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Introduction

Luxriot LPR is an automatic License Plate Recognition application that is designed to work with Luxriot VMS Server. This application accommodates customers with the specific need to detect, recognize and register motor vehicle license plates. Luxriot LPR is ideally suited for vehicle access control applications as well as for traffic control and enforcement applications.

See 'Quick Start' section if you would like to try get LPR running without reading in-depth overview of features and configuration. Otherwise, skip 'Quick Start'.

Software requirements

- Microsoft .NET Framework 3.5 ®
- Luxriot® Client Kit API of version 1.8.3 or higher (Included in Luxriot VMS client install)
- Intel Core i3™ processor equivalent or better.

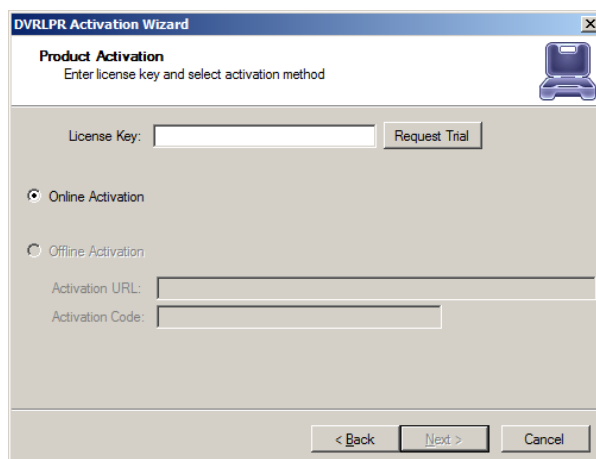
Quick start

1. Install and activate Luxriot Luxriot LPR software.

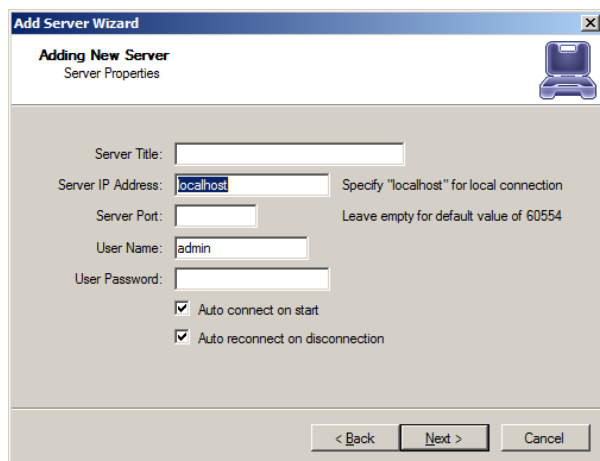
Installation itself is pretty much straight-forward - just follow the setup wizard. After installation, if you are running software for the first time, you will see an activation wizard appear - it is used to activate your LPR copy with a previously obtained licence key or with a trial key, which can be requested for your machine with a press of a 'Request Trial' button (requires internet connection).

Evaluation mode does not impose any limits other than 30 day duration.

Please note that only one trial license key is assigned per single public IP address – this means you will be unable to get two trial keys in a local network with single public IP.



2. Add server(s)

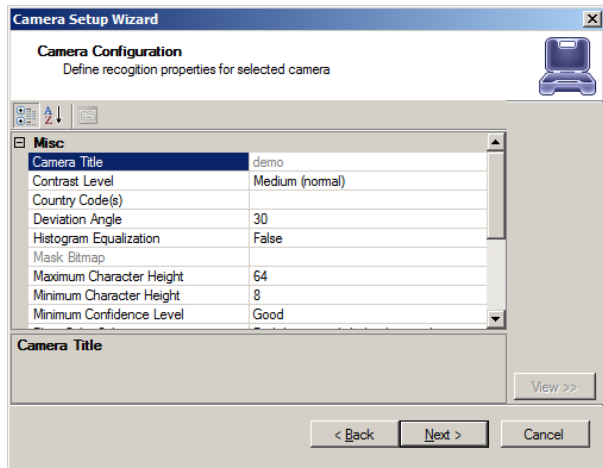
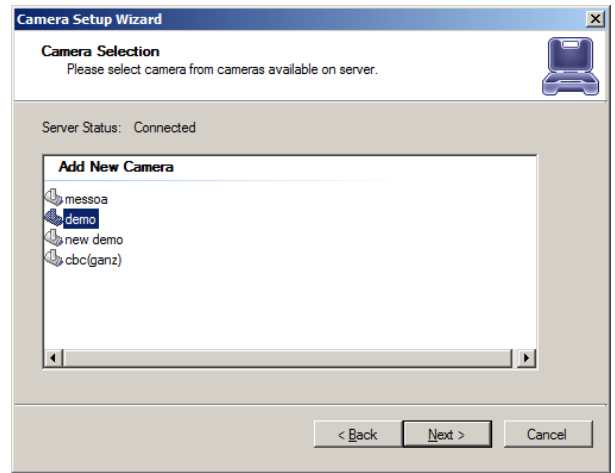


