

Autosophy data / image compression and encryption

Klaus Holtz, Eric Holtz, Diana Kalienky
Autosophy, 602 Mason Street #305, San Francisco, CA, USA, 94108-3804

ABSTRACT

Multimedia data may be transmitted or stored either according to the classical Shannon information theory or according to the newer Autosophy information theory. Autosophy algorithms combine very high "lossless" data and image compression with virtually unbreakable "codebook" encryption. Shannon's theory treats all data items as "quantities", which are converted into binary digits (bit), for transmission in meaningless bit streams. Only "lossy" data compression is possible. A new "Autosophy" theory was developed by Klaus Holtz in 1974 to explain the functioning of natural self-assembling structures, such as chemical crystals or living trees. The same processes can also be used for growing self-assembling data structures, which grow like data crystals or data trees in electronic memories. This provides true mathematical learning algorithms, according to a new Autosophy information theory. Information in essence is only that which can be perceived and which is not already known by the receiver. The transmission bit rates are dependent on the data content only. Applications already include the V.42bis compression standard in modems, the gif and tif formats for lossless image compression, and Autosophy Internet television. A new 64bit data format could make all future communications compatible and solve the Internet's Quality of Service (QoS) problems.

Keywords: Autosophy, Information theory, Data Compression, Image Compression, Encryption, Internet video, Quality of Service (QoS)

1. INTRODUCTION

Data transmission or data storage bandwidth requirements were originally defined by Claude Shannon³¹ in 1948 in his famous paper "A Mathematical Theory of Communication". The communications methods were intended for machine or computer communications only; they did not include natural or human communications. There are no known biological creatures that actually use Shannon's methods of communication using "quantities" or binary digits (bit). As a result of Shannon's information theory, most modern communication devices and the programmed data processing computer are now built according to that theory. Once the communication bandwidth has been calculated, then any attempt of reducing the bandwidth through data compression must result in inevitable data distortions or loss of resolution. The more the data is compressed the worse the data quality becomes. Because Shannon's data transmissions use meaningless bit streams, data encryption can only use bit scrambling, such as pseudo random number generators. Most such encryption codes may be broken by high speed computing and determined efforts.

In 1974 Klaus Holtz proposed a new "Autosophy"¹ information theory²⁷ in which bit rates are determined by the data content or "meaning". The communication methods are based on self-assembling data networks²⁸, which grow like data crystals or data trees in electronic memories. This provides true mathematical learning algorithms, which strikingly emulate the learning modes in our own brains. Applications already include the "lossless" data compression methods in the V.42bis modem standard¹⁷ and the gif and tif format used for lossless still image compression. Recent additions include Autosophy Internet Television⁷ and more efficient still image compression algorithms⁵. Very high "lossless" data compression is achieved by growing hyperspace libraries, which contain the knowledge shared by both the transmitter and the receiver. Information is re-defined as that which is not already known by the receiver and only the portion of the data that can actually be perceived or reproduced by the receiver. Virtually unbreakable built-in "codebook" encryption can be added by growing special hyperspace libraries for each user. Data compression and encryption can be provided for any multimedia type of data, including live video with synchronized sound, text, and still images. The various data types can be randomly mixed and transmitted via the Internet in a new universal 64bit code³ to avoid most of the Internet's Quality of Service (QoS) problems. This would allow the transmission of compressed and encrypted video with synchronized sound in any media, even via the Internet's intermittent packet stream⁶. The new Autosophy based Internet television⁸ method is already being demonstrated in a software simulation.

holtzk@autosophy.com, phone 415 834-1646, www.autosophy.com

2. THE EVOLUTION OF AUTOSOPHY

Theoretical research to define the exact nature of "communication," could have a revolutionary impact on data communication, data storage, and encryption. It could also eventually replace the programmed data processing computer with brain-like self-learning electronic machines².

There are two competing information theories: the classical Shannon information theory³¹ and the newer Autosophy information theory¹⁰. In 1948 Claude Shannon published "A Mathematical Theory of Communication," which defines "communication" as binary digits. In 1974 Klaus Holtz developed a new Autosophy information theory, which defines "communication" according to the data content or "meaning." Both theories can be used for data compression and encryption but yielding entirely different results.

The Autosophy theory²⁴ evolved from theoretical research, by Klaus Holtz in 1974, into self-assembling natural structures, such as chemical crystals or living trees. The word "Autosophy" is a combination of two Greek words: autos (meaning self like in automobile) and sophia (meaning knowledge or wisdom as in philosophy). This can be translated as self-knowledge or the understanding of oneself. An "Autosopher"⁴ is a self-learning entity that may be either electronic or biological. On June 17, 1974 Klaus Holtz realized that the same methods and principles found in nature may also be applied for growing self-assembling data structures in electronic memories. Guided by simple algorithms, these data structures grow like data crystals or data trees in electronic memories to provide learning modes that strikingly emulate the learning modes in our own brains. There are now seven known classes of self-learning "Omni Dimensional Networks" each providing a different learning mode. This includes learning modes that are not available in our own brains. Some of these learning networks are already implemented in commercial applications, while others have been simulated or are known only in theory. A self-learning Autosopher text database was built back in 1988 to verify the theoretical predictions. New applications, such as live Internet video⁷ or advanced lossless still image compression⁵, are now being added at an accelerating rate.

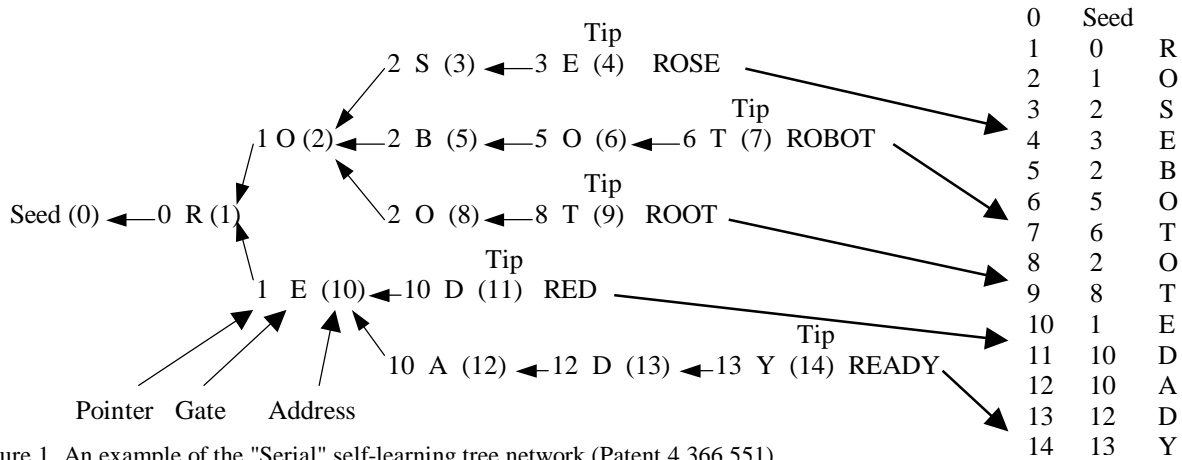


Figure 1. An example of the "Serial" self-learning tree network (Patent 4,366,551)

THE BASIC SERIAL TREE NETWORK GENERATION ALGORITHM

MATRIX [POINTER] GATE] (The MATRIX is a working register in the hardware.)

