

The principles of CCTV design in VideoCAD

Part I Camera view area

Edition for VideoCAD 7

S. Utochkin

Effectiveness of CCTV systems, constructed even with the application of the best equipment, is substantially determined by qualification of these systems' designers.

The project is the first stage of video surveillance system creation. The current arrangement of cameras in the project isn't satisfactory any more, because it demands frequent rearrangements and replacements of lenses after installation is done.

Professionally developed project should contain the information about what and how detailed each video camera will cover and which areas it will control.

VideoCAD software facilitates the process of professional CCTV system design. Actually, the software allows creation of projects at qualitatively new level inaccessible without its application, and within a shorter period of time.

However, like any multipurpose tool, VideoCAD requires certain efforts and time at initial studying. This article helps beginners and skilled experts, unfamiliar with the VideoCAD to manage it faster.

Table of contents

<u>Modeling Camera view area</u>	2
<u>Camera view area</u>	2
<u>Projections of view area</u>	2
<u>Camera positions</u>	5
<u>Program operation</u>	7
<u>Navigation in the Graphics window</u>	7
<u>Tools in Graphics window</u>	7
<u>Creation of a project</u>	8
<u>Saving the project</u>	8
<u>Opening the project</u>	8
<u>Setting projection visibility</u>	8
<u>Loading a background</u>	8
<u>Presetting camera parameters</u>	10
<u>Placement of the camera on a plan</u>	10
<u>Three-dimensional model of image from the camera</u>	12
<u>Copying cameras</u>	13
<u>Active camera</u>	14
<u>Arrangement of cameras</u>	14
<u>Completion of the project</u>	15
<u>Conclusion</u>	16

Modeling Camera view area

Before starting to work with this program, it is necessary to specify modeling **camera view area** in VideoCAD.

Camera view area

View area is a three-dimensional geometrical pyramid-shaped figure (a convex tetrahedral angle) with the vertex, starting from a camera lens. All objects (or parts of objects) inside the pyramid will be visible on the screen, when **it is not shaded by other objects on the scene**. The objects outside the pyramid will not be visible.

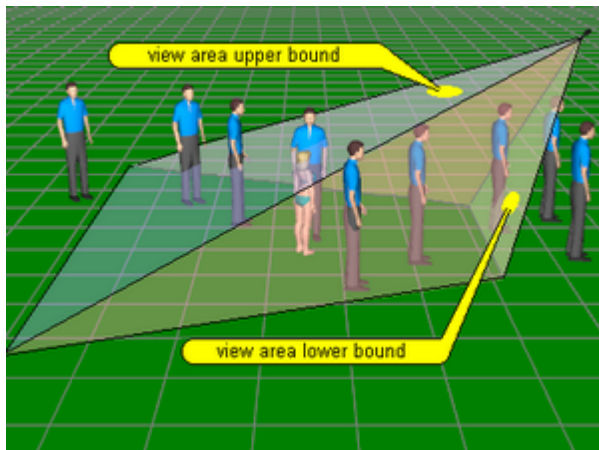


Fig. 1. Camera view area. Side view.

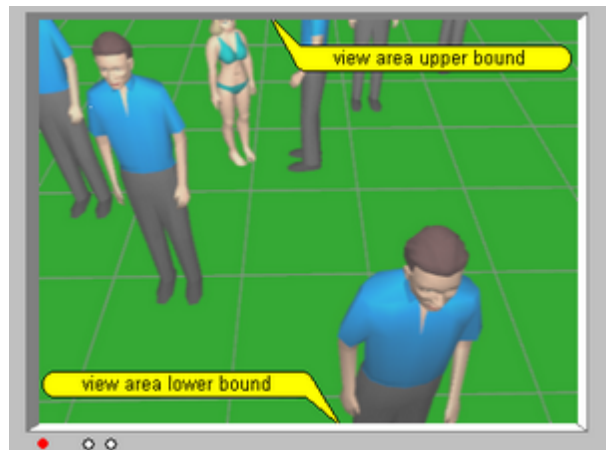


Fig. 2. Image on the screen from the same camera.

View area can be infinite or limited by ground and other objects. Angles between view area faces are calculated in VideoCAD automatically on the base of **lens focal length** and **image sensor format**.

Thus, having set a lens focal length and image sensor format, we completely determine the form and the size of view area.

Let's name the top side of this pyramid, which corresponds to the top image border on the screen "**view area upper bound**". The bottom side of the pyramid, which corresponds to the bottom border of the screen we will name "**view area lower bound**" (Fig. 1, Fig. 2).

Projections of view area

It's much more convenient and quick to design CCTV systems in two-dimensional space, than in three-dimensional one. This, probably, explains why the 3D design software in video surveillance is not used much and why the view area was modeled in the form of a triangle or a rectangle.

*Thus, it is necessary to model a view area **in the form of a two-dimensional figure** and it is quite easy to do.*

In VideoCAD we can get **horizontal and vertical projections of a view area**. However in design process the **horizontal projection**, i.e. projection on location plan, is more often used.

