

CCTV CAMERA IS FOR PROTECTION AND LIVE TELECAST OF EVENT FOR SURVEILLANCE AND SECURITY OF 24×7 THROUGHOUT DAY AND NIGHT IN HOUSE AND OUT HOUSE

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ABSTRACT

CCTV cameras help protect your home or business by recording video and letting you watch live streams from your phone. CCTV stands for Closed-Circuit Television.

KEYWORDS: CCTV, LED, surveillance, security, 24 hours.

Popular Types of CCTV Cameras

- **Wi-Fi Pan & Tilt (PTZ) Cameras:** These rotate 360 degrees to cover an entire room or yard. Models like the CP Plus Ezykam cost around ₹3,400 to ₹3,900 and offer colour night vision.
- **Outdoor Bullet Cameras:** These weather-resistant wired cameras mount on walls for permanent exterior perimeter security. A standard Hikvision 2MP Outdoor Bullet Camera costs about ₹890 to ₹1,050.
- **Indoor Plug-and-Play Cameras:** Small wireless options like the TP-Link Tapo C201 sit on tables or shelves to monitor pets or children.

Key Features to Check

- **Resolution:** 1080p (2MP) provides basic clarity, while 2K or 4MP offers sharper details when zooming in.

- **Night Vision:** Infrared (IR) LEDs let the camera see in total darkness, while colour night vision uses spotlights to show hues after dark.

- **Storage:** Local micro-SD cards (supporting up to 256GB or 512GB) keep costs low, whereas cloud storage protects footage if the physical camera gets stolen.

CCTV (Closed-Circuit Television) systems provide effective visual surveillance and security oversight for homes, businesses, and public spaces. A Wi-Fi CCTV camera connects directly to your wireless router so you can stream live video and receive alerts on your phone without messy cable wiring.



Figure-1: CCTV camera & Inventor: Walter Bruch.

Walter Bruch (2 March 1908 – 5 May 1990) was a German electrical engineer and pioneer of German television. He was the inventor of closed-circuit television. German electrical engineer Walter Bruch invented the first operational Closed-circuit television (CCTV) system in 1942 to monitor V-2 rocket launches safely. The first patent for a CCTV-based home security system was granted in 1969 (U.S. Patent 3,482,037) to Marie Van Brittan Brown and her husband Albert Brown.

- **Inventor:** Marie Van Brittan Brown, an African-American nurse from Queens, New York.
- **Filing Date:** August 1, 1966.
- **Grant Date:** December 2, 1969.
- **Invention Details:** The system used motorized cameras, peepholes, a television monitor, a two-way microphone/intercom, and an emergency alarm button linked to the police.
- **Prior History:** While basic closed-circuit television technology was developed earlier. —such as Léon Theremin's mechanical setup in 1927 and Walter Bruch's system monitoring V-2 rockets in Germany in 1942—Brown's 1969 patent was the first for a home security surveillance system.

Early Milestones in CCTV History

- **1927 (Mechanical System):** Russian physicist Leon Theremin built an early mechanical scanning-transmitting setup installed at the Moscow Kremlin.
- **1942 (Modern Electronic CCTV):** Walter Bruch designed the 1942 German CCTV system for live military observation without recording capacity.
- **1949 (Commercial Release):** The Vericon system brought closed-circuit equipment to the United States market for banks and industrial safety.
- **1966 (Home Security):** Nurse Marie Van Brittan Brown invented the first patented home security system featuring a motorized camera and television monitor.

Advantages of CCTV

- **Crime Deterrence:** Visible cameras discourage thieves, vandals, and trespassers from targeting a property.

• **Evidence Collection:** Recorded footage provides clear video and audio proof for police investigations and legal cases.

• **Remote Monitoring:** Modern IP systems allow users to check live feeds and alerts using smartphones or computers from anywhere.

• **Activity Tracking:** Helps business owners and managers oversee daily operations, employee safety, and productivity.

Disadvantages of CCTV

• **Privacy Concerns:** Constant recording can invade personal privacy and cause discomfort for employees or neighbours.

• **High Costs:** Purchasing quality hardware, professional installation, and ongoing maintenance or cloud storage can be expensive.

• **Vulnerability to Hacking:** Internet-connected cameras can be compromised by cyber threats or malware if network security is weak.

• **Inability to Stop Crimes:** Cameras only record and alert; they cannot physically prevent a determined intruder from committing a crime.

A complete CCTV (Closed-Circuit Television) system consists of physical camera internal/external components and the broader system hardware required to record and view footage.

Core Parts of the Camera Unit

- **Lens:** Focuses incoming light onto the image sensor to capture the visual scene.
- **Image Sensor (CMOS or CCD):** Converts optical light signals into electrical video signals.
- **Processor (DSP):** Enhances image quality, adjusts color, and compresses the digital video feed.
- **IR LEDs (Infrared Illuminators):** Provides night vision by emitting invisible infrared light for dark areas.
- **Housing/Casing:** Protects internal electronics from weather, dust, or vandalism (dome or bullet styles).

