International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 11 Issue 3 ǁ March 2023 ǁ PP. 332-336

Comparative analysis of methods for streaming and broadcasting of analog CCTV camera

Kartick Upadhyay*
**Advanced Centre for Energetic Material, DRDO, Nasik*

Abstract
With the advent of digital internet protocol cameras, analog cameras are slowly being phased out for CCTV applications. However, analog cameras are not only mass-distributed but are relatively simple to install and maintain. Moreover, analog cameras are affordable and require the least amount of technical expertise to operate and troubleshoot. Analog cameras can still be effectively used to enable features of digital cameras, like live broadcasts and streams. Analog cameras can also be combined with digital cameras to create a hybrid CCTV monitoring ecosystem. Videos of analog camera can be recorded, played in real time using NVR, software decoder or compatible browser.

Keywords: *CCTV, Analog, Digital, Camera, Internet Protocol (IP), Digital Video Recorder (DVR), Network Video Recorder (NVR), Coaxial, Optical Fibre, Twisted pair, Transmission Control Protocol/ Internet Protocol (TCP/IP)*

Date of Submission: 05-03-2023 Date of acceptance: 18-03-2023

I. INTRODUCTION

When it comes to securing commercial spaces, residential apartments, or critical installations of national importance, analog CCTV cameras are the most popular product. Analog cameras were also popular due to ease of installation and commissioning, ease of maintenance, and the requirement of less technical expertise for operation. These cameras were also economical when compared with similar specifications to their digital counterparts.

Analog cameras are lightweight due to fewer onboard electronics and less signal processing. An analog camera consists of a lens and an image sensor. The image sensor can either be a Charged Coupled Device (CCD) or a Complementary Metal Oxide Semiconductor (CMOS). When light is incident upon these imaging sensors a charge is generated. The charge generated is amplified and carried over by a coaxial cable as a voltage signal. This voltage signal is brought up to a Digital Video Recorder (DVR). These DVRs convert analog voltage signals into digital signals for storage, processing, and transmission.

II. Installation and commissioning

Analog cameras are easy to install and coaxial cables are generally used to carry video signals. These cameras were powered by a switched-mode power supply (SMPS) or DC power supply that could be made available to each camera locally. Up to 4 cameras can be powered by a single SMPS at the monitoring station. The newer versions of cables include power, signal, and audio (if required) over the same cable. Cables run from the field to the monitoring station, providing power to the camera and bringing information. These cameras are of two types: Fixed and Pan-Tilt-Zoom (PTZ).

An additional feature of PTZ cameras is the capability of drifting the camera over an area for advanced analysis and zone-wise monitoring. There is a requirement for cabling and a console for a PTZ camera for controlling the motion and degree of the camera. In the monitoring station, the signal cables are terminated at the DVR. A terminal connector can be BNC, TNC, etc. An HDD of the recommended size can be integrated with a DVR for storage and retrieval of data

III. Methods

There are two medium for transmission of signal:

i. Unguided or wireless
ii. Guided or wired

i. Unguided /wireless communication

Unguided communication involves the use of Radio Waves, Microwaves, and Infrared. By using high-gain antennas, video signals can be transmitted over long distances. These antennas need to be installed both on the site and at the monitoring station. Multiple receiving antennas can also be used if there are multiple monitoring

units. The selection of an antenna is guided by the factors of the geographical location of the site, natural barriers like mountains or valleys, vegetation, man-made structures in line of sight (LoS), and distance. The selection of an appropriate frequency is one of the most important requirements for the transmission of a signal.

ii. Guided Communication/ wired communication

Guided communication involves the use of wires for the transmission of data. It can be a coaxial cable, a copper cable (twisted or untwisted), or an optical fibre cable. The selection of wire is generally guided by factors like the volume of data being transmitted, the bandwidth required, and the distance up to which data is to be carried. An optical fibre cable provides the highest speed and minimum attenuation and is hence preferred for long-distance transmission.

3.1 Methods/ Techniques

There are three methods employed for broadcasting and transmission of analog camera footage:

3.1.1 Transmission over coaxial cable.
3.1.2 Transmission using an IP encoder.
3.1.3 Transmission of data using DVR.

3.1.1 Transmission over coaxial cable: This method involves laying cable up to the monitoring station. The maximum distance up to which signals can be carried over these cables is approximately 1000 meters.