Let's consider the most common case of camera installation:

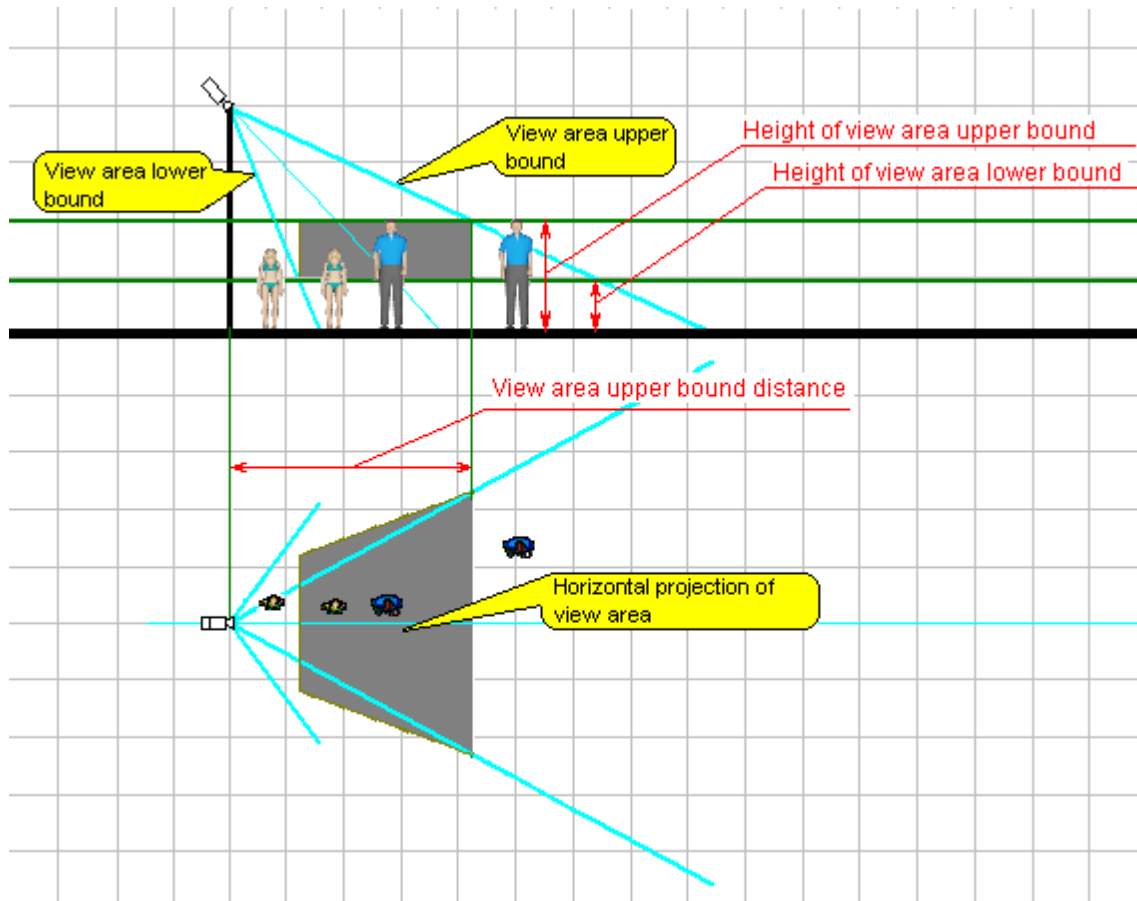


Fig. 3. Camera view area projections.

As a rule, we are not interested in the whole view area, but only in **its part in the certain range of heights**. If project obtained section of the pyramid in the specified range of heights on a horizontal plane, we'll get a **horizontal projection of the view area**.

Horizontal projection of a view area in VideoCAD is determined by the following **key parameters**:

- **Height of view area upper bound;**
- **Height of view area lower bound;**
- **View area upper bound distance.**

On the **Fig. 3** we can see the meaning of the following parameters: **Height of view area upper bound** and **Height of view area lower bound**. Changing values of these heights, we'll get different sizes of projection, and **any object, which is at the height between these bounds, and on a horizontal plane within the limits of horizontal projection of view area will be visible on the screen, when it is not shaded by other objects on the scene.**

*For example, if we are interested in people surveillance, who are not trying to hide from surveillance, it is enough to set **1 m. View area lower bound** and **2 m. Height of view area upper bound**. If crawling crossing of the controlled area is possible, then the lower bound should be lowered to zero. If surveillance over trucks is necessary, the height of the upper bound should be lifted up to height of a truck.*

The last parameter which we should determine is the **View area upper bound distance**. From **Fig. 3** we can see, that this is the **projection on the horizontal plane of the distance from the camera to the intersection of View area upper bound with Height of view area upper bound** which we have set earlier.

Though the view area can be infinite, as a rule, we are interested in surveillance not only in a range of heights from the lower bound up to the upper bound of a view area, but also **up to the specified distance**.

This distance is the **View area upper bound distance** in this particular position of camera.

Please, be aware that if the values of **Height of view area upper bound**, **View area upper bound distance** and **installation height of camera** are specified, then the position of the camera which is optimal for surveillance up to the specified height and specified distance is completely determined (**Fig. 4**). That means that it's not

necessary to introduce any other parameters, for example **angle of slope**. In case of change of the camera inclination, its position will not be optimum for surveillance up to the specified height and up to the specified distance.

Camera position in VideoCAD is not determined by the **Height of installation** and **Angle of slope**, as in others 3D software, but by the **Height of installation, Height of a view area upper bound and View area upper bound distance**. It is much more convenient in practice, as we will see further in this article.

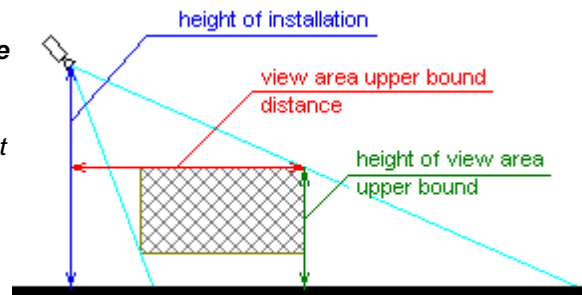


Fig. 4. Definition of the camera position in VideoCAD.