Start: Set POINTER = Seed (= 0)

Loop: Move the next input character into the GATE

If End Of Sequence (a SPACE character) then output the POINTER as a Tip code; Goto Start

Else search the library for a matching MATRIX

If found then move the library ADDRESS where it was found to the POINTER; Goto Loop

Else, if not found, then store the MATRIX into a next empty library ADDRESS;

Move the library ADDRESS where it was stored into the POINTER; Goto Loop

THE BASIC SERIAL TREE NETWORK RETRIEVAL ALGORITHM

MATRIX [POINTER] GATE]

Start: Move the input Tip code into the POINTER

Loop: Use the POINTER as a library ADDRESS to fetch a next MATRIX from the library

Push the GATE into a First-In-Last-Out (FILO) stack

If the POINTER = Seed (= 0) then pull the output data string from the FILO stack; Goto Start

Else Goto Loop

The serial network, shown in Figure 1, provides true mathematical "learning", according to the Autosophy information theory. A new unit of knowledge is created by new information (GATE), related to already established knowledge (POINTER), which may then create a new "engram" (ADDRESS) as an extension to that which is already known. The process can be imagined like the growing of data trees or data crystals. A stored tree network consists of separate nodes, where each ADDRESS represents an engram of knowledge. The library ADDRESS is a mathematical equivalent to a point in omni dimensional hyperspace. The content of each library ADDRESS is unique and can be stored only once. One cannot learn what one already knows. The network starts growing from an arbitrarily pre-selected SEED ADDRESS. Data transmissions use "tip" codes, which are the node ADDRESSES at the final tip of the tree branches. Each transmitted tip ADDRESS code may represent any length data string. The data strings are later retrieved from the tip codes, in reverse order, by following the POINTER trail back to the SEED ADDRESS. In addition to the serial network, shown in Figure 1, there are six other known self-learning networks each providing a different learning mode. All seven networks may be developed for data compression and encryption applications⁹.

Serial networks store serial data sequences such as text, sound, or serially scanned images. These networks were invented by Klaus Holtz in 1974 (Patent 4,366,551)²⁸. A similar algorithm was later developed by Jacob Ziv and Abraham Lempel (the LZ-78 code: Lempel Ziv published in 1978)²⁵. Most commercial application use the simplified LZW code²², (Lempel Ziv Welch) a variation invented by Terry Welch in 1984. Examples are the V.42bis data compression standard in modems and the gif and tif formats used for lossless still image compression.

Parallel networks¹⁴ store images in a hyperspace funnel, yielding high image compression and fast access to archives. Machine vision²¹ is the ultimate application¹⁶. These networks are especially suitable for compression and encryption of imaging¹⁸ and video data¹⁵.

Associative networks²³ connect various networks into a system. They can, for example, connect questions to answers, text to images, or commands to execution sequences.

Interrelational networks¹³ provide grammatical languages that could evolve into talking databases. Grammatical speech would be the ultimate method of communication between humans and machines.

Logical networks yield an advanced form of self-learning data processing with logical reasoning capabilities. They may evolve into intelligent robots.

Primary networks provide unstructured access to archives or databases through deductive reasoning and automatic indexing.

Hypertree networks promise true brain-like learning, which is currently being researched.

3. SHANNON COMMUNICATION VS. AUTOSOPHY COMMUNICATION

The question "what exactly is communication?" can be answered in two very different ways, each leading to entirely different technologies. In 1948 Claude Shannon³¹ published "A Mathematical Theory of Communication," which defines communication in binary digits. In 1974 Klaus Holtz developed a new Autosophy information theory²⁷, which defines communication by the data content. Autosophy involves a radical change in communications technology.

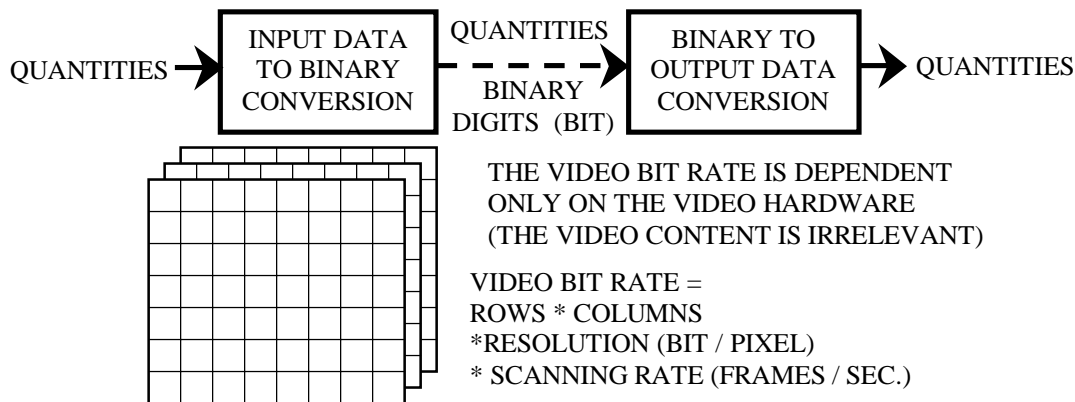


Figure 2. Conventional Shannon data and video communication

Communication, according to the Shannon information theory, is mere data in a bit stream that has no "meaning." All data items (ASCII character or Pixel) are regarded as "quantities," which are converted, using Shannon's equations, into binary digits (bit) for storage or transmission.

A unit of communication is a binary digit, called a "bit," which may also provide a yes-no answer to a question. In television, for example, the video "information" or bit-rate is determined by the imaging hardware, i.e., screen size, pixel resolution, and scanning rates. The video images actually shown on the screen are irrelevant. A totally random noise video image would require the same bit rate as a blank screen video image. The purpose of the communication is to "remove uncertainty" in the receiver. The higher the bit rate being transmitted, the higher the image quality becomes. Any attempt of reducing the bit rate through video compression will increase "uncertainty" and therefore cause image distortions or loss of resolution. The more the video images are compressed, the worse the image quality will become. Lossy video compression methods such as: Cosine Transforms (JPEG, MPEG), Wavelets, or Fractals, only attempt to hide the video distortions from the human observers. This method of communication was intended for computers only. There is no known biological creature that communicates with "quantities" or binary digits. The video quality is determined by the bit rate, whether or not any improvement in the video quality is actually visible to the human eye. Data encryption is possible by bit scrambling, such as pseudo random number generators, which is added as a separate feature. The codes can be broken, with certainty, by high speed computing and determined efforts.