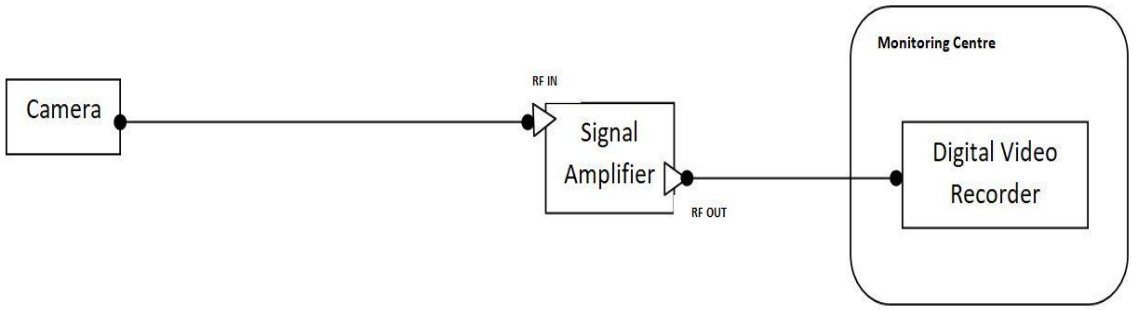

Fig. 1: Schematic diagram for transmission of video using coaxial cable

The distance limitation can be overcome by using signal boosters or signal amplifiers at appropriate distance. Video signals get degraded after some distance and signal booster amplifies quality of input signal.

3.1.2 Video transmission using an IP encoder: These devices are very reliable when it comes to transmitting video. These modules come in many variants input and output variants. IP encoder is called so because it uses internet protocols (like UDP, TCP/IP, RTSP etc.) for transmission of data.

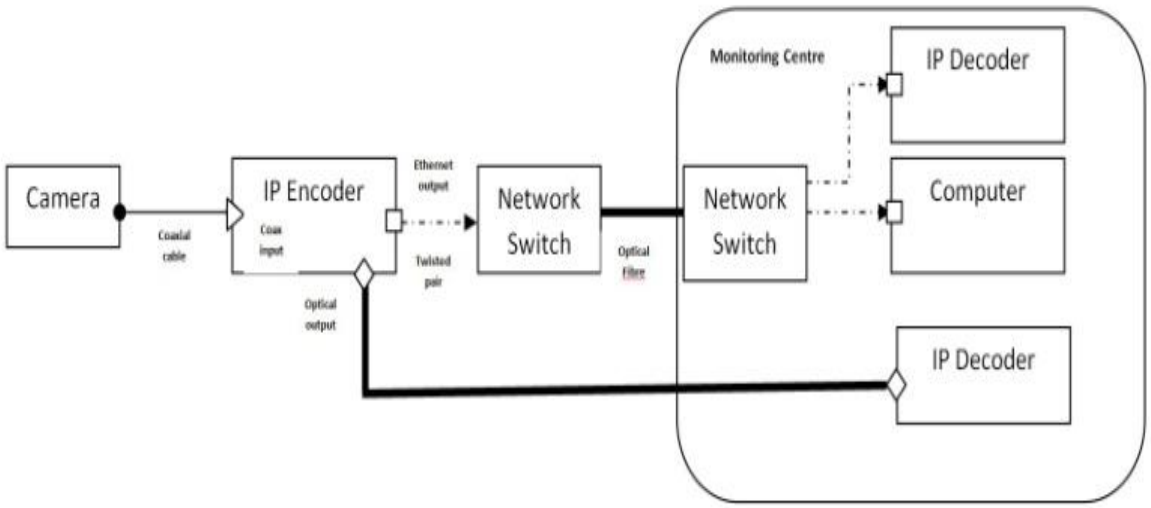

Fig. 2: Schematic diagram for transmission of video using IP encoder

The most popular output interface is either Ethernet or optical. Its interface has a coaxial input through which it takes analog data from the camera and processes them into packets over UTP cable or optical fibre cable. Processing analog signals involves compression, encryption, etc. The IP address of the encoder needs to be configured. Decoder or application software at the receiver's end is required for the acquisition of real-time video streams. This method also involves laying fibre or UTP cable up to the monitoring station. It is also necessary to install other hardware components, such as network switches, optical receivers, and media converters. IP encoders are available as one/two or four input options which can be selected as per the requirement

3.1.3 Transmission of video using DVR: As with an IP encoder, requirements like cabling and network devices almost remain the same. The IP address of the DVR also needs to be configured.