Thus, in order to get the sizes and position of a **view area projection** in relation to a camera, it is necessary to set the following parameters (Fig.3):

- Image sensor format and a lens focal length.
- Height of the camera installation.
- Heights of the upper and the lower bounds of view area.
- View area upper bound distance

VideoCAD will calculate all other parameters of the **view area projection** and will display the projection graphically.

It is very convenient to work with such projections. It is enough to set the initial parameters defined above, to place a camera with a projection of view area to the location plan, and directly on the plan we'll see the area, within which the objects will be visible on the monitor screen.

*Designing in VideoCAD basically consists of creation, placing and editing of **view areas' projections** of cameras. For this purpose there are a lot of convenient tools.*

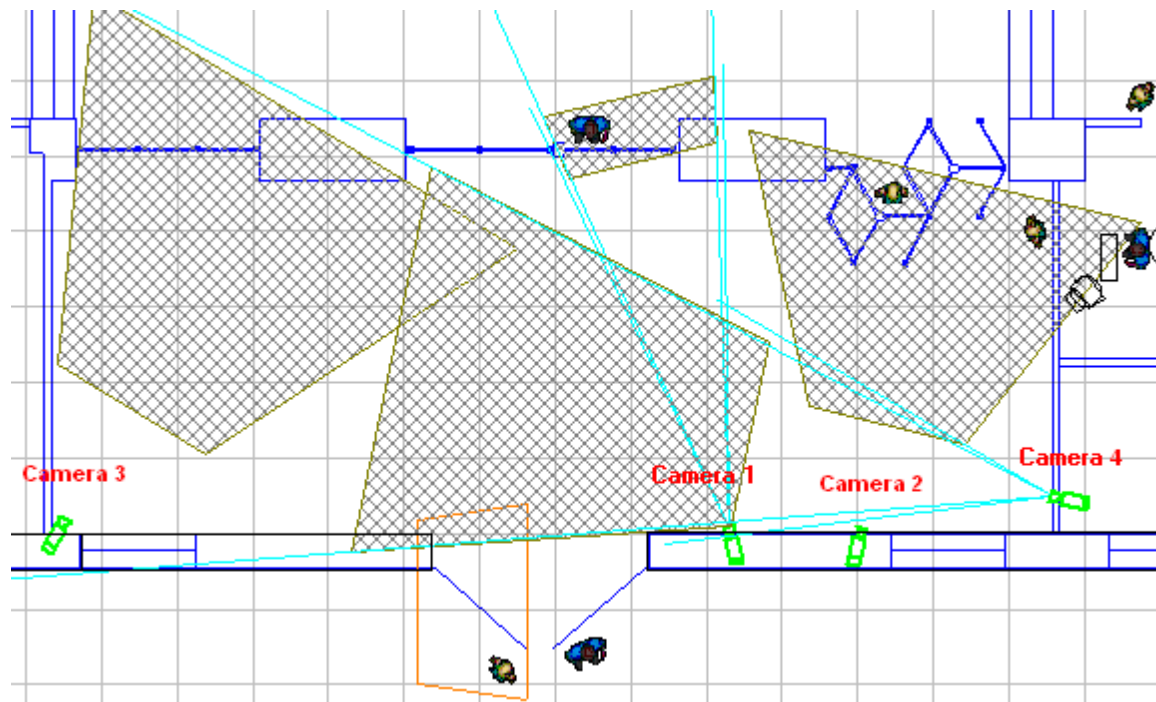


Fig. 5. Layout of view area projections on the location plan.

Camera positions

We have considered only one, the most common camera position. Depending on a ratio of set parameters, there can be **8** such positions on each pointing direction of the camera (from left to the right or from right to the left).