Upon first start after activation, you will be prompted to add a DVR server (if you have DVR client installed on same machine, you will be prompted to import servers configured in DVR client).

Server title: Server name as it appears in list

3. Add camera(s) and create basic configuration

After you have completed server configuration, Camera Setup Wizard will start to assist you with selecting camera to use for plate recognition. In case you don't have cameras where number plates can be seen, it is possible to set up camera emulation on Server using pre-recorded stream. Sample stream file is available at <http://luxriot.com/Downloads/Temp/SANY0011.h264>.

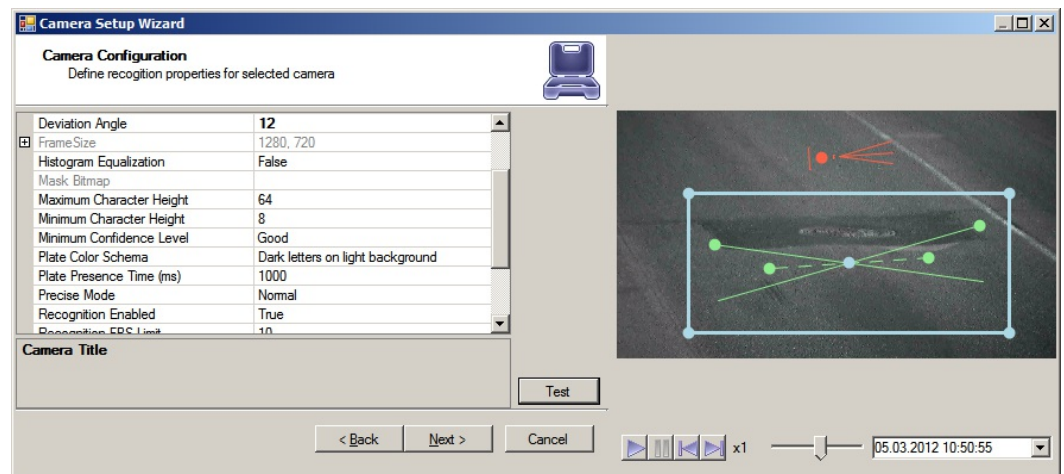


Add camera with default recognition settings first. You will be able to edit it and add more cameras at later time. Please note that by default recognition is turned on, and as soon as software will start receiving video, cpu load will increase a lot and if something is captured, it will be stored to default local database.

It makes sense to turn recognition off when initially adding a camera, and turning it back on after basic configuration is achieved.

After initially adding a camera, right click on the newly added camera in structure pane and go to Camera Setup Wizard again for adjusting actual configuration.

Detailed description of recognition engine parameters can be found below.



Camera setup wizard window consists of two parts - recognition parameter table on the left and parameter preview on the right (enabled by pressing 'View>>' button). Parameter preview is shown using DVR archive data, so you need to have archive recorded for camera you are configuring to be able to use preview. There is no need for continuous archive recording - it is enough to create a small archive record by enabling recording for given camera during one minute or so and disabling recording afterwards.

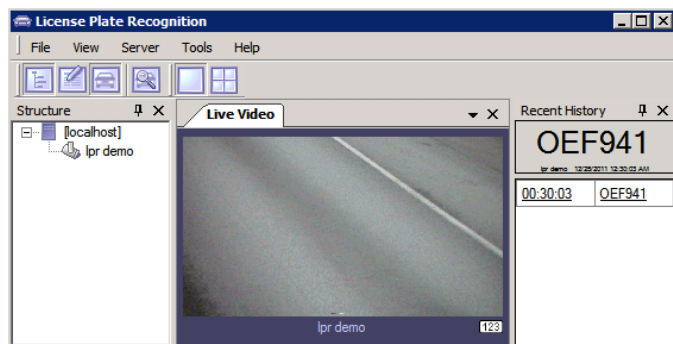
Blue frame defines active recognition area - anything outside this area will not be accounted. Solid green lines define amount of variation in degrees from a base level, which is shown with green dotted line. Orange lines represent allowed visual character size range.