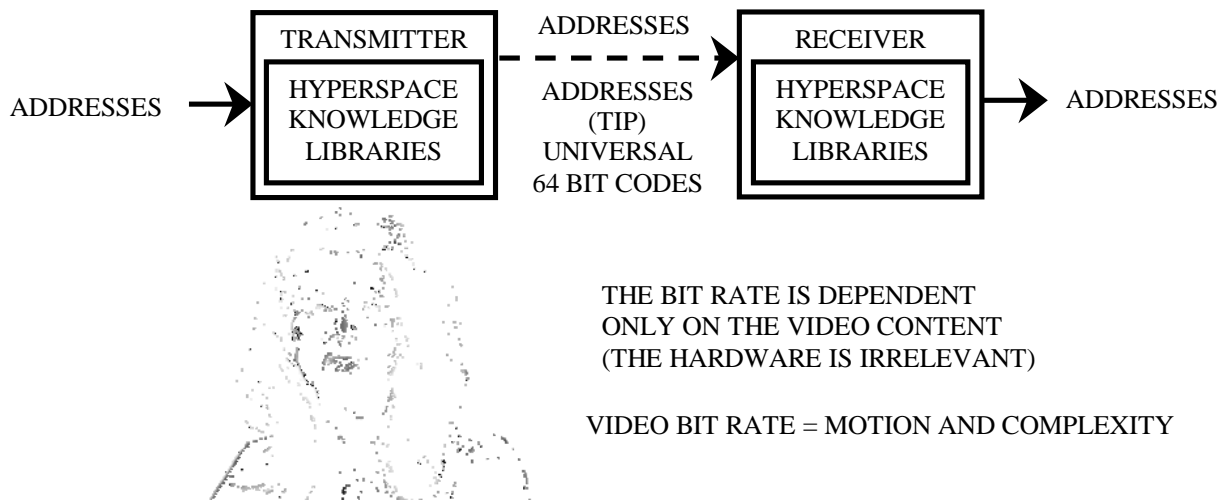


Figure 3. Autoscopy data and video communication

In Autoscopy communication¹⁰, all data items (ASCII character or pixel) are regarded as "addresses" which convey "meaning." The transmission bit rates are determined by the data content. Information in essence is only that which is not already known by the receiver and only the portion, which can be perceived or reproduced by the receiver. Video for example is transmitted in tiny pixel clusters, each representing motion and complexity in the images. Each cluster of up to 16 full color pixels is transmitted with a standard 64bit packet code to be inserted at any location in the output image. All communications are regarded as "addresses" acting as entry pointers to various knowledge libraries. A unit of communication is an "address" (called a "tip"), which may create a unit of knowledge (called an "engram") in the receiver. The purpose of a communication is to increase knowledge in the receiver, i.e. to teach it something.

High "lossless" data compression is achieved by transmitting only that which is not already known by the receiver, i.e. that which is not already in the receiver's libraries. Additional compression can be achieved by transmitting only the portions of the data that is actually perceptible or reproducible by the receiver. In television¹¹, for example, only the moving portions of the images are transmitted in tiny pixel clusters to represent movement in the video images. The static portions of the video are not re-transmitted because, they are already known by the receiver. Each cluster may contain up to 16 full color pixels to represent complexity in the video images. Simple, evenly colored video requires fewer code transmissions than complex noisy video images. The color resolution may be restricted to only that which can be resolved by the human eye, a method called "visually lossless" compression.

All Autoscopy communication systems must contain at least one library, which contains the knowledge shared between the transmitter and the receiver. The construction of the library - the network algorithm - determines the performance and data compression efficiency in a system. The library content in the transmitter and the receiver must remain identical at all times. This can be exploited for virtually unbreakable "codebook" encryption for secure communications. Data encryption is accomplished by growing special hyperspace libraries for each user or group of users. These libraries may be distributed to all authorized users by encrypted Internet downloading. Without an exact copy of the library data retrieval by unauthorized users becomes virtually impossible.

4. OLDER AUTOSOPHY COMPRESSION AND ENCRYPTION METHODS

The Huffman - Fano codes³⁰ were the only known lossless data compression methods prior to 1974. These codes are now being recognized as very primitive Autosophy codes because they require a library and transmit data as "addresses" rather than as "quantities." The system first creates a library in which the character set (such as the 26 character in English text) is sorted according to the relative frequency of use for each character. The library is then used to generate addresses with variable bit length for communication, where the most often used character are transmitted by fewer bit than less often used character. This method is still used today, even though it produced very few commercially viable data compression algorithms. Very weak encryption is possible by scrambling the library, but this will reduce the optimum compression ratios. The codes can be broken through character frequency analysis.

The LZ-77 (Lempel Ziv published in 1977) code²⁶ uses a sliding shift register type library, which stores the previously transmitted data. New input data strings are compared with the previously transmitted strings, stored in the shift register library, to find the longest matching data strings. Each matching data string is identified by a separate string-start-string-length code. The string-start address points to the first matching character in the shift register library. The string-length code counts the number of matching characters in the string. This data compression method is much less efficient than more modern methods, but remains the most common commercial data compression method. The main drawbacks are the need for a string-length code and a very inefficient library containing duplicate data strings. Near unbreakable encryption is possible by pre-loading the shift register libraries with a long secret code message, which is only known to the transmitter and the receiver. The code message is pre-loaded into both the transmitter and the receiver shift register library before starting the transmissions. The code can be broken only by guessing the content of the pre-loaded code message, which may be very difficult for very long code messages.

The V.42bis data compression standard¹⁷ is used in virtually all Internet modems. A dynamic version of a serial Autosophy tree network is used to learn the transmitted data patterns in an internal serial tree library. The data actually being transmitted via the modems are "address" codes, which point to the internal library. The library will automatically adapt itself to the type of data being transmitted by continuously recycling the nodes in the library¹⁹. The algorithms are very outdated and inefficient and can operate only at telephone line speed, even when using the Sussenguth²⁹ search trees. Virtually unbreakable encryption can be added by secret code strings, which are only known to the transmitter and the receiver. The code strings may be text messages of any length. The transmitter would first input the code string while blocking the modem transmissions. The receiver would input the identical code string through a bypass simulating transmissions from the input modem. The main message would then use normal V.42bis address codes. Because the code string would scramble the internal recycling library the main message can only be decoded by guessing the secret code string, which may be virtually impossible. A more efficient "fixed library"¹ system is now being developed to provide higher compression ratios, built-in encryption, and unlimited speed.

The gif and tif formats are used for lossless still image compression. A serial Autosophy tree network library is grown according to the LZW (Lempel Ziv Welch) code²². The algorithm in effect learns the input pixel patterns in a tree library. Already learned pixel sequences are re-used in the encoding of the following pixel sequences. An input image is thus converted into a serial network tree library, which is then transmitted or stored to yield lossless image compression. The original image can then be fully reconstructed from the library. Encryption can be added by initiating the library with a code pattern, such as from a code image, which is blocked from transmission or storage. The code image should be available to the transmitter and the receiver only. The receiver would be initiating its own library using the identical code image. The code transmissions would then contain the image but missing the lower part of the library. A newer "fixed library" system⁵ can provide much higher compression ratios, unbreakable built-in encryption, and higher resistance to the Internet's Quality of Service (QoS) problems.