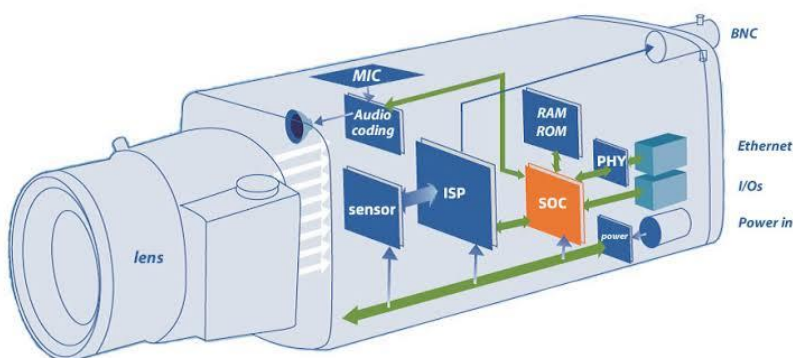


Figure-2: Anatomy of CCTV camera.

A complete CCTV (Closed-Circuit Television) system consists of physical camera internal/external components and the broader system hardware required to record and view footage. A CCTV camera's internal view reveals a compact assembly of precision optics, electronic sensors, and processing hardware working together to capture and transmit video.

Core Internal Components

- **Lens Assembly:** Focuses incoming light onto the sensor. It determines the camera's field of view and focal length.
- **Image Sensor (CMOS or CCD):** Converts optical light signals into electrical signals to form the digital image frame.
- **Printed Circuit Board (PCB):** The main processor board housing the chipset, memory, and firmware that encode the video feed.
- **Infrared (IR) LEDs:** A ring of small infrared lights surrounding the lens that illuminate dark areas for night vision.
- **Microphone & Speaker:** Enables two-way audio recording and communication capabilities.
- **Pan/Tilt Motors:** Found in 360° rotating smart and Wi-Fi cameras to mechanically pan and tilt the lens module.

Power Supply & Connectors: Regulates incoming voltage and handles wired (BNC/Ethernet) or wireless data transmission. Ethernet is a family of wired computer networking standards used to connect devices in a local area network (LAN).

What Is Ethernet?

- **Wired Connection:** It uses physical cables—such as twisted-pair copper wires or fiber optics—to link computers, routers, and switches.
- **Data Standard:** It follows the IEEE 802.3 rules to format and transmit data packets between devices safely and reliably.
- **Speed:** It supports speeds from 10 megabits per second (Mbps) up to hundreds of gigabits per second (Gbps).

Why Use Ethernet?

- **Stability:** It offers a steady connection that does not drop like Wi-Fi.

• **Speed and Low Latency:** It transfers data faster with less delay, making it ideal for online gaming and video streaming.

• **Security:** Wired signals are harder to hack or intercept from afar than wireless radio waves.

A CCTV buzzer sound signal is an internal or external audible alert triggered by a DVR, NVR, or security camera to indicate a system error, event, or security breach.

Common Causes of a CCTV Beeping Sound

- **Missing or Faulty Hard Drive (HDD):** The recorder beeps if no hard drive is installed, if the hard drive is failing, or if storage is full.
- **Network Disconnection:** Network cable failure or an IP conflict on an NVR.
- **Motion Detection or Alarms:** The system is set to buzz when a camera detects motion or an external sensor trips.
- **Video Loss:** A camera is disconnected or not receiving power.

The main purpose of a Closed-Circuit Television (CCTV) system is to monitor activities, deter crime, and record video evidence within a specific, restricted network.

Key Purposes and Uses of CCTV

- **Crime Deterrence:** Visible cameras discourage potential intruders, thieves, and vandals from targeting a property.
- **Evidence Collection:** Recorded video helps law enforcement identify suspects and provides factual evidence in legal proceedings.
- **24/7 Surveillance:** Systems offer continuous, real-time observation of homes, public streets, and restricted zones without needing constant human oversight.
- **Public and Workplace Safety:** Businesses and authorities use feeds to manage crowds, enforce safety rules, and respond quickly to emergencies like fires or accidents.
- **Operational Monitoring:** Companies track workflow, monitor employee productivity, and oversee logistics or manufacturing processes.



Figure-3: CCTV surveillance.

A home CCTV (closed-circuit television) system works by using strategically placed cameras to capture light, convert it into video signals, and transmit those signals to a recording device or your phone.