You can seek archive in preview window using navigation buttons to get a video frame with licence plate inside configured recognition area and check if recognition settings are fine with a 'Test' button. Please note that such recognition test is not accurate, as it is testing settings using single frame, while in normal operation LPR uses multiple frames to read licence plate number.

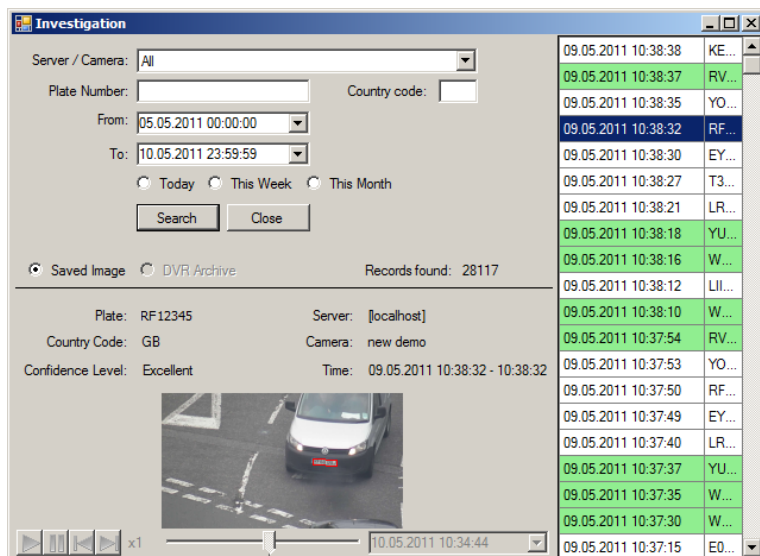
You might have also noticed that non-default recognition engine settings are marked with **bold**

License plate recognition takes a few seconds. If calibration was correct, software will start recognizing licence plate numbers and you will see them appearing in a recent number plates list. Clicking on any number from the recent list will open investigation window positioned on clicked number. Investigation history window is used to browse all recognized number plates and has an extended event viewer with search option.

Main view



Investigation



Investigation window is used to examine and search through recognition data. Upper-left part contains search-related options and lower-left part displays a snapshot of recognized plate, if you have enabled snapshot storage or have a DVR archive for the camera where plate was found for the given time.

Investigation window can be opened from a toolbar (will show all recent entries) or using recent history panel. In latter case investigation will show all entries for a licence plate number, if you click on licence plate number column entry in recent history, or all records until given time if you click on time column entry.

You also can export single entry as a report in jpeg or pdf format using 'Save as' button.

Search for a recognition entry can be issued using a pattern - entering '**AB**' to *Plate Number* field will return licence plates: **AB**001', '001**AB**' and '01**AB**01'.

Select camera name from a drop box to search only for licence plates recognized by given camera.

Specifying country code will return only numbers belonging to specified country (if any).

You can also use special characters in search query - '?' for single unknown character (at most 1) and '*' for multiple unknown characters (at least 0), for example searching for 'AB*3' will return plate numbers 'AB3', 'AB23', 'DDAB23' and 'AB12D12D3', while 'AB?3' will return 'AB23' and 'DDAB23'.

When you enter '**AB**' search is done for '***AB***' and entering '**A?B**' will search for '***A?B***'.

If you have a DVR archive available for the camera, DVR archive radio button (and playback controls after you check it) will be available. Using DVR archive and selecting recognized licence plate from a list on the right will seek archived stream to a time when plate was recognized, draw corresponding frame of the stream and pause it. Red highlighting border will also be drawn to show where licence plate was found. From this point you will be able to playback video from archive to see vehicle passing camera on video.

You can also save investigation snapshots (a still frame where recognized number plate is present, along with information) using 'Save As' button to either pdf or jpeg file. Still frame itself can also be saved.

Configuration

Generally speaking, LPR configuration can be logically divided into parts - recognition engine configuration, database and frame archive configuration and optional advanced configuration. This section describes configuration parameters in detail.