5. A UNIVERSAL HARDWARE-INDEPENDENT DATA FORMAT

Data compression and encryption must become an integral part of a practical data communication or data storage system. It cannot be concerned with compression ratios only. Real time data communication via the Internet³, for example, are subject to the Internet's Quality of Service (QoS) problems, including unpredictable bit rates, packet latencies, transmission errors, packets being delivered out of sequence, and packets being dropped in a congested network. The future Internet⁶ will require the simultaneous transmission of all multimedia communications, including live video with synchronized live sound, text, still images, and random data files. All these data types must be randomly mixed together and remain synchronized in the Internet's intermittent packet stream. The new 64bit data formats, shown in Fig.4, could make all future communications compatible. The new data format was developed for the purpose of transmitting live video with synchronized sound via the Internet¹² while avoiding its Quality of Service (QoS) problems. The 64bit data format may be used in all media: cellular telephone, satellites, radio, or the Internet.

The Autosophy information theory claims that all data communications can be defined only by the data content. The hardware parameter such as screen size, pixel resolution, and scanning rates in television, for example, would become irrelevant. The new 64bit universal data format could make all future communications compatible and virtually eliminate the current Quality of Service (QoS) problems when sending live video with synchronized live sound via the packet switching Internet. This may cause a great leap forward in all Internet communications.

AUTOSOPHY REAL TIME SOUND	AUTOSOPHY REAL TIME VIDEO	AUTOSOPHY COMPRESSED TEXT	RANDOM BIT, AUTOSOPHY STILL IMAGES
1 1 Channel Spare	1 0 Spare	0 1 Index (8 bit)	0 0 Data type
Rotating index in 0.1 ms (16 bit)	Screen Address of the Start pixel (20 bit)	Character 1	Index (8 bit)
Library Address (16 bit)	Hyperspace library Address (16 bit)	Character 2	Random bit files Payload 6 bytes
Duration in 0.1 ms (16 bit)	Type Brightn. log	Character 3	
+/- Amplitude log.	Red Green	Character 4	
	Blue	Character 5	
		Character 6	Still images All 16bit codes

Figure 4. Media-independent data formats using a universal hardware-independent 64bit code

A 2bit header defines the type and priority of the data. Real-time sound has the highest priority because any interruption in sound is particularly disturbing to the receiver. Real-time Autosophy video requires a lower priority because of its inherent resistance to packet latency and transmission errors. Autosophy compressed text data can be transmitted with low priority because it is not time dependent. Random bit files or compressed still images are transmitted with the lowest priority. All these types of data are randomly mixed together into larger packets for transport via the Internet TCP/IP or ATM protocols. Lower priority containers may be delayed until data traffic in higher priority containers has eased. All data types contain their own control, timing, and error checking codes.

Sound codes (11) transmit sound by cutting sound wave forms (sine waves) at the analog zero crossing point. Each 64bit code would represent a waveform in the sound stream. Sound codes must be randomly mixed with video codes to achieve synchronized sound in teleconferencing or television broadcast. There is no fixed relationship between the number of sound and video codes. In Autosophy television, for example, there may be times when the video is changing rapidly with little sound, while at other times the video may move slowly with continuous sound. The bit-rate for sound transmission is determined by the sound content. Lower frequency simple sound, such as speech, would require fewer codes than higher frequency complex sound, such as music. Silence would require no code transmissions at all. Only sound that can be heard by the human ear or reproduced needs to be transmitted.

Video codes (10) would each insert a small cluster of up to 16 full color pixels anywhere within the output image. Only moving portions of the video are transmitted to describe motion and complexity in the video. The 64bit cluster codes provide hardware-independent communication protocols. The video camera and monitor may both have entirely different image formats, image sizes, color resolution, or scanning rates and yet always remain both forwards and backwards compatible. This allows television technology to evolve towards larger and larger screens and higher resolution, while using a universal media independent protocol. The new television system is ideal for the packet switching Internet environment by avoiding most of its Quality of Service (QoS) problems.

Text codes (01) use either 9bit or 18bit codes for compressed and encrypted text communication. A 9bit code represents a single ASCII character, while an 18bit code represents a whole word of many characters. Autosophy text compression can achieve an average 3:1 compression ratio. More important is the built-in encryption. Virtually unbreakable security can be achieved when using private hyperspace encryption libraries. The system uses a pre-grown hyperspace library, which contains the most common words in a language.

Random bit codes (00) are used to transmit compressed still images or other random bit files from legacy formats. Autosophy compressed and encrypted still images are transmitted using only 16bit codes, which are hardware-independent to allow the transmission of any-sized images at any resolution. Random data types may, for example, be random bit codes, computer programs, library downloads, or any other unknown data formats. A 6bit "data type" field allows up to 64 different data types or separate data files to be simultaneously transmitted and mixed in the same channel. An 8bit index is required because data packets may be received out of sequence on the Internet.

6. AUTOSOPHY SOUND COMPRESSION AND ENCRYPTION

Autoscopy sound compression and encryption poses the greatest challenges and also the greatest potential for future improvements. For example, when comparing the number of bits required for a written text message transmission, with the number of bits required for transmitting the same message using grammatical speech, one can appreciate the enormous inefficiency in human speech. However, sound and speech is the way we humans communicate. If we could teach computer or autosopher to understand and communicate using grammatical speech then this may become the ultimate method of communication between humans and machines.

Current digital sound transmission and recordings are based on the Shannon information theory. The analog sound waves are sampled at a fixed rate while the amplitude of each sample is converted into a digital word with sufficient resolution. The digital bit from the analog samples are then transmitted in a constant bit stream using a fixed bit rate channel. The content or meaning of the sound is irrelevant. A totally random noise sound transmission would require the same bit rate as total silence. Such sound transmissions cannot be compressed without reduction in the sound quality, i.e. fewer bit per sample or slower sampling rates. Transmitting such sound via the packet switching Internet is very difficult because of the Internet's Quality of Service (QoS) problems including: unpredictable bit rates, packet latencies, packets being dropped in a congested network, or packets being received out of sequence. Using the Internet's packet retransmission scheme in the TCP/IP protocol for correcting transmission errors is not possible for live sound because of unpredictable retransmission delays. Sound encryption is possible, using pseudo random number generators, but this would worsen the Internet's Quality of Service problems.

Sound or voice communications must be reproduced in real time by the receiver, regardless of the transmission methods used. In fixed bit rate channels compression implies that fewer bits are required for transmission in less time. This would destroy the time reference for sound reproduction in real time depending on the varying compression ratios. The problems are worse on the Internet because of the unpredictable bit rates and packet latencies. The human ear is also very sensitive to sound or voice distortions. Any interruption in the sound, including speed-up or slow-down in the sound, would be very disturbing to the human ear. However, the human ear is very tolerant to noise interference and sound volume (amplitude). This makes sound encryption very difficult. The human ear can make sense even of very distorted sound caused by conventional sound encryption methods (frequency swapping).