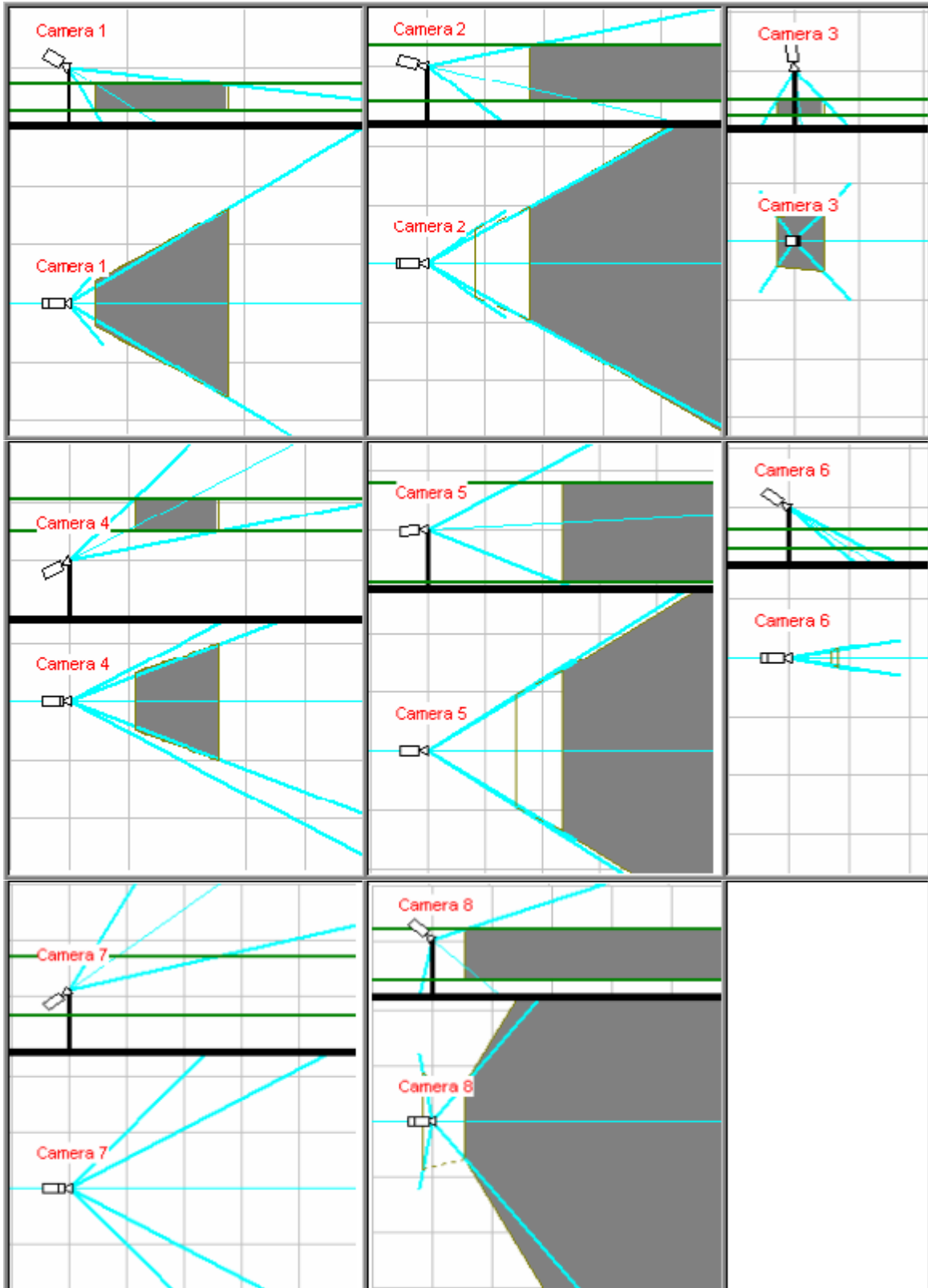


Fig. 6. Possible positions of a camera.

VideoCAD can calculate all positions. In any case an exact position of the camera and a projection are determined by the same parameters, mentioned above. But the meaning of parameters, depending on a camera position, can vary.

Cameras 2, 5, 8 have infinite projection of view area.

Cameras 6 and 7 don't have it at all (obviously, positions of cameras 6 and 7 have no practical sense).

View area upper bound distance of cameras 2 and 8 determines not the end, but the beginning of the view area projection.

Program operation

If you have not installed VideoCAD in your computer yet, do it now.

The order of installation and registration is described in detail in the **ReadMe.txt** file, which is in the archive of the distribution kit of the program.

All instructions are related to the version **VideoCAD 7.0**. If you use earlier version, please update it because the version 7.0 has a lot of new options.

At the first start of the program **Graphics window** is displayed, in which you can see one camera.

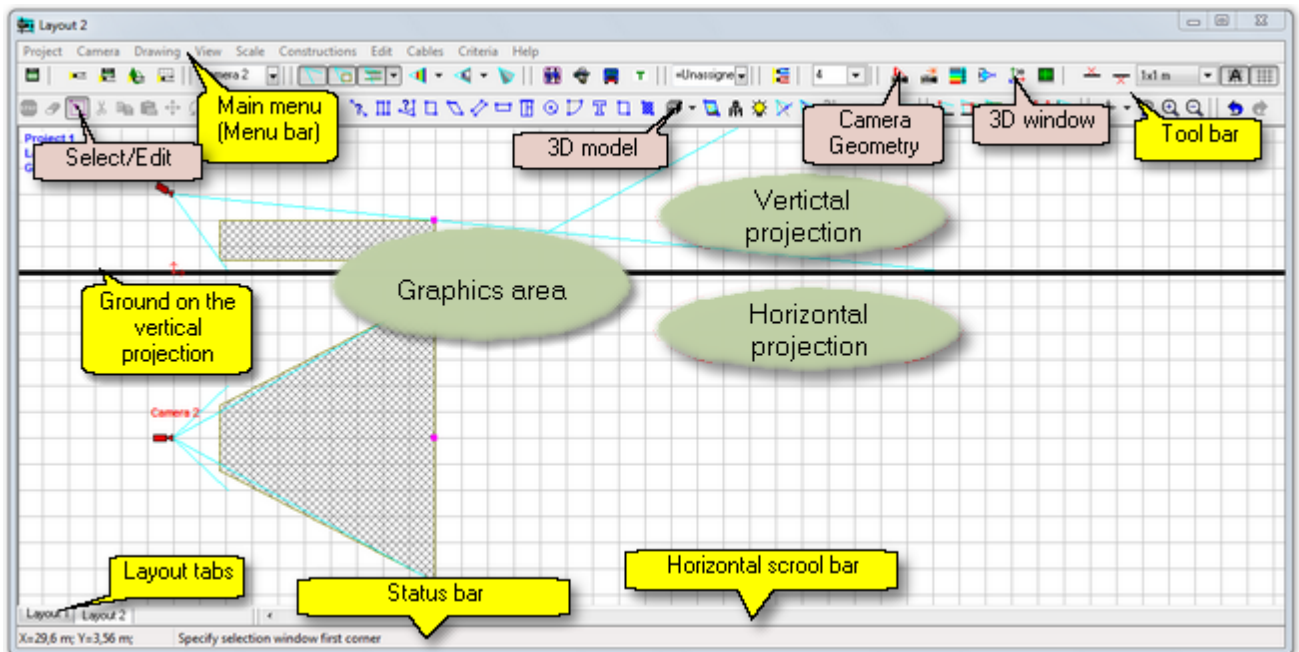
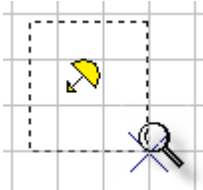


Fig. 7. Graphics window.