Camera setup notes

Cameras with faster shutter speed are recommended - even if you are receiving quality 1080p video stream at 25fps - with low shutter speed moving objects on single frames will be blurred, despite they look clear to human eye on video playback. Shutter speeds above 1/1000s are preferred.

Physical position of a camera also takes an important role in quality of recognition and amount of computer resources required for analysis. Modern computers are effective in mathematic calculations, and describe everything with equations and logic operations - in turn, describing and processing some abstract actions (like reading characters) using such methods is not an easy task. In another words, finding and reading text for a computer is a lot harder than for a human. Due to this there's high demand on processing power for recognition engine.

Choosing a good place for a camera will give more confident results and will require less processing power. Generally, it is best to place a camera in front of expected vehicle movement direction to minimize relative side speed of licence plate to camera. This allows to shrink active recognition area and licence plate will appear in view for a longer time, which means more frames with visible licence plate will be received by recognition engine for analysis. Also, having more time analysis can be done a bit slower, saving CPU power.

If licence plate number as it appears on video frame is not clearly readable by you, recognition engine will not see it as well.

Recognition engine parameters

Camera Title - can not be changed in current version

Contrast Level - expected contrast of License plate on input images.

Medium - suitable for most cases, since LPR recognition algorithm is adaptive to different lighting conditions.

Low - low contrast.

High - high contrast

Country Code - the ISO 3166 two character country code, where LP was issued (Latvia - LV, Germany - DE, USA - US).

Number plates from following countries are supported:

- | | | | |
|-------------------------------|------------------|--------------------|-----------------------|
| • Argentina (AR) | • Denmark (DK) | • South Korea (KR) | • Slovenia (SL) |
| • Australia (AU) | • Estonia (EE) | • Latvia (LV) | • South Africa (SA) |
| • Austria (AT) | • Finland (FN) | • Lithuania (LT) | • Singapore (SG) |
| • Belgium (BE) | • France (FR) | • Malaysia (MY) | • Slovakia (SK) |
| • Bosnia and Herzegovina (BA) | • Germany (DE) | • New Zealand (NZ) | • Spain (ES) |
| • Brazil (BR) | • Georgia (GE) | • Netherlands (NL) | • Sweden (SE) |
| • Brunei (BN) | • Hungary (HU) | • Norway (NO) | • Switzerland (CH) |
| • Bulgaria (BG) | • India (IN) | • Philippines (PH) | • Taiwan (TN) |
| • Chile (CL) | • Indonesia (ID) | • Poland (PL) | • Turkey (TR) |
| • Columbia (CO) | • Israel (IL) | • Portugal (PT) | • Ukraine (UA) |
| • Croatia (HR) | • Italy (IT) | • Romania (RO) | • United Kingdom (GB) |
| • Czech Republic (CZ) | • Kuwait (KW) | • Russia (RU) | • United States (US) |
| | | • Serbia (RS) | • Vietnam (VN) |

More countries will be added in future.

Deviation Angle - This parameter describes expected amount of variation in number plate position relative to horizontal level. Minimizing deviation angle improves recognition performance, since less data has to be processed. It is best used in combination with Rotation Angle parameter, which sets constant adjustment angle that is applied to picture to make it appear as horizontally levelled to recognition engine. Deviation parameter can be used more efficiently from this point. Shown with solid green line on preview. Smaller deviation angle - less load.

Histogram Equalization - This controls whether the contrast adjustment pre-processing should be applied. Increases CPU load and recognition precision. Please leave it as **False**

Mask Bitmap - Not implemented in current version

Minimum/Maximum Character Height - Minimal and maximal expected visual size of characters on license plate, as it appears in video. These parameters are represented with orange lines in visual configuration.

Plate colour schema - Instructs LPR to look for number plates with either dark characters on bright background, or bright characters on dark background.

Plate Presence Time (ms) - To be detected, number plates should be seen in at least half of frames during this time. Increasing this value makes recognition more accurate, but don't set it too high, otherwise licence plate numbers from faster moving cars will be ignored, due to insufficient presence in view. Setting this too low might cause number plates to be detected more than once - if presence time is set to 200 ms and vehicle is moving by at slow speed, during it's (for example) 700ms presence time there might be two successful recognitions (200ms each) with minor difference in some single character.

