

Jan Artymiuk*, Knut Aashamar**

IP BASED CCTV IN DRILLING

1. WORLDWIDE CAMERA MARKET

Digital photography has changed the world of photography. The same change is expected for CCTV (Closed Circuit TV) (Fig. 1).

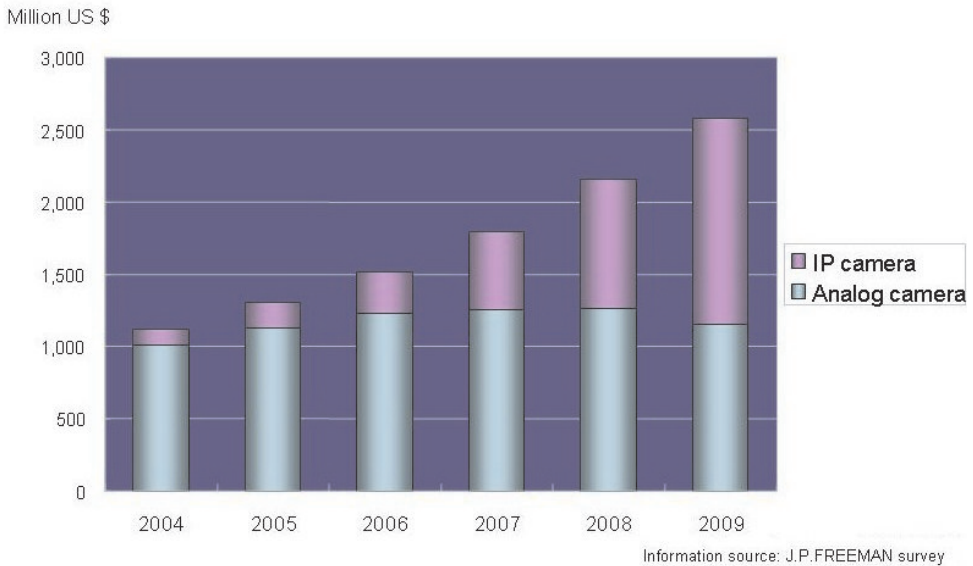


Fig. 1. The graph above shows the expected change in CCTV camera sale from analog to digital systems

* AGH University of Science and Technology, Krakow

** Network, HMI & Process Control Systems, Aker Kvaerner MH, Dvergsnes, N-4604 Kristiansand, Norway

2. DIGITAL CCTV CAMERA TECHNOLOGY

2.1. CCD camera chip development

CCD (Charge Coupled Devices) has revolutionized camera technology [7]. There are two developments that are easily recognized:

- 1) Number of pixels.
- 2) Dynamic range.

The number of pixels gives the maximum resolution of the picture. A normal CCTV picture is viewed on a digital screen is viewed in a resolution of 640×480 pixels. This is the same resolution as a normal DVD film will give. For a film with 25 pictures per second, this is acceptable. However, when still pictures are grabbed and presented, it may look a bit grainy.

In order to improve the picture, a higher resolution CCD chip can be used. Most manufacturers are now using 1,3 MegaPixels in their new cameras. There are two advantages:

- 1) the pictures are sharper,
- 2) you can zoom in the picture (e.g. recognize number plates of cars) (Fig. 2).



(picture from IQinVision)

Fig. 2. The disadvantage is of course that you need more disk space in order to save the CCTV pictures on the hard disk

2.2. CCD size

The number of pixels gives the resolution. In still digital photography, 6 to 8 MegaPixels are the norm for consumer type of cameras, while the newest cameras have 12 MegaPixels (Fig. 3).



Fig. 3. Mega Pixel camera gives improved resolution

For CCTV cameras, the norm is now going to 1,3 MegaPixels. However, for special purposes CCTV cameras with 10 MegaPixels are available.

The Table 1 shows the relations between CCD size in MegaPixel, the maximum resolution and the number of pictures per second that is transferred from a typical camera range.

Table 1
The relations between CCD size in MegaPixel

CCD size (MegaPixel)	CCTV picture resolution	Frames per second
400 to 800 kP	720 x 576	25
1,3 MP	1280 x 1024	25
2 MP	1600 x 1200	25
3,1 MP	2048 x 1356	12
5 MP	2592 x 1944	10

The frames per second are a typical value today (2008). The development of CCD chips will increase the transfer speed from the camera and thus increase the number of frames per second.