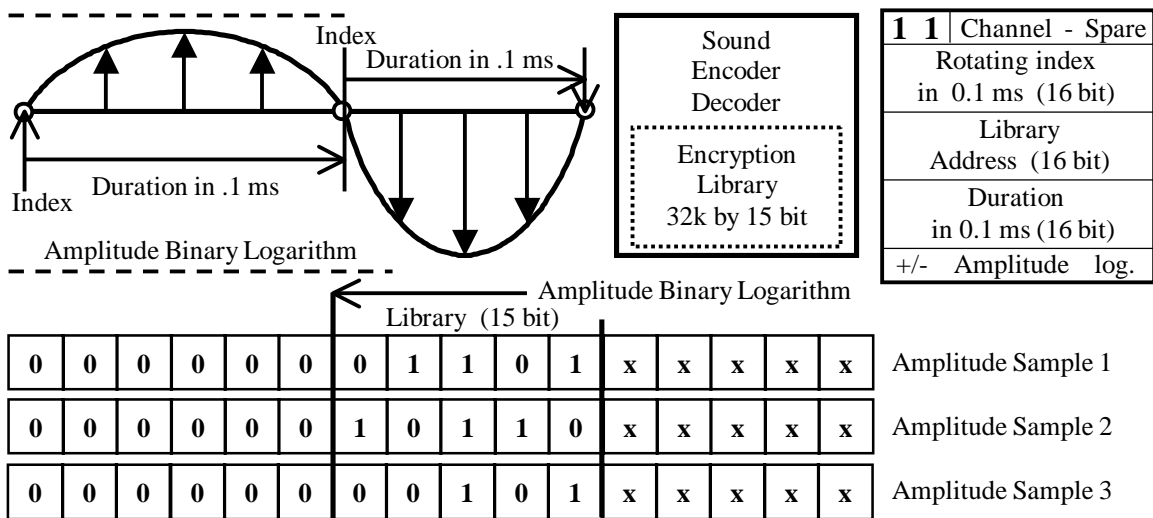


Figure 5. Autoscopy sound compression and encryption

Autoscopy sound and voice transmission via the Internet is now being researched. Sound packets must be randomly mixed with video packets to achieve synchronized sound in teleconferencing or television broadcast. There is no fixed relationship between the number of sound and video packets. In television, for example, there may be times when the video is changing rapidly with little sound, while at other times the video may move slowly with continuous sound. The packet rate for sound transmission is determined by the sound content. Lower frequency simple sound, such as human speech, would require fewer packets than higher frequency more complex sound such as music. Silence would require no packet transmissions at all.

The sound compression and encryption method, shown in Figure 5, can be implemented in both software or in tiny chipsets. Starting from the analog zero crossing point, the encoder would sample the analog signal at a constant 10k per second rate until the next zero crossing point. The time of the first zero crossing is entered as the index into the output packet. The time of the index is taken from a 16bit address counter, which is free running at 10,240 hz, and which is pointing to the address of a 64k by 16bit buffer memory. The interval between the first zero crossing to the next zero crossing provides the duration of the analog wave in the output packet. The encoder then determines the highest value in the buffer memory to generate a binary logarithmic amplitude value for the output packet. The encoder determines the location of three samples in the buffer by dividing the duration value into 4 equal portions. The five most significant bits in the three samples are then combined as the library address in the output packet. The output packet also contains six spare bit, which may be used to define separate sound channels, such as stereo or cubic sound, and other control bit. The 64bit packet code is then freely mixed with other packets representing video, text, or random bit. The sound packet contains all the information required to re-assemble the analog wave in the receiver. The sound codes may be sent in any media, such as radio, wire, cellular telephone, satellites, and even via the packet switching Internet. Packets may be forwarded from media to media without having to be re-formatted. The packets may also be stored in an archiving memory, which contains mixed data (sound, video, text, still images, legacy data formats), for later replay. The replay system is self-synchronizing and requires no constant disc or tape speed.

A sound encoding system for open, non encrypted, communications does not require a library. An encryption library may be grown by recording input data such as speech or music. A software system would encode each input wave into a 15bit code, which is stored in sequence in a library memory. Each 15bit code must be unique and stored only once in the library. After all the recorded input data has been entered into the library, then the remaining library locations must be loaded to assure that all possible 15bit combinations are stored in the library. The transmitter and the receiver libraries must contain the same wave codes but in a crossed CAM or RAM format. The transmitter library would use the 15bit wave code as an address for the library where the memory location address is stored as data in the library, i.e. forming a Content Addressable Memory (CAM). The receiver would use the library address from the packet as an address to retrieve the original 15bit wave code stored in the receiver library, i.e. forming a Random Addressable Memory (RAM). The library address in the code packet would point to a library location in the receiver, which then contains the actual wave code. Without a matching encryption library for both the transmitter and the receiver, sound retrieval becomes virtually impossible. The encryption libraries may be downloaded via the Internet to all authorized communication partners. Each user may even have a different library for positive authentication. Encrypted sound may be retrieved and re-encrypted indefinitely without loss of the sound quality. For additional encryption security, the wave code available in both libraries may be added to the index, duration, and amplitude field in the communications packets. Only a receiver with the correct library would be able to retrieve the sound data.

7. AUTOSOPHY VIDEO COMPRESSION AND ENCRYPTION

A new live video via the Internet has recently been demonstrated. The system provides both very high lossless video compression and virtually unbreakable encryption. The new video method is perfectly suited for the packet switching Internet by avoiding its Quality of Service (QoS) problems. The video is transmitted in standard 64bit packets, which can be mixed with 64bit sound packets, to achieve live Internet television with synchronized sound.



Figure 6. Autosophy video compression and encryption for Internet transmission

Autosophy video achieves very high data compression by transmitting only the moving or changing portions of the video images. The static portions of the images are not retransmitted.

Each 64bit packet transmission inserts a small cluster of pixels into the output image. Each cluster may contain up to 16 full color pixels (16bit/color resolution) and be located anywhere within the output image. The image on the left in Figure 6 shows the reconstructed video image, which is identical to the input video image because the compression is entirely “lossless.” The image on the right shows the changed pixel clusters, which are actually transmitted. The compression ratio is approximately the “colored” portion of the left image divided by the “colored” portion of the right image. The compression ratio depends on the video content or the motion and complexity in the video images.