Efficient setting also depends on FPS, some examples can be found [below](#).

For detecting numbers in short amount of time, for example if cars are moving past camera at high speed, Recognition FPS must be increased. If recognition is running at 7 frames per second and Presence Time is set to 300-400ms frames per second, recognition will only get 2-3 frames during this time and result will not be accurate. If cars are in view for a short time, decrease Plate Presence Time and increase Recognition FPS. If cars are in view for longer time, it's better to increase Plate Presence Time and reduce Recognition FPS (if necessary).

Precise mode - Possible values are:

PM_Normal - for video mode and images with normal quality without noise and blurring.

PM_Mode1 - for noised and night images.

PM_Mode2 - for noised and night images captured with motion blur effect.

PM_Night - for night images captured with IR illumination.

Recognition Enabled - Enable/Disable recognition. this can also be toggled from camera context menu in structure pane
When recognition is enabled, [123] icon is displayed under video stream.

Recognition FPS - Desired processing rate of the video stream. Analysing more frames gives more reliable result but also consumes more CPU. Good setting depends on quality of received video stream and on speed at which cars are moving. If numbers are not seen very well on video or cars are moving fast it's recommended to increase this setting. For 25 fps stream fine settings would be 7 or 13 fps, for even omitting of excessive frames - $25/2 = 12.5$ (13 fps, every second frame analysed); $25/4 = 6.25$ (7 fps, every fourth frame is analysed).

Rotate Angle - indicates whether the source image should be rotated by specified angle in degrees to be horizontally levelled. Effects CPU consumption and recognition precision. Shown with dotted green line on preview

Save Image - This feature enables storage of still frames containing recognized licence plates. As of version 1.4.0 images are saved to a filesystem by default, but will be retrieved from a database as well, if found. You still can configure LPR to store images to database, but we surely do not recommend doing so. It is also possible to disable image storage at all and use DVR archive to display frames containing recognized licence plates, however in this case viewing of snapshots will be limited to DVR archive duration.

Scan Rectangle - The scan rectangle defines the active area within the image, where recognition takes place. Area outside rectangle will not be processed. On the image below we show the scan rectangle, which covers reasonable range of possible licence plate positions. Effects CPU load, recognition precision and speed. Smaller rectangle - less load.

Example timing/fps settings

Though these settings highly depend on video stream and camera configuration, we provide some examples to give you idea about possible values for few kinds of situations. Do not take this as a valid setting for your setup.

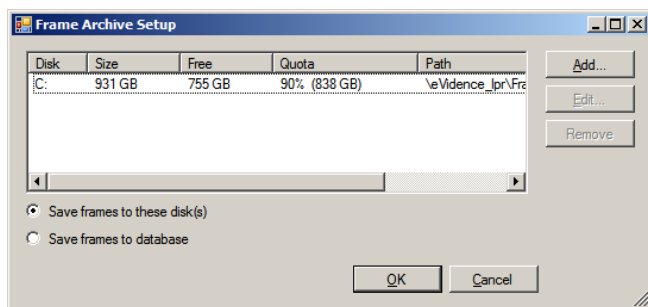
Far camera zooming at road crossing at moderate angle (relative to camera side speed is average), cars moving at average speed:
Plate Presence Time: 350ms; Recognition FPS: 7;

Camera zooming at road crossing at low angle (relative to camera side speed is low), cars moving at low to average speed:
Plate Presence Time: 750ms; Recognition FPS: 3;

Camera positioned on ceiling inside parking, looking at parking entrance, in front of car moving direction (no angle), cars moving at slow speed:
Plate Presence Time: 1000ms; Recognition FPS: 3;

Camera targeted along straight road at moderate angle, cars moving at average to high speed:
Plate Presence Time: 200ms; Recognition FPS: 13;