Navigation in the Graphics window

A **Wheel mouse** is particularly convenient when working in the **Graphics window**. Using the Wheel mouse you can change a drawing scale with the simultaneous zooming in the drawing sections pointed by the cursor. You can move the drawing by pressing and holding down the **mouse wheel** (or the middle button of it). If **Ctrl** is not pressed, the entire drawing can be dragged; if **Ctrl** is pressed, only the **horizontal projection** can be dragged.



To increase any screen area press in the corner of the area and hold the **right mouse button** then move the mouse with the right button pressed in the diagonal direction. At the same time you will see the **zoom window**. After releasing the button, the area inside the zoom window will be shown on the full screen.

* A regular click of the right mouse button without moving between pressing and release displays the **pop-up menu**, as well as in other programs.

Tools in the Graphics window

VideoCAD has a lot of useful tools for designing. There are more and more of them with every new version. You can get to know the full list and purpose of each tool in **Help system**. To start your work with the VideoCAD it is enough to use only some tools which we'll examine during creation of a simple project.

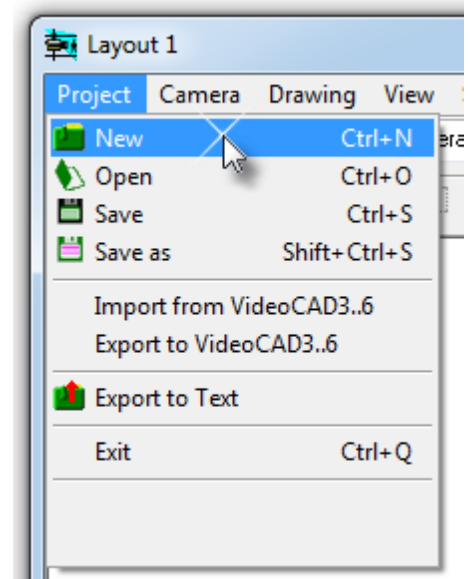
Creation of a project

Create a new project (at the first start of the program a project is created automatically).

Main menu>Project>New

In the dialog box of new project type the new project name and click **OK**.

It is possible to choose the **measurement system** for the new project: **Metric (meters, millimeters)** or **Imperial (feet, inches)**.



* To get the **context help** for any **menu item** select it by mouse and press **F1**

Saving the project

Main menu>Project>Save as


In the appearing dialog box choose a filename and a directory to save it.

Opening the project

To open the earlier saved project, click on the menu item: **Main menu>Project>Open**.

In the appearing dialog box choose a project file and click **Open**.

Setting projection visibility

During creation of this simple project we'll work only with the **horizontal projection**, therefore hide the **vertical projection**, by clicking on the **Hide vertical projection** button  on the **toolbar**.

* To get the **context help** for any button on the toolbar click it by the **right mouse button** and then on the

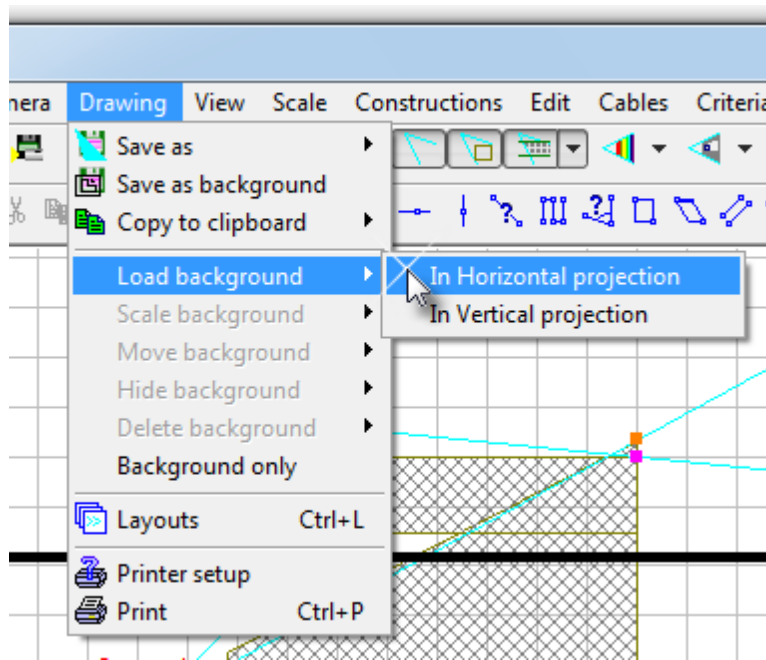


appeared item **What's this?**

Loading background

Though VideoCAD has its own drawing tools, it is more convenient to use the layout, already created in AutoCAD, Visio or in other graphic programs.

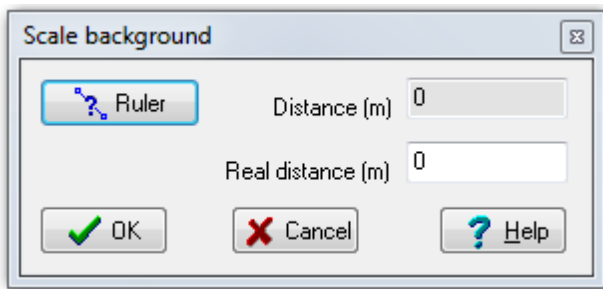
*.bmp, *.jpg, *.gif, *.tif, , *.png *.emf, *.emf+, *.wmf, AutoCAD *.dwg, *.dxf graphic files can be used as a background.



To load a layout of surveillance site as a background, click on the item **Main menu>Drawing>Load background>In Horizontal projection**.