Dynamic range

Not many years ago, CCTV cameras were easily overloaded from a strong light source. When looking out of a room, everything outside was white and you could see inside, alternatively you could see outside but everything inside was black. The newest technology here has changed that completely. Panasonic for example, has a pixel based 160× dynamic range. This gives a more natural contrast regardless of the subject. This is done by changing the shutter speed of EACH pixel, from 1/8000 second for bright areas to 1/50 second for dark areas.

In addition a new technology for reducing the difference between dark and light areas is being developed. Panasonic calls this technology for “adaptive black stretch” (Fig. 4).



Fig. 4. This is an example of adaptive black stretch

CCTV picture transfer

The standard for transferring pictures from a CCTV camera to the user has been:

- JPEG standard for still pictures,
- MPEG standard for streaming.

The JPEG standard is a still picture standard that was developed for still picture cameras. The JPEG standard is a “no loss” compression of the CCD picture (raw) picture data.

The MPEG standard is a moving picture (i.e. film) standard (see references) [6]. The idea behind MPEG compression is to transmit the changes in a frame to the next, rather than to send the whole picture. This reduces the amount of data transmitted, however it is not very good for making still pictures. The main standards are MPEG2 and MPEG4. The MPEG2 is the oldest, and gives the best quality. You pay by having increased bit rate, up to as much as 16 Mbit/s. The MPEG4 is a newer standard with more complicated algorithm. The quality is DVD standard and the bit rate is usually less than 3 Mbit/s.

Most IP based CCTV cameras are now dual stream cameras. They transmit both JPEG pictures and MPEG4 streams. The JPEG is used for storing while MPEG4 is used for viewing.

3. DRILLING CCTV NETWORKS

The purpose of the CCTV system in drilling is [1, 3]:

- give safe operation of drilling equipment,
- give the driller a view of the operation being performed,

- give the driller a view of the area where he is operating,
- record operation for training purpose,
- record operation in order to analyze safety of operations,
- record and view incidents,
- record operation details in order to document for third parties.

Safety

The main object of the CCTV system is to improve safety, for personnel and for equipment. The view from the driller's position can always be improved. Examples are views of fingerboards, drawwork drum and roughneck.

The safety on rigs has reduced the number of people working in noisy areas, such as shale shaker rooms, mud pump room and close to hydraulic power units. By using CCTV cameras these areas can be monitored without having personnel in the area.

During normal operation, incidents may happen. The recording of the CCTV will then give valuable information to exactly what has happened.

Training

The recording of operations is very useful in training of personnel. This training effect is improved when the CCTV recording is coupled with the drilling control system recording. The effect on control signals will then be presented directly.

Commissioning

When commissioning a drilling system, a large number of parameters need to be set. By recording the CCTV pictures together with the new settings, the rig can be tuned for optimal performance.

Recording system

Recording is done using hard disk on the CCTV server (Fig. 5). JPEG is the best format for storage. Normally all cameras are recorded. The number of frames per second recorded by the server may be adjusted. Normally the number of frames recorded is depending on movement in the picture. If it is movement in the picture, a high frame rate of for example 10 frames per second, will be recorded. If there is no movement in the picture (e.g. from mud pump room), then only 1 frame per second will be recorded. For most systems, the change from low frame rate (no movement) to high frame rate is started some seconds before the movement in the picture occurs. This means that if there is a door in the picture, fast storage starts before the door is opened.

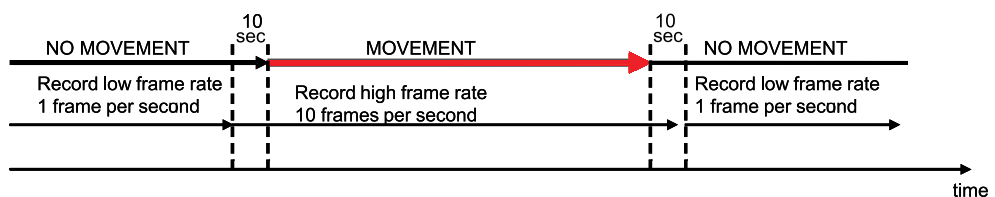


Fig. 5. Example of recording system

A large CCTV system will have hard disk capacity of some Terabyte. A very large system with MegaPixels cameras may have towards 1000 Terabyte (1 PetaByte).