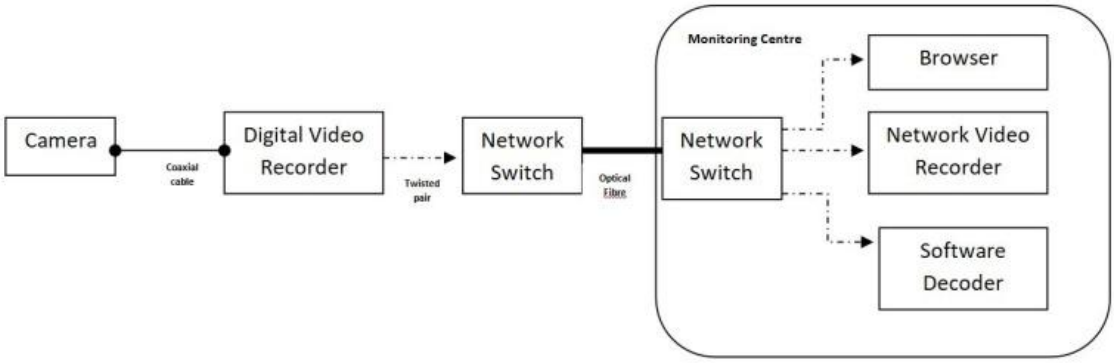

Fig. 3: Schematic diagram for transmission of video using DVR

Depending on the model, DVRs can have 4/8/16/32/64 channels to choose from. The number of channels represents the number of cameras that can be connected to the DVR. In other words, it represents the number of video streams that can be recorded simultaneously by the DVR. Unlike IP encoders, which are only capable of simultaneous processing of a maximum of 4 channels, the DVR can cater to the needs of up to 128 channels and beyond. Contrary to IP encoders which need to be configured individually, only one DVR need to be configured.

IV. Selection of cables

Three different types of cables are employed for video signal transmission. Coaxial, twisted Pair, and optical fibre. These are either used independently or in a combination of the other two for the transmission of data to the monitoring station. Before making a decision, users should consider their merit and demerit.

4.1 Speed vs. distance

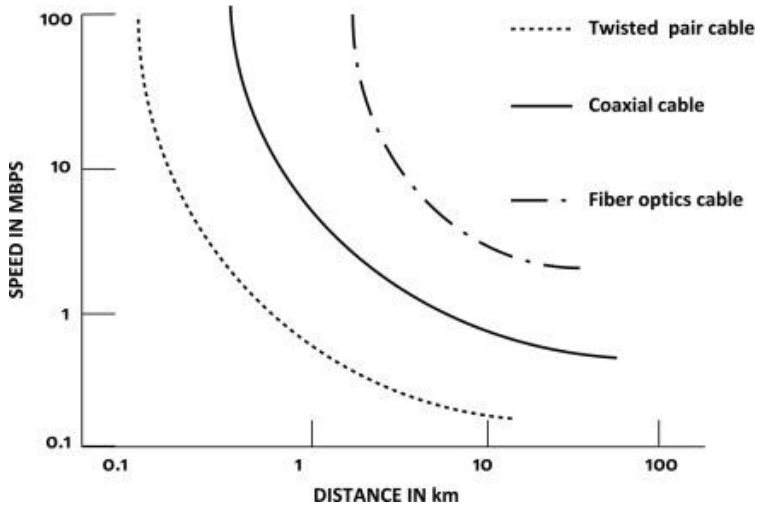

Fig. 4: Speed vs. distance for coaxial, twisted pair & optical fibre cable
Source: www.sciencedirect.com

Fig. 4 represents, optical fibre is the fastest and carries data up to longer distances without attenuation followed by coaxial and twisted pair cables.

4.2 Cost

In terms of cost twisted pair cost is least followed by coaxial and optical fibre. Installation of optical fibre is a costly affair. Commissioning and fault repair require professional expertise along with sophisticated machines like a fibre optic cable splicing machine and OTDR (Optical Time Domain Reflector). Optical fibre cables are highly sensitive to stress and can easily be damaged. Coaxial cables have a high degree of strength as compared to the other two due to their construction. However coaxial cables are heavy and bulky to handle

4.3 Signal attenuation & security

Signals in analog cameras are transmitted using coaxial cable. These signals were not encrypted and hence insecure. In mid-course, anyone can access these video signals using a 3-way RF connector (tee connector). Digital IP-based camera signals are immune to unauthorized access as they are encrypted.

Fibre optic cables carry signals as light in a glass medium having a refractive index of 1.5. The optical fibre cable offers the least attenuation and is highly resistant to external noises. In contrast, twisted pair cables transmit data in electrical signals and are highly susceptible to external interference. Twisted pair cables have the highest attenuation. Coaxial cables transmit data as an electric signal over a central metal core and offer better protection against external noise and better attenuation as compared to twisted pair cables.

4.4 Transmission delay

There is a delay that is incorporated at every stage of transmission. An encoder can have an average delay of up to 5 seconds. A transport medium can have a delay of up to 50 seconds. Decoders can have a delay of up to 1 second. The average delay due to individual members sums up to 28 seconds. The delay can increase or decrease depending upon various factors of chain members like encoding and decoding delay, congestion, bandwidth issues, packet loss, etc.

V. DISCUSSION

Whenever it comes to the transmission of data or signals, wired communication is always preferred over wireless communication. Installing, commissioning, and maintaining wireless systems require extensive investment, labor, and expertise. Wireless communication is susceptible to weather conditions like fog, rain, etc. To ensure smooth transmission, the antennas should be placed at elevated structures and in line of sight. Wireless communication is recommended only in areas where it is difficult to lay cables due to geophysical constraints. As compared with wired communications, wireless communications are less secure, prone to interference, and have lower bandwidth availability.