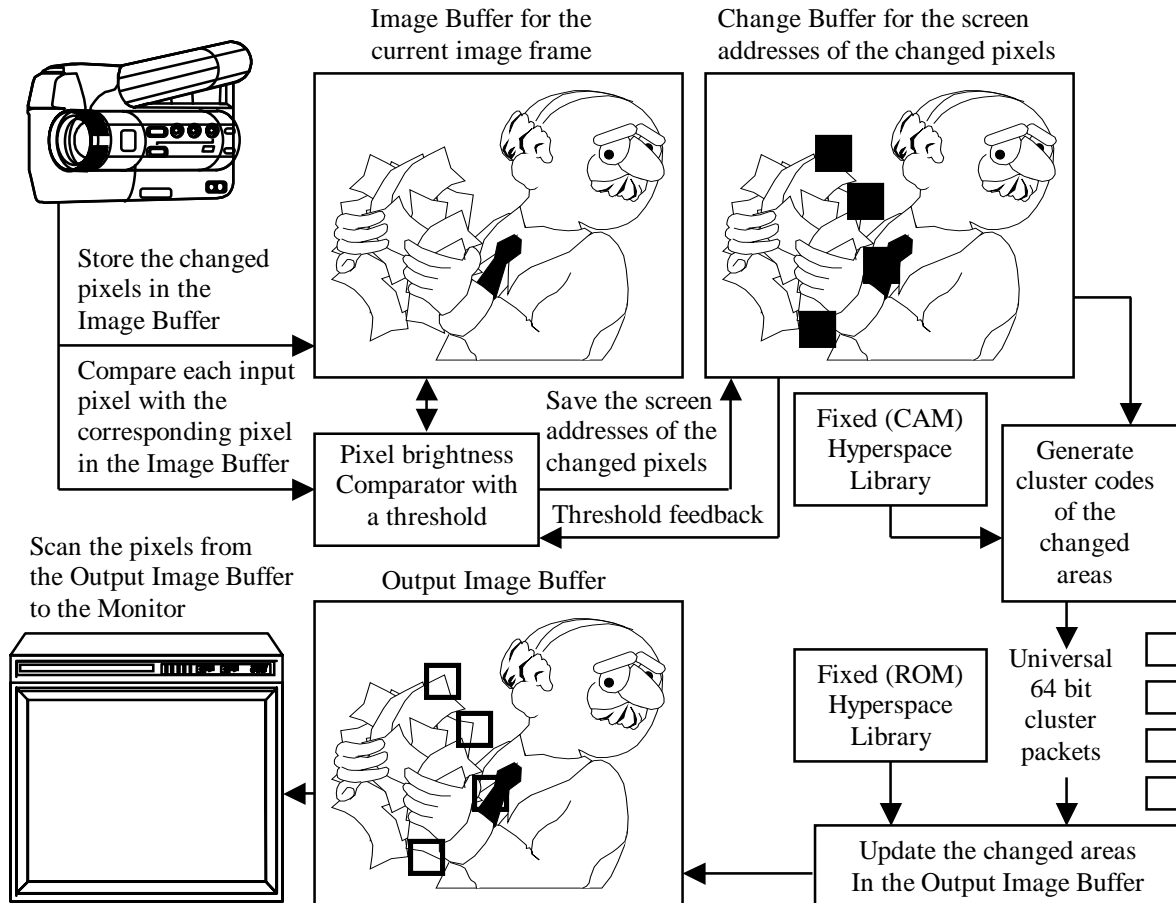


Figure 7. An Autoscopy video compression and encryption system

Autoscopy television contains an image buffer in both transmitter and receiver, which holds the current image frame. A new input image frame, from the television camera, is compared with the current image frame to detect the pixels whose brightness or color has changed more than a threshold limit. The newly changed pixel are stored into the image buffer. Non-changing pixels are ignored. The screen location addresses of the changing pixels are accumulated in a change buffer. The encoding process combines the changed pixels into spiral clusters using a fixed hyperspace knowledge library. The output is a universal 64bit code packet, which defines a group of changing pixels in a spiral cluster that can be anywhere within the output image frame. The video code packets are randomly mixed with other data packets (representing sound, text, or random bit files) for storage or transmission. The receiver retrieves the spiral image cluster from the code packets using a duplicate fixed hyperspace library. The changing pixel clusters are used to update small areas in the output image buffer. The output image buffer is scanned at regular intervals to the output monitor. In this way only the changing portions of the video are being transmitted resulting in very high lossless video compression depending on the motion and complexity in the video images. The fixed hyperspace libraries in both the transmitter and the receiver provide virtually unbreakable encryption for secure television. Without a matching library, video retrieval is virtually impossible. A generic library provides open communications. Encryption libraries are downloaded via the Internet to all authorized receivers or groups of receivers.

The packet rate in Autoscopy television is dependent only on the video content, i.e. motion and complexity in the video images. The video hardware (i.e. the screen size, resolution and scanning rates) becomes virtually irrelevant. This is analog to human or biological vision. A blank or static video image would require no packet transmissions at all. On the other hand, totally random noise video images (snow) would require excessive packet rates unless special defensive means are implemented to reduce the packet rates. Random noise video or excessive motion and complexity in the video cannot be perceived by the human eye and brain and therefore provides no real information. Data compression is achieved because only the moving portion of the video is encoded for transmission. The complexity in the video images is reduced by a hyperspace library, which contains only the most often used imaging clusters. Most video images are composed of larger areas of mostly equal brightness and color. Also, moving objects in the video usually change many adjacent pixels at a time instead of changing single pixels. The changing pixels can be combined, through spiral scanning, to combine several changed pixels in a cluster packet. Simple, evenly colored video images therefore require fewer packet transmissions, therefore increasing data compression performance.

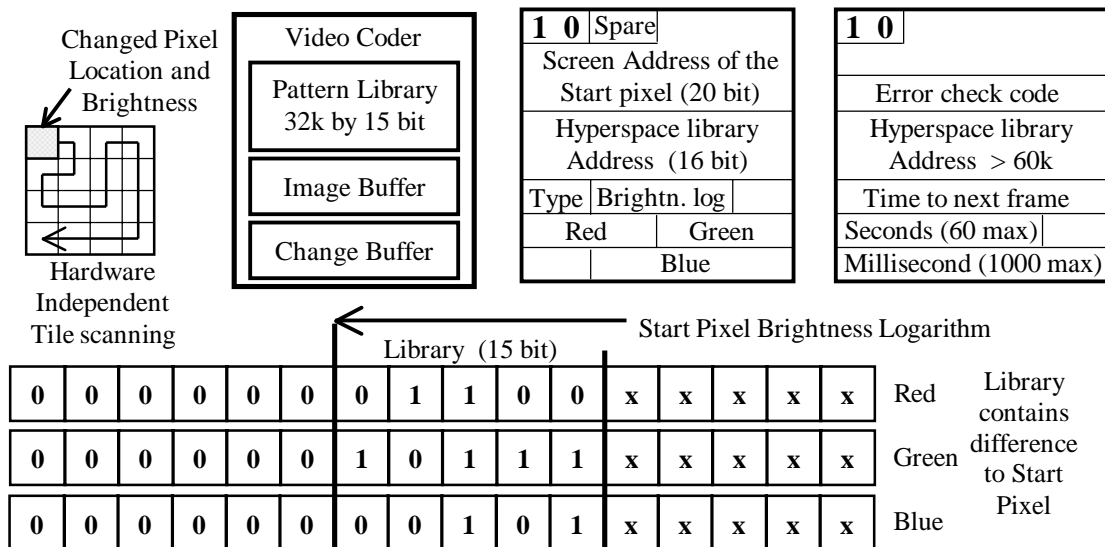


Figure 8. Autoscopy video compression and communication codes

The video encoding process starts with the screen location (screen address) of a changed pixel from the change buffer. The new color brightness of the changed pixel, from the image buffer, is encoded into a 18bit color code and a 4bit logarithmic brightness code. The color code is determined by the dominant color, i.e. the most significant bit=1 in the 3 color samples. Only 5bit/color are used to define the difference color resolution. The logarithmic brightness code counts the digits to the location where the dominant color bit = 1 is found. The 15bit difference in color brightness to the start pixel code is then applied to the hyperspace library to combine up to 15 pixels into a library address code, using a serial tree network. The codes are then combined into a 64bit cluster code for transmission. If the hyperspace library address is larger than 60k then the 64bit packet is used for communication with the receiver to define other parameter, such as error checking codes or a waiting delay before starting the decoding of the next frame.