CCTV user Operation

For larger CCTV systems the CCTV user (viewer) is normally interfaced to the CCTV sever, not directly to the cameras. The CCTV server manages the cameras and the users and has a login script with user name and a password (Fig. 6).

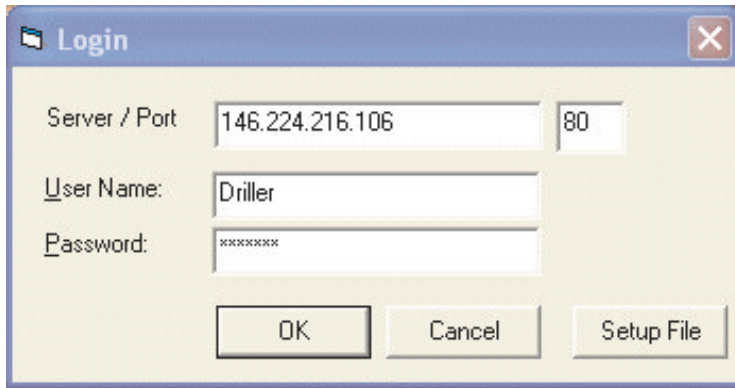


Fig. 6. Example window login with name and password

CCTV server software

The CCTV user is interfaced shown below is a typical CCTV viewer application. With all IP CCTV cameras there will be a software package with administration software and with CCTV viewer software. Most of these single camera software are based on Windows Explorer. This is acceptable for single camera applications. For larger systems, dedicated software is required.

There are a number of large specialized software packages available. The Aker Kvaerner MH CCTV system uses Milestone Enterprise software package. XProtect supports more than 400 different IP cameras, encoders and selected DVRs from 35 manufacturers [4, 5].

CCTV Viewer

The CCTV viewer is the application software used by the CCTV viewer. The AKMH Viewer picture is shown above (Fig. 7) [2]. More than one viewer can be active simultaneously.

1. Live Indicator. A green flashing light means the camera is online; you are viewing Live Video.
2. Button for Hiding/Showing the CCTV Controls. Click once and all the controls on the left side will disappear (the picture will cover the CCTV window completely), click once more for showing the controls.
3. Camera List, Click for selecting.

4. Buttons for Zoom in (+) and Zoom out (-). One zoom level per click.
5. Buttons for Pan and Tilt functions. Click on the buttons for moving the cameras in directions indicated by the arrows. Use “H”-button for moving to “Home”-position; you can define a separate preset position called “Home”.
6. Preset List, click for selecting.

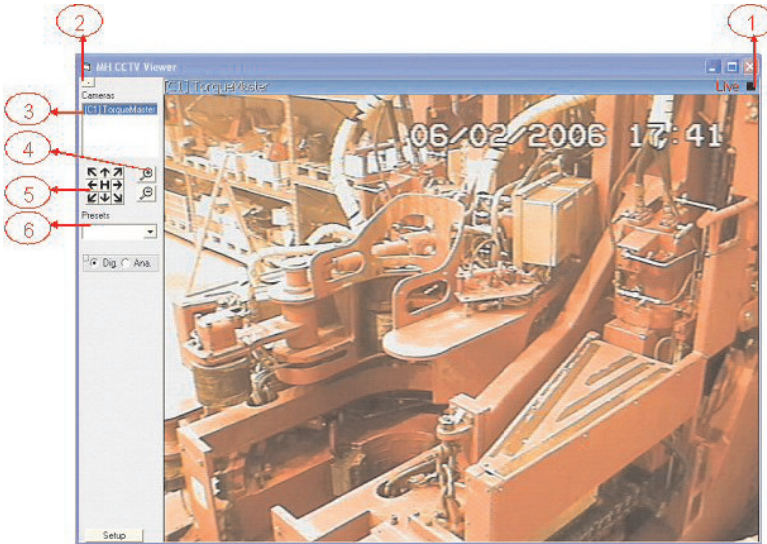


Fig. 7. Remote control TorqueMaster of Automatic Roughneck
1–6 – see text

4. NETWORK

The CCTV network for an IP network will be LAN (Local Area Network). Care should be taken with larger nets, due to the amount of data that may be carried. Network management is normally required for larger nets (Fig. 8).