Choose the necessary file in the dialog box and click **Open**.

The background will appear in the horizontal projection along with the **Scale Background** dialog box. Using its tools is necessary to bring an image scale on the background in correspondence with the general VideoCAD scale.



Sequence of actions:

- Click the **Ruler** button.
- Specify by clicking 2 points on the background image, the **distance between which is known to you** (e.g., the length of a building, a wall, etc.). In the **Distance** box the measured distance at the current background scale will appear.
- Enter the **known distance** into the **Real distance** box and click **OK**.

The background will be automatically scaled so that the distance, specified by you, will be equal to the real distance value entered by you.

** To get the **context help** for any window click it and press **F1**. If there is a **Help** button in the window, you can click it..*

** In case of significant change of scale, the background can be displaced and disappear from the screen. Find it, using the mouse.*

So, there is a plan of surveillance object at real scale and one camera on the screen.

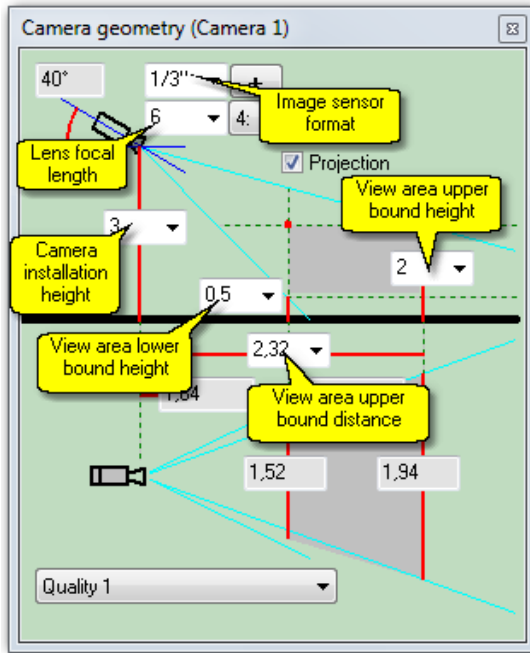
Presetting camera parameters

Click the **Camera Geometry** button .

The **Camera geometry box** appears, in which you can see those parameters about which we read in the first part of the article.

If you move cursor to a box with a parameter, a name of the parameter will be shown.

* To get the context help for any box select it by mouse and press F1



We can change values of parameters only in white boxes. Parameters in grey boxes are calculation results and for now we can do without studying them.

Now we'll set parameters preliminary, subsequently we'll be able to change any parameter for any camera.

The **Image sensor format** can be chosen only out from the list: **1/4"**, **1/3"**, **1/2"**, **2/3"**, and **1"**. Choose a value given in the camera manual in this box.

The most popular formats are **1/4"** (for the mini- and DOME-cameras), **1/3"** (for the better part of cameras) and **1/2"** (for the certain cameras of extended quality).

A **Lens focal length** can be chosen out of the list or typed. Meanwhile it is possible not to change this parameter. We'll choose a focal length later.

Choose from the list or enter from keyboard **Height of installation**. Possible height of installation is determined by room parameters, requirements of vandal-protectability, etc.


For surveillance over people you should set **Height of view area lower bound - 1 m.**, **Height of view area upper bound - 2 m.**


View area upper bound distance is possible not to change yet, we'll do it later.

Fig. 8. Camera geometry box.


Close **Camera geometry** box.

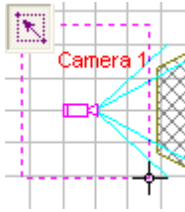
In **Graphics window** on a background of the object's plan you see one camera with a projection of view area, calculated according to the set parameters.

Pay attention to the buttons  on the Toolbar. These buttons switch on and off displaying **View area edges**, **View area projection border lines**, **hatching or filling of view area projection**, **control displaying spatial resolution**, **considering shadows**, **displaying view area in the 3D window** accordingly. Try these buttons in order to see, how they operate.

If the **3D View area** button  is down, these area will be displayed as three dimensional and semi-transparent in the **3D window**. This will allow us to see the camera view area from the outside.

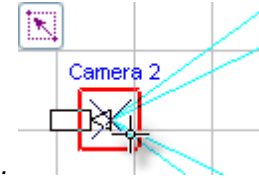
Placement of the camera on layout

Switch to the **Selection mode**, by clicking on the **Select/Edit** button . You can switch to the **Selection mode** by pressing **ESC** key.




Click on the plan near the camera's icon and drag the **selection window** diagonally to enclose the camera's lens. Then click once again. The camera's icon will become lilac - the camera will be **selected**.

* It is similarly possible to select some objects simultaneously, and not only cameras, using the **selection window**.



* It is possible to select one camera, just having click precisely on its lens.

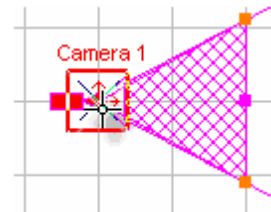
* For more information about various opportunities of selection and removal of selection from objects see the description of the **Select/Edit** button  in the Help system.



* Pay attention to tips, which are displayed on **Status bar** below the window.

* You can stop any operation by the **Stop operation**  button or by the **ESC** key.

To move the loaded camera:

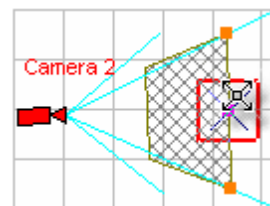
- Select the camera by clicking on its lens;
- Move the cursor to the lens, then press the left mouse button;
- Keeping mouse button pressed, move the selected camera to a new place;
- Release the left mouse button.