How the Process Works

- **Capturing Light:** The camera lens focuses incoming light onto an internal image sensor (like a CMOS or CCD chip).
- **Converting Signals:** The sensor turns that light into electronic or digital video data.
- **Transmission:** The video travels from the camera to a storage hub either through physical cables (like Ethernet or coaxial cables) or via your home Wi-Fi network.
- **Processing and Recording:** A Digital Video Recorder (DVR) or Network Video Recorder (NVR) receives, compresses, and saves the footage onto a hard drive, solid-state drive (SSD), or secure cloud storage.
- **Viewing and Alerts:** You can view live or recorded video through a connected monitor or an app on your smartphone. Many systems also feature motion detection that sends instant push notifications to your phone when activity is detected.

CCTV in **chemistry** primarily refers to the application of computer vision and video monitoring to track chemical reactions, kinetics, and laboratory safety.

Computer Vision for Reaction Monitoring

- **Kinetics Tracking:** Researchers use standard digital cameras and computer vision algorithms to turn everyday visual changes—like colour shifts, precipitation, and mixing patterns—into quantitative kinetic data.
- **Process Analysis:** This chemistry-agnostic approach allows scientists to monitor bulk chemical processes across various scales cheaply without needing complex standalone spectrometers for every basic visual phase.

Safety and Autonomous Laboratories

- **Self-Driving Labs:** Systems like "Chemist Eye" use camera stations and visual language models to monitor robotic and autonomous chemistry labs.
- **Hazard Detection:** These camera networks watch for safety violations, such as workers failing to wear proper personal protective equipment (PPE), and send immediate accident-prevention alerts.

The **physics** of Closed-Circuit Television (CCTV) relies on geometrical optics, the photoelectric effect, and solid-state electronics to capture, focus, and convert light into viewable video signals.

1. Light and Geometrical Optics (The Lens)

- **Refraction:** Light rays reflecting off a target object pass through the camera lens, which uses a convex glass or plastic element to bend (refract) the light waves.
- **Image Formation:** The lens converges these light rays to a specific focal point, projecting a real, inverted image onto the digital image sensor inside the camera.

- **Aperture and Depth of Field:** The physical opening (aperture) controls the volume of light entering the camera. A wider aperture lets in more light for dim environments but narrows the depth of focus.

The Photoelectric Effect (The Sensor)

- **Photon-to-Electron Conversion:** Modern CCTV sensors use Charge-Coupled Devices (CCD) or Complementary Metal-Oxide-Semiconductor (CMOS) technology. These operate on Einstein's photoelectric effect, where incoming light photons strike a silicon-based pixel array and knock free electrons loose.
- **Charge Proportionality:** The number of free electrons accumulated in a specific pixel is directly proportional to the light intensity of that part of the image.
- **Colour Filtering:** Colour cameras overlay microscopic red, green, and blue (RGB) mosaic filters on top of the pixel grid to split light spectrums into discrete colour channels.

3. Signal Processing and Noise

- **Charge Transfer:** Voltage pulses systematically shift and transfer the accumulated electron charges across the pixel grid to a read-out amplifier, converting spatial light data into continuous electrical voltage (video signals).
 - **Thermal Noise:** Ambient heat energy above absolute zero generates unwanted thermal electrons. This random "noise" doubles roughly every 3°C increase, degrading surveillance clarity in low-light environments.
 - **Infrared (IR) Physics:** To see in total darkness, monochrome CCTV cameras use complementary near-infrared illuminators (wavelengths >700 nm), reflecting invisible light waves back to silicon sensors that remain sensitive outside the human visual spectrum.
- CCTV camera prices in India range from ₹1,000 to ₹8,000+ per individual unit, while full multi-camera security kits cost between ₹10,000 and ₹30,000+.

Price Breakdown by Camera Type

- Analog & Basic HD Cameras: ₹1,000 – ₹3,000 per unit (Entry-level wired systems).
 - Wireless / Wi-Fi PTZ Cameras: ₹2,000 – ₹5,000 per unit (Popular plug-and-play indoor/outdoor options like CP Plus or Ezviz).
 - 4G SIM & Solar Outdoor Cameras: ₹3,800 – ₹7,000 per unit (For remote locations without fixed Wi-Fi).
 - AI & High-Security IP Cameras: ₹6,000 – ₹20,000+ per unit (Advanced tracking and 4K resolution).
- Additional System & Installation Costs**
- DVR / NVR Unit: ₹3,000 – ₹8,000 (Required for wired multi-camera setups).
 - Hard Disk Storage (1TB/2TB): ₹3,000 – ₹6,000.
 - Installation Charges: ₹500 – ₹1,000 per camera unit.
 - Cabling & Power Supplies: ₹500 – ₹1,000 per camera.

CONCLUSION

Closed-circuit television (CCTV), also known as video surveillance, is the use of closed-circuit television cameras to transmit a signal to a specific place on a limited set of monitors. A closed-circuit television

(CCTV) system uses video cameras to transmit signals to a specific, limited set of monitors for property monitoring and crime deterrence.

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