The hyperspace libraries are grown prior to the video transmissions from an assortment of sample images using a software package. The library only contains the most common color patterns, which are selected by a special "bubble" algorithm. It takes only a few minutes time to generate an encryption library using the software package. The library is then distributed via encrypted Internet downloading to all authorized receivers or groups of receivers. Open, non-encrypted video, can use a generic library which is part of the software package. Without an exactly matching library copy, video interception is virtually impossible. Encryption must be improved because the human eye has the amazing capability to recognize objects even with greatly distorted colors. A moving object in the video can be recognized from its movement alone (as shown in Figure 6). Encryption can be improved by generating a checksum code from the color patterns found in the hyperspace tree library, as specified in the 16bit hyperspace library address code. The up to 15 pixel cluster codes retrieved from the hyperspace library address are combined to generate the 16bit encryption code. The encryption code is then added to the screen address code and the pixel brightness code in the 64bit packet. This would prevent video retrieval except for users having the correct encryption library.

8. AUTOSOPHY TEXT COMPRESSION AND ENCRYPTION

Text communications are highly efficient and can be compressed only with an average 2:1 to 3:1 compression ratio. More important is the built-in encryption. Virtually unbreakable text encryption can be achieved when using private hyperspace libraries. The standard 64bit text codes can be mixed with other data, such as sound and video during an Internet teleconferencing session.

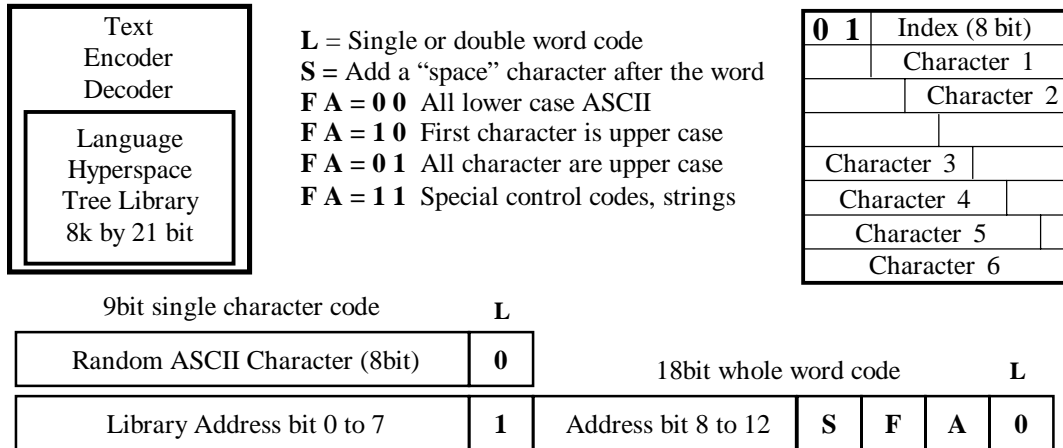


Figure 9. Autosophy text compression and encryption codes

Text compression and encryption systems use a pre-grown hyperspace library, which contains the most common words in a language. Test results show that an 8k by 21bit library may contain about 4000 of the most common words in English communications. About 90% of the words in normal Internet communications are contained in the library. Words not found in the library are automatically chopped into known fragments. Standard libraries for non-encrypted communications are available in the software system for most world languages. To grow a special encryption library requires a large sample of text in the specific language. The software system will then use the text to grow a hyperspace serial tree library in which only the most often used words are selected using a special bubble algorithm. The new library is then distributed to all authorized users by encrypted Internet downloading. The text transmission method can transmit any data type, including foreign languages or random bit files, but compression ratios are highest when using the correct language library. An 8bit index is required because Internet packets may be delivered out of sequence, or packets may be dropped in a congested network. Special messages to the receiver are transmitted in packets with the F and A bit = 11. This may include language codes, error checking codes, and text formatting. Single characters of random text are transmitted in a 9bit code while 18bit codes may represent any length whole word in a language including the "space" character. Without a matching encryption library, text retrieval is impossible.

9. AUTOSOPHY STILL IMAGE COMPRESSION AND ENCRYPTION

A still image compression system can be implemented in either hardware chipsets or using software-only in a computer. For real-time television the transmitter library must be a Content Addressable Memory (CAM). Input images of any size or resolution can be encoded into a hardware-independent format.

The still image compression algorithms may be either "lossless" or "visually lossless." In lossless compression, according to the Shannon information theory, every bit is precisely reproduced. In visually lossless compression, according to the Autosophy information theory, only that which can actually be seen by the human eye is transmitted. This provides both higher compression ratios and it will actually improve the perceived image quality.

The input images are cut into square tiles to reduce the hardware requirements. Each tile may be regarded as a separate image. The tiles can be of any size, ranging from a single pixel to the entire image as a single tile. In this example, a 4 by 4 pixel tile is shown, scanned in a special hardware-independent pattern. The scanning sequence starts from a start pixel and proceeds until the entire tile has been scanned. The absolute red-green-blue brightness of the start pixel is stored in a reference register. Differences between the start pixel in the reference register and the next pixel in the scanning sequence are applied to the hyperspace pattern library.