For moving any selected objects you can use **Move**  tool. To do this, select the objects, choose the **Move**  button on the **Toolbar**, then specify by clicking initial and final point of moving on the layout.

For tilting and panning the loaded camera on the layout in **Select /edit** mode:

- Move the cursor to the pink grip in the middle of the view area bound. Thereupon, the point will be outlined by red square;
- Click on it by mouse;
- Move the cursor;
- To stop tilting or panning click once again on a point where the middle of the view area bound is to be located.

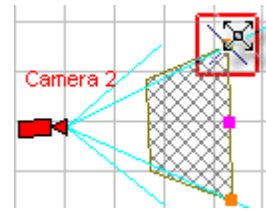



If the projection is too wide or narrow, choose lens focal length. It can be done directly in Graphics window, using the **Focal length** box

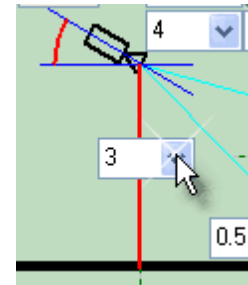


To change lens focal length of the loaded camera on the layout in **Select /edit** mode:

- Move the cursor to any orange grip on the ends of view area bound. Thereupon, the point will be outlined by red square;
- Click on it by mouse;
- Move the cursor;
- To stop changing focal length click Once again on a point where the end of view area bound is to be located.




In order to change **Camera installation height**, **Heights of view area upper and lower bounds** it is more convenient to use **Camera geometry** box, which can be displayed or hidden at any moment by clicking the button .



Use **moving**, **rotating**, changing of the **view area upper bound** and **lens focal length** to locate and adjust the first camera in the optimum way.

Three-dimensional model of image from the camera

It is possible to see 3D model of **image from this camera**.

To get the image click on the **D window** button .

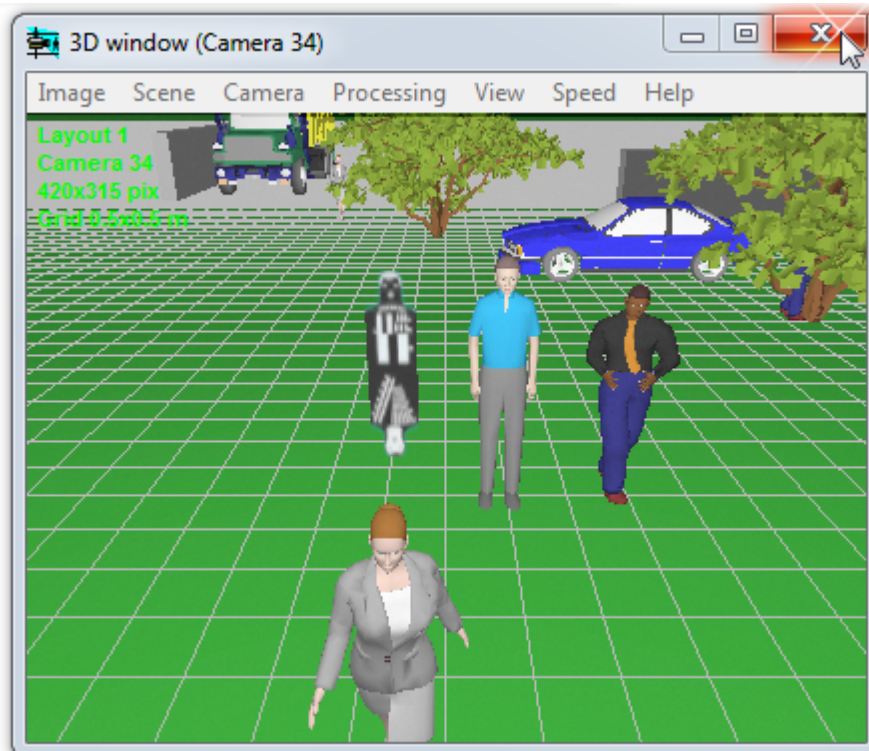
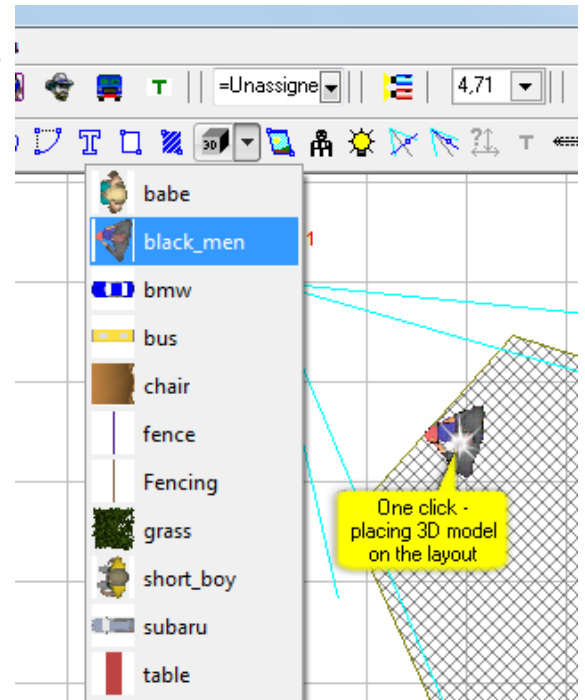



Fig. 9. 3D window.

In order to see, how a person or a car will appear in view area of the camera, click on the **3D model** button on the **Toolbar**, and then click on any point within the limits of **view area projection**.

* Located 3D model is possible to select, move, rotate and copy, as well as the camera.




It is possible to draw walls, windows, doors, various objects in 3D space, using tools from the main menu **Main menu> Constructions>** ... or corresponding buttons  on the **Toolbar**.