Frame archive

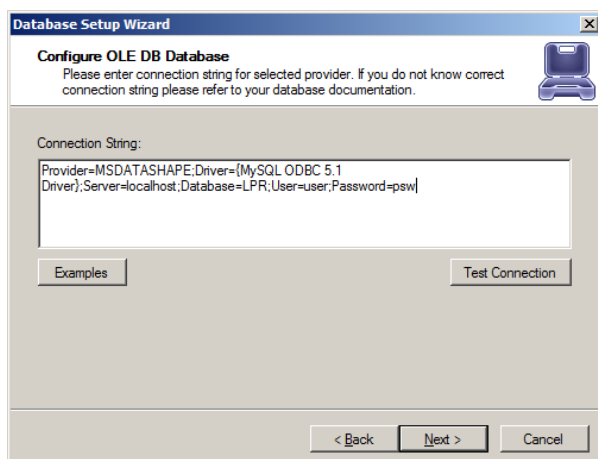


As of version 1.4.0 it is possible (and recommended) to store still frames on a filesystem instead of a database. This allows you to have a lot more records in database without performance penalties, which come from populating database with image data. This also allows you to use mssql express without having to worry about 10gb database limit. (Ofcourse, it is still possible to reach 10gb size limit, but it would take few years and millions of records)

Frame archive configuration is quite simple - you select drives that should be used for frame storage and set a quota for each drive. When drive usage matches quota, oldest frames will be removed.

load - because of this, drive usage is TOTAL drive usage, NOT drive usage by frame archive only. In other words this means that if more hard drive space is used to store other data, less space will be available for frame archive and quota will trigger faster.

External database accounting

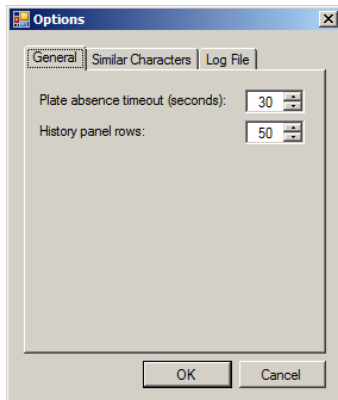


External database communication is done in Luxriot LPR by standard OLE DB means. We will do a brief overview on setting up external accounting with a popular MySQL database. You will need a working MySQL server (consult MySQL documentation on how to install and configure it) and a MySQL ODBC 5.1 driver, which can be obtained from MySQL website. The name ODBC is a bit confusing - driver package actually contains both ODBC and OLE DB drivers for MySQL. You also need to create an account for LPR to use, as well as create empty database.

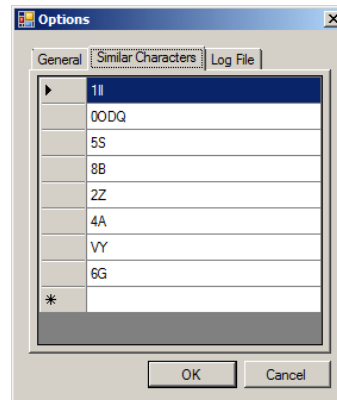
After database and set up, configure LPR to work with your database using OLE DB connection string, which contains instructions on data source to use and login credentials.

```
Provider=MSDATASHAPE;Driver=(MySQL ODBC 5.1 Driver);Server=localhost;Database=LPR;User=user;Password=psw
```

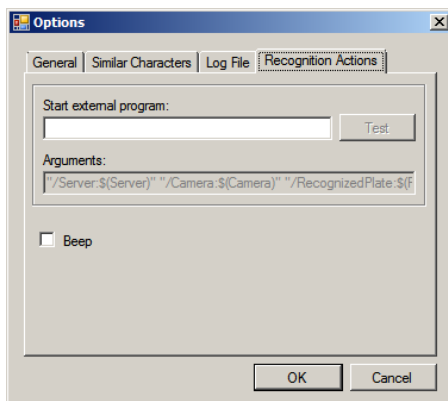
We provide a way to test configured database correct operation and performance by filling it with randomized test data. It is done by starting LPR with a /FillWithRandomData command-line argument. You will be prompted for amount of random entries to create. You can also specify an image to use for creating corresponding frame archive entries. This way you can see how database will operate with expected number of records (i.e. with 2 millions of records and images, as after 3 years of production use). For deleting all database data and frame archives, run LPR with /DeleteAllData.



General options. Plate absence time, given in seconds, defines how long licence plate should be out of view to get recognized again. This is useful, for example, if parked cars might appear inside recognition area. A person walking by and covering plate for few seconds will not trigger re-recognition.



Here you can define characters that will be considered similar. It is used for investigation search and trigger matching.