For a large drilling site, there may be a number of LAN, for drilling, operator, 3rd parties, power control etc. These LAN's will normally be group in a VLAN Each LAN in a VLAN can have a dedicated data streams [8]. For example a Gigabit network can be divided into 5×200 Mbit VLANs.

Transmission from site

The transfer of real time data from a drilling site to the company headquarter is not always easy. The main transmission methods used can be:

- Satellite,
- Radio link,
- Fiber optical communication,
- Rented broadband,
- 3G or GSM (mobile communication).

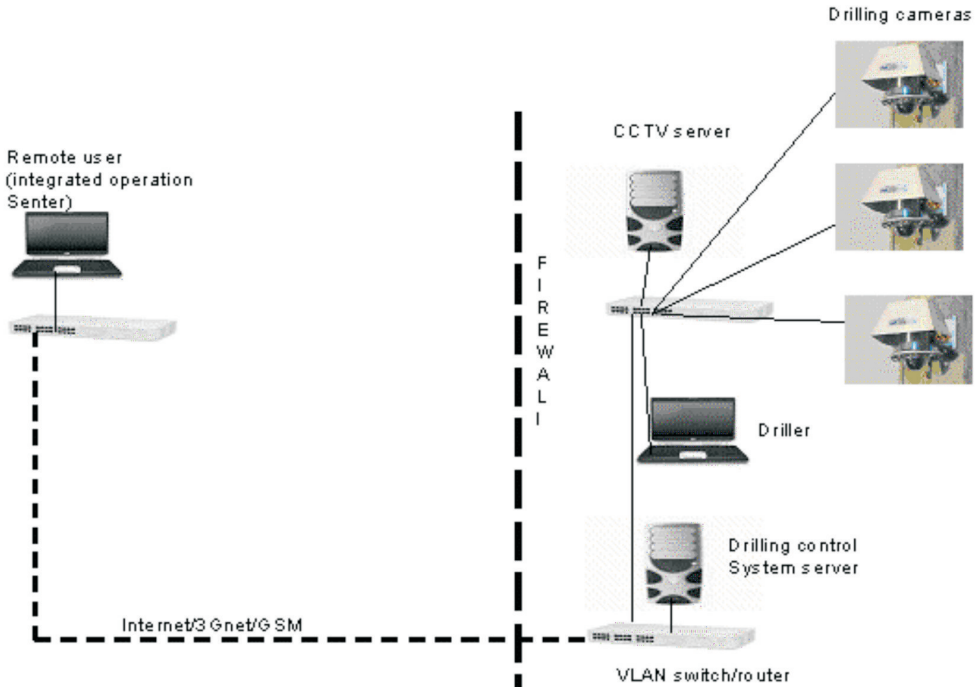


Fig. 8. Example of recording system with analog and digital

The data rate capacity will vary from a few kBit/s (GSM) to Gigabit/s (fiber). The smaller the bandwidth, the tougher is the priority.

Using advanced CCTV software, the data rate for transfer of pictures can be reduced. The method of CCTV reduction mainly used is:

- hard JPEG compression,
- reduce number of frames per second (or per minute),
- setting priority on traffic,
- store and forward.

Integrated operation

Integrated Operation (IO) is to use real time data and new technology in order to remove the boundaries between operators, companies and 3rd parties. Normally it involves transferring real time data from a drilling site to a remote site, for example drilling company headquarter.

CCTV pictures are an important part of integrated operation. Without the simultaneously transfer of operational control data and CCTV pictures, the main advantages of integrated operation is lost.

The main advantages are:

- improved safety,
- more effective drilling operations,

- better placing of wells,
- optimization of production,
- improved surveillance of equipment and site.

Integrated operation will change the way of operating a drilling rig. The support of experts at the drilling operator headquarter, or a drilling equipment manufacturer, will be available at a short notice. Remote fault diagnostics of equipment is a normal situation when data communication between drilling site and drilling equipment manufacturer is available. On some rigs a wireless IP camera (e.g. VisiWear) is available for remote inspection of equipment on the rig.

5. CONCLUSION

IP CCTV is increasingly being used in drilling operation. With new MegaPixel cameras the picture resolution is improved and new CCD picture device gives improved dynamic range. Modern PC's (servers) with Terabyte hard disks gives easy storage of large data streams. Transmission of real time CCTV pictures and real time drilling data for integrated operations is changing the way drilling installations are operated and maintained.

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