Such modeling in VideoCAD is performed as well easy, as in 2D space. You do not need to study complexities of 3D modeling for this purpose!

By double-clicking or right-clicking on the **3D window** you can open the **Image parameter panel**, which allow to obtain an image, that is **very similar to the image from the real camera** taking into account parameters of the scene, possible distortions of real cameras and DVRs.

For more information about this see **Help system**, chapter **3D window**.

Copying cameras

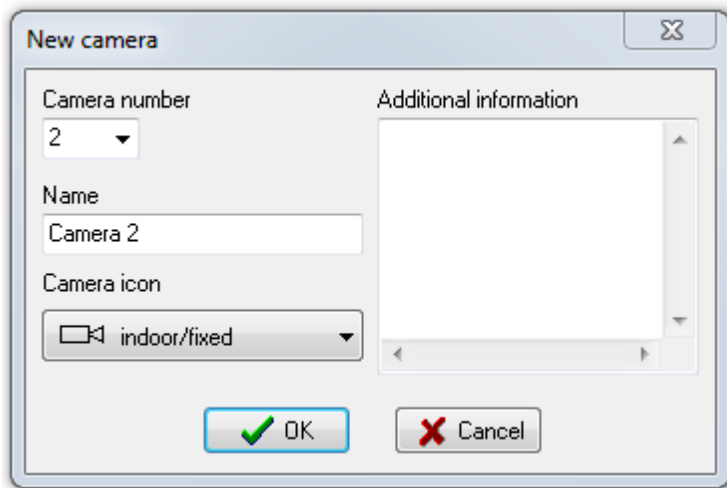
Switch to the **Selection mode**  again and select the only camera by **selection window** or by clicking on its lens.

Click **Copy** button .

The camera will be copied.

Click **Paste** button .

Specify by clicking the place for new camera. **New camera box** will appear. In this box you can change camera name and enter the description for it.



You should not change value in **Camera number** box now. In the **Camera Icon** combo box you can choose an icon for the camera.

Click **OK**.

The exact copy of the first camera will be created on the plan.

Specify by clicking the places for all other cameras in the project, creating new cameras every time.

After creation of all cameras, click on the **Stop operation**  or **Select/Edit**  button.

Active camera

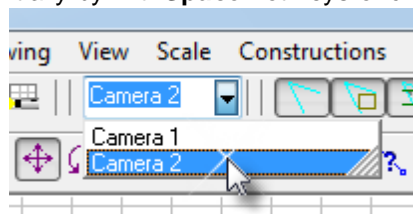
Pay attention, that the icon of the first camera is **red highlighted**, and icons of other cameras are blue. The first camera is **active**. Parameters of **active** camera are displayed in **Camera geometry** box. The image from the **active** camera can be seen in the **3D window**, the **active** camera can be rotated in both planes. You can change lens focal length by moving pink grips on the layout. View of **active** camera view area can be changed by clicking

the buttons .

Other cameras can be moved, rotated, copied, but it is impossible to change **parameters of their view areas**.

In order to **activate** another camera – double click precisely on its lens

- * It is possible to **activate** cameras sequentially by **Alt+Space** hot keys or choose any camera from the **A**



ctive camera combo box on the **Tool bar**.


Arrangement of cameras

Moving cameras, changing their view area parameters, get optimum layout.

If necessary, create new cameras by copying the existing ones. Delete the cameras which became unnecessary.

To delete the camera, select it and click on the **Erase** button  or press **Del** on the keyboard.

- * **Active camera** can not be deleted.

* You can rename, delete, activate cameras from the **list of cameras** which can be displayed by clicking on the **Camera list** button .

Completion of the project

Layout of cameras is ready, all you have to do is to print it out or to export it to any format: *.bmp, *.jpg, *.gif, *.tif, *.png *.emf, *.emf+, *.wmf, AutoCAD *.dwg, *.dxf for further processing.

It is possible to get static and animated **three-dimensional models of images from all cameras** in the project, to get directly on the plan **person detection area, person identification area, vehicle license plate reading area**, taking into account the **image quality** of each camera.

We can show the **control areas** of cameras taking into account shadows arisen from obstacles on the scene.

We can visualize by color spatial resolution and field of view size of cameras inside the view area projections.

We can calculate and model **depth of field** for every camera.

It is possible to specify **scene illumination** and **place illuminators**, then assign **sensitivity and resolution** parameters and obtain image models taking into account these parameters.

It is possible to assign **real camera models** with known parameters to the cameras in the project.

It is possible to get **detailed adjustable table** with all parameters of all cameras and export the table to *.txt, *.csv, *.htm, *.rtf, *.xls formats.

It is possible to add **constructions, texts, frame** and **Title-Block** to the layout.

It is possible to get a **text file** with full description of all cameras in the project, which can be later inserted into explanatory note.

It is possible to calculate **length and parameters of signal and power cables** and many others.

Conclusion

In this article we have considered step-by-step creation of a simple project in VideoCAD. Because of limited size of the article we did not cover a lot of useful opportunities. Within the limits of the article one can give only impetus to studying this multipurpose and very useful software, usage of which will allow creating effective video surveillance systems, saving time and considerable funds. All necessary information is available in Help system. In the same place you can find some examples of calculations and a ready project of CCTV system of an office building. You can always receive answers to your questions, having sent us by e-mail.

We wish you every success with your projects!

Continue:

[Part II. Person detection area, person identification area, license plate reading area. Spatial resolution.](#)

[Part III. 3D modeling in VideoCAD.](#)

[Part IV. Illumination and camera sensitivity in CCTV.](#)

[Part V. Video surveillance of moving objects.](#)