In most cases, data transmission over coaxial cables is the easiest and most popular method. Even today's household televisions efficiently use coaxial cable. High-speed internet service is provided using coaxial cable. The simple construction design of the cable is the key to its popularity even today. These cables provide excellent immunity to external electromagnetic interference. There are many standards of coaxial cable; however, RG 59 and RG 6 are preferred for the transmission of video signals. This system requires the least amount of technical expertise to install and commission. Connectors and other assemblies were also readily available due to their popularity. Coaxial cables are capable of carrying data at high speeds and up to long distances as compared to twisted pair cables.

Transmission using an IP encoder involves the use of a coaxial cable from an analog camera. This coaxial cable is connected to an IP encoder. An IP encoder is a device that acts as a media converter. It converts the analog signal into a digital signal and then compresses, encrypts, and packetizes the data for transmission. The packets were carried over by twisted pair cables up to the network switch. TCP/IP communication is the main concept behind the transmission method. Depending upon the distance of the monitoring station data can be transmitted either by twisted pair cable or optical fibre cable. This method is preferred where the distance is very large and data cannot be carried over coaxial cables. This method also takes care of attenuation as the signals are reconstructed by the network switch. If data is carried over by optical fibre cables the signal loss is negligible. Even though this method offers high-quality streaming with minimal data loss, it is not widely adopted due to high encoder costs; protocol mismatches, and limited input channels. Transmission using an IP encoder requires a power arrangement for every encoder, configuration of IP for every device, and a decoder at the receiver's end. Protocol mismatch occurs because every encoder uses its own proprietary video compression algorithms which may not be compatible with every decoder. ONVIF (Open Network Video Interface Forum) compatible devices, however, provide interoperability among different encoders.

Transmission of video using DVR is a less known, least popular but cost-effective method of video transmission. The method requires similar hardware and techniques for transmitting video signals. The conversion of input signals into digital packets is done using a similar protocol. However, this method effectively overcomes the limitations of IP encoders like the number of input channels, power requirements, output cabling, and TCP/IP configuration of individual encoders. We have to configure the IP address of DVR

only. The DVR is available up to 128 input analog channels which are sufficient for the entire premises. The price of a DVR along with an HDD is also less when compared with an IP Encoder. DVR can record and simultaneously transmit high-quality images in real time. Servicing and repairing DVRs are also easy and economical.

VI. CONCLUSION

Analog cameras are the simplest means of surveillance and are used worldwide. However, digital cameras are slowly changing the scenario but installation of surveillance systems at any premises involves a huge investment. The digital camera needs professional-level expertise for installation, commissioning, and servicing. The cabling requirement for digital cameras is not as extensive as it is for analog cameras. The twisted pair cable which brings data is utilized to power the camera via PoE (Power over Ethernet). The analog camera can still be utilized effectively by the methods stated. A Network Video Recorder (NVR) is a device that is designed to record video from digital IP cameras. This NVR can be configured to record video from analog cameras using a DVR. The footage of DVR can also be accessed in real-time using a software decoder or a compatible browser. This will enable the creation of a hybrid CCTV ecosystem using both analog and digital cameras.

REFERENCES

[1]. Voorthuijsen, G. & Hoof, H. & Klima, M. & Roubik, Karel & Bernas, Martin & Pata, Petr. (2005).” CCTV effectiveness study” 105 - 108. 10.1109/CCST.2005.1594815.
[2]. Matczak, P., Wójtowicz, A., Dąbrowski, A. et al., “Cost-Effectiveness of CCTV Surveillance Systems: Evidence from a Polish City. Eur J Crim Policy Res”, 2022.
[3]. B.P. Lathi, Zhi Ding, “Modern Digital and Analog Communication Systems” (Fourth Edition), 2010, Oxford University Press, New York, Oxford.
[4]. Swapan Basu, Ajay Kumar Debnath, “Intelligent Control Systems” Power Plant Instrumentation and Control Handbook (Second Edition), 2019, Elsevier Science.
[5]. “Network Media Types”, CCNA, 2001, Third Edition, 2003, Cisco Press 201 West 103rd Street Indianapolis, Indiana 46290 USA.
[6]. Cisco Networking Academy Program, “CCNA 1 and 2 Companion Guide”, Third Edition, 2003, Cisco Press 201 West 103rd Street Indianapolis, Indiana 46290 USA.
[7]. Cisco Networking Academy Program, “Second-Year Companion Guide Second Edition, 2001”, Cisco Press 201 West 103rd Street Indianapolis, Indiana 46290 USA.