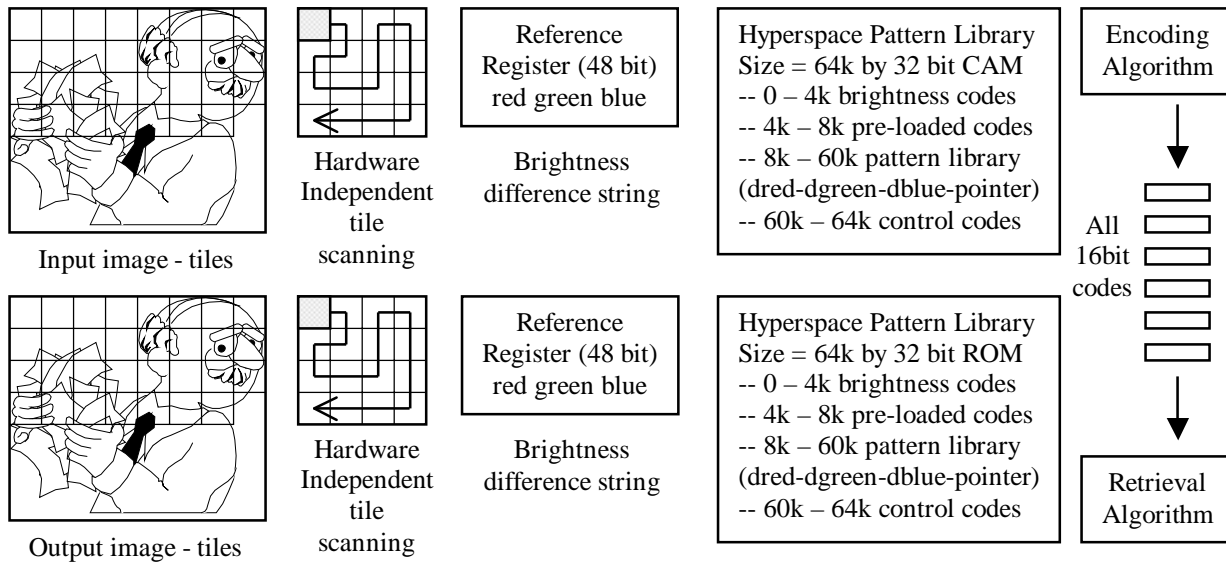


Figure 10. Autosophy still image compression and encryption

Autosophy still image compression systems, shown in Figure 10, contains an image buffer in the transmitter and receiver, which holds the images to be encoded or retrieved. Because the image transmissions are entirely hardware-independent, both the transmitter and receiver can have entirely different buffer sizes and resolution. The images must be stored in raw bit pattern format, such as separate red-green-blue fields. As the compression algorithm is "visually lossless," the images can be compressed and expanded indefinitely without reduction in the image quality. The encoding algorithm encodes the images into 16bit codes, which are stuffed into universal 64bit packets. The 64bit packets can be randomly mixed with other data, including live video, sound, text, or random bit files for universal communications. The retrieval algorithm then retrieves the output image tiles from the 16bit codes, using a duplicate hyperspace library and the reverse hardware-independent spiral scanning sequence. The output image tiles are then pasted into the output image buffer. Special 16bit control or command codes are embedded into the code stream.

A hyperspace library is grown prior to transmissions. It contains many thousands of the most common image "patterns" stored in a hyperspace mode. The library does not change during the image compression process. A generic library is part of the compression software to be used for open communications. Special encryption libraries may be grown for secure, encrypted communications. Both the transmitter and the receiver must have an identical copy of the hyperspace library. Useful image retrieval is virtually impossible without a matching library.

10. TRANSMISSION OF RANDOM BIT FILES FROM LEGACY FORMATS

According to both the Shannon and the Autosophy information theory, files such as: totally random bit files, encrypted files, or previously compressed data files, cannot be further compressed without the risk of data expansion (negative compression). Data compression should therefore not even be attempted for random bit files or files of unknown data format. Encryption is best provided by the originating program, which generated the data file. Compressed and encrypted still image files are encoded into all 16bit codes, which are transmitted like random bit files. In an Internet teleconferencing session, for example, it should be possible to mix and insert up to 64 separate random bit files into the sound and video code stream for transmission in the Internet's intermittent packet stream.

A universal 64bit code packet is used for all random bit files or files of unknown origin. Each code contains a 48bit payload, an 8bit index, and a 6bit type code. The index and the type code are combined to allow the simultaneous transmission of up to 64 different data files, which are mixed in the same channel on the Internet. The index is required because data packets may be delivered out of order on the Internet. The current Internet TCP/IP protocol provides error retransmission and sorting of packets, but this cannot be relied upon in a universal protocol. The 64 data type codes may be assigned for generic files, such as still images, Microsoft compatible files, or control register arrays. Combining all data including video, sound, text, and random bit files, into a common 64bit format could greatly improve the Internet's Quality of Service problems and allow for recording the data in large archives.

11. CONCLUSIONS

Information theories: Shannon vs. Autosophy

The classical Shannon information theory was originally developed for primitive telegraph and computer communications. It treats all data as meaningless bit streams, which does not allow for lossless data compression. Data encryption uses bit scrambling, such as pseudo random number generators, resulting in encryption codes that can be broken through high speed computing and determined efforts. The Autosophy information theory, in contrast, was developed for natural or human compatible communications based on mathematical "learning" algorithms. This provides both very high lossless data compression and virtually unbreakable encryption. As suggested in this paper: communication based on the Shannon theory can and should be replaced by communication according to the Autosophy theory. This may require extensive research and development, but the effort will be well worth it.

Impact on the Internet

Communicating real time data, such as sound and video, via the packet switching Internet is very difficult because of the Internet's Quality of Service (QoS) problems, including unpredictable bit rates, packet latencies, transmission errors, packets delivered out of sequence or dropped in a congested network. Error re-transmission in the TCP/IP protocols does not work well for real time data, such as live video and sound, because of unpredictable re-transmission delays. Data compression and encryption is no longer an option but a necessity. Conventional Shannon communications would require expensive and continuous upgrading of the Internet's Quality of Service. A new 64bit universal data format, in contrast, may solve most of the Internet's Quality of Service problems and allowing high data compression and built-in encryption. Further work will be required to establish the new Internet data formats.

Data compatibility standards

Conventional Shannon communication data standards are defined by the hardware. In television, for example, the transmission standard is determined by the screen size, resolution and scanning rates. Any new development towards better television with larger screens and better image quality would require a new standard, which may not be compatible with older standards. In Autosophy communications, in contrast, the imaging standards are defined only by the video content, such as movement and complexity of the images shown on the screen. The screen size, resolution and scanning rates would become irrelevant. This would make all future video compatible. Any advances in image size, resolution or scanning rates could be accommodated without having to change the transmission standards. Video communication would be possible between any media or terminal, ranging from cellular telephone, to laptop computer, all the way to wall size giant television monitors. Many video images could be merged into a single picture.

Media compatibility

Internet compatibility and compatibility with other media will be a requirement of any future communication system. Using the universal 64bit data standard real time video with synchronized sound and other data can be forwarded from radio, to cellular telephone, to satellites, and through the Internet without needing to be reformatted.

Conventional lossy vs. Autosophy lossless compression

In conventional lossy image compression (JPEG, MPEG, DCT, Wavelets, Fractals) the compression is achieved only by sacrificing image quality. The more the images are compressed the worse the image quality will become. Image distortions include blurring, blocking artifacts, jagged motion, and introduced image artifacts. Lossless Autosophy image compression, in contrast, will not distort the images or introduce imaging artifacts. It offers both "lossless" image compression in which each bit is precisely reproduced or "visually lossless" compression in which only that which can actually be seen by the human eye, or being reproduced on the monitor, is transmitted. Visually lossless image compression can both greatly increase the compression ratios and the perceived image quality.

Sensitivity to transmission errors

Error sensitivity is a severe problem in conventional video compression (JPEG, MPEG, DCT, Wavelets, Fractals). A single wrong bit or gaps in the transmission can cause the video images to break up into random (snow) noise. Autosophy video, in contrast, is extremely resistant to transmission errors. Wrong bits in the transmission, or missing portion in radio transmissions, will only cause tiny spots on the video screen to freeze when they were supposed to change. The video quality will therefore remain excellent even in very noisy transmission channels.

Secure communications and encryption

Encryption is required to authenticate communication partners and to prevent the interception of data by unauthorized users. Autosophy methods offer built-in virtually unbreakable "codebook" encryption by growing separate encryption libraries for each user or groups of users.

Future impact on computing, and multimedia archiving

The Autosophy information theory may eventually replace the programmed data processing computer with brain-like self-learning archives able to communicate with us, and each other, in a universal hardware independent format. From there the path lies open towards self-learning intelligent robots, and eventually to true Artificial Intelligence.

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