it will be investigated in unsupervised learning mode with completely assimilated capabilities and if the imminent request have inadequate semantics or relations in the storage then it will necessitate learning which will support the Risk Manager component on the roots of prior knowledge and human interference the appropriate technique of treatment for this class of suspected request in semi-supervised learning style which is the blend of some pre-learned and real time developed capabilities but lastly if the imminent suspected request has no relations or resemblance in storage component has no knowledge of treatment this kind of request then human interference is essential for the confirmation or investigation of distrusted request. Risk Manager module will assess the imminent request on the grounds of some predetermined constraints like:

- Resemblance or relations of request to the standing or former distrusted request.
- Experience threshold depend upon learning to manage this class of distrusted request.
- Lastly, success or satisfaction level gotten after the enquiry and confirmation of this sort of distrusted request.

Now in response of coming suspected request, the Risk Manager module simultaneously chooses appropriate configuration of photons among all possible and accessible constraints from storage unit on the basis of response gotten through last accomplishment of same sort of situations.

1.2 Digital to Hologram Conversion Segment

Digital to hologram conversion module will receive the 2D CGH with respective 3D digital data, transformed it into the holograms and sends it towards holographic interface. An advanced 3D image can be developed with 3D information attainment; A digital hologram incorporates the intensity but also the depth information of the 3D entity. That is, both the entire amplitude and the phase information are important to recreate the genuine 3D entity, which are incorporated into the interference pattern between the reference light and the entity light so, Information Acquirer module will be responsible for attainment the relevant information. This module will be responsible for receiving 2D CGH with relevant 3D information, the acquired 3D information will be encoded with appropriate coding algorithms according to the characteristics of the 3D information in the data compression steps for size reduction purpose. The Model Transmission & Decompression module will get the encoded information from Model Compression module and will be diffused and after that the obtained information will be decoded with the decoding schemes that are reliant on the encoding procedure. This module will be in charge of producing the three-dimensional directions of volumetric image in a consistent lattice. A

voxel represents a value on a consistent lattice in three-dimensional space likewise with pixels in a bitmap. Now 3D Generator module will be responsible for collecting the 3D information and structural information regarding hologram formation and transmitting this combination to the CGH Generation Module. Eventually, CGH Generator module will be able to receive the combination of structural and textural information to generate a respective CGH for further processing.

1.3 Holographic Interface

3D Display module will be responsible for displaying 3D holograms and providing the interface to interact and manipulate with it physically. In this module, the received holograms will be displayed to the users where they will be able to see, modify and save the changes in the ongoing scenario. Now if Modification Notification module will receive any notification regarding structural changes according to the requirement of ongoing scenario then it will turn to the Successful Configuration Module in Holographic Storage module where all successful configuration will reside and transfer it to the Photonic Reconfiguration Module. If it will find higher degree of similarity between query and any successful configuration in storage, then it will be able to fetch this configuration episode and implement it exactly. After receiving a message from Modification Notification module Photonic Reconfiguration module will be activated and will contact to the Successful Configuration Module in Holographic Storage module for higher degree of identical episode. Now this module will be in authority to implement this archived identical episode as it is or after modification according to the requirement of data request by photonic pattern management. If there will be no identical successful episode in holographic storage, then photonic configuration will be managed manually. Similarity Analyzer module will be able to collect the message through Photonic Reconfiguration module and it will also be directly connected to Holographic Storage where each episode will be stored and will accumulate these episodes as successful or erroneous story. It will be responsible for categorizing the found result related to corresponding query in successful Configuration module residing in Holographic Storage module in High, Medium or Low matching categories. Photonic Change Analyzer Module will be responsible for receiving notice regarding alteration and fetching the feedback of implementation, then it will analyze it and declared this configuration as Successful configuration or Erroneous configuration and will deposit these results to the corresponding module in Holographic Storage. Either these changes may be related to the structure or parameters of communication.

1.4 Holographic Storage

Stored episodes will be retrieved at any later stage if required. Volume holography has generated widespread recent interest as a possible next-generation storage technology. Holography can offer both fast parallel access and high storage density. Successful Configuration module of Holographic Storage will be able to accumulate the successful configurations as episodes in holographic database after apt implementation, received through Modification Analyzer module and it will also provide matched configuration to the received request in case of notification received for modification or false configuration implementation. Erroneous Configuration module of Holographic Storage will be responsible for accumulating the erroneous configurations as episodes in holographic database after false implementation, received through Modification Analyzer module. After this, holographic information will be transferred towards the Hologram to Digital Conversion module. Now this module will be in authority for receiving manipulated holograms for reverse procedure.

1.5 Memory Module/ Knowledgebase/ LTM

Finally, memory module will be able to categorize the received data with the help of category module and accumulate it to two sub modules Evolvable Configuration Module and Predefined Configuration Module. The arrived data will be compared with the exiting groups in category module if the degree of similarity will be maximum then it will be categorized in Predefined Configuration Module, if the degree of similarity will be normal then it will be categorized into Evolvable Configuration Module and finally if the degree of similarity will be low or zero then new category will be generated in Category Module. Such intelligent schemes have capacity to be further flexible, more adaptive and more human-like than conventional schemes because they have the capability to learn, and can supervise unfamiliar input and unpredicted situations. These memories want to be equipped with firm human-like capabilities that will support them in remembrance of former practices, make forecasts and take appropriate movements, hence presenting an effect of behavioral rationality and reliability

4. Conclusion

Quantum-Photonic frameworks will be among the most develop and promising procedures for the detection of changings in the surrounding. In this paper, we have presented a natural user interface, which will have the likelihood of changing the rebuilt perceptions on-the-fly and will give the complete representation, which is

intended to solve this challenge and give a user full control over the holograms of complete scenario while using the conventional 3D displays. Holographic storage empowers colossal information capacity than ordinary storage with much getting and putting away speed. The drive of the proposed framework is to provide an easy, rapid and innovative way for photonic management, it will manage the photon during channelization itself with the help of cognition, evolution and limited human intervention when required. All above mentioned modules will work in supervised learning mode initially but with the passage of time the proposed framework will become mature by integrating learning ability and ultimately it will behave autonomously on the basis of its learning in prior scenarios and will manage all its prospect operations in unsupervised learning mode or with circumscribed human involvement. Additionally, the scheme automatically reconfigures itself in light of the new guidelines. The scheme is presented because it is believed that it will closely mirrors real world deployments.

5. Limitation

Limitation of the proposed framework would be elimination and incompatibility with the existing digital technology.

6. Future Work

Future work would be provision of backward compatible framework which can simultaneously and autonomously manage digital interface and holographic interface for better and higher dimensional view of information without abolition of standing digital technology.

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