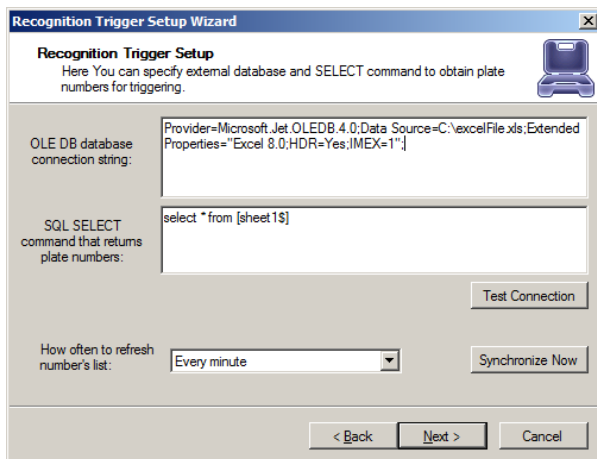


Allows you to run external program upon any new recognition entry.

Third 'Log file' tab is used to set amount of logging performed, limit log file size and set maximum amount of log files, as well as view current log. At the moment logging is used for debugging purposes only and most users can ignore it.

Black/white lists

Luxriot LPR allows you to set up an automatic control point. It requires a source of allowed plate numbers (which can be any Microsoft OLE DB compatible source) and external program (for opening gate, for example) to run when recognized LP number matches one of numbers found in database. Recognition trigger configuration is found under *Tools -> Trigger Setup*.



Screenshot on the left shows LPR configured to use a Microsoft Excel file for retrieving triggering plate numbers.

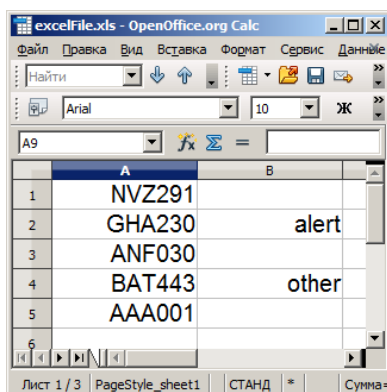
First field (OLE DB connection string) contains instructions on what source to use for reading triggering numbers. Second field (SQL SELECT command) contains instructions on how to retrieve required data from specified source. Drop box is for selecting delay between re-reading data source.

Note that similar characters have effect here as well - if you have O and 0 set as similar characters, both 000 and OOO number plates will match 000 given in allowed plate number list. Characters are not case-sensitive.

Provider=Microsoft.Jet.OLEDB.4.0;Data Source=C:\excelFile.xls;Extended Properties="Excel 8.0;HDR=No;IMEX=1";

(HDR=No instructs OLE DB not to use first row as column names)

select * from [sheet1\$] Please note that we refer to 'sheet1', as our test xls document worksheet name is 'sheet1'. It may be different with different regional settings, so please adjust as necessary.



This is example contents of an MS Excel file. First column contains triggering number plates. Second, optional column, contains additional information about number plate, which is referred to as a Triggered Plate Tag and can be supplied as command-line argument, **TriggeredPlateTag**. You can check what number plates are currently triggering under *Tools -> Trigger Plates* menu

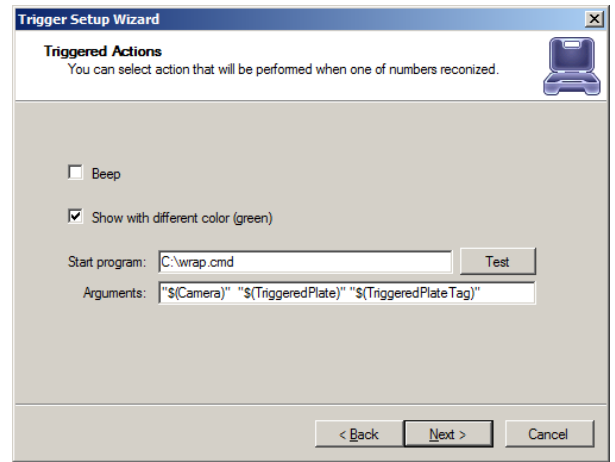
Upon trigger an external program (or wrapping command script) is called. Specify a path to program to be executed upon trigger in *Start program*: field. Arguments to be passed to external program are filled in *Arguments* field.

Besides constant arguments you can supply following dynamic arguments (they will be replaced with actual values) to external program executed upon trigger:

\$(Server) - Name of a server where LP was found
\$(Camera) - Camera where LP was found
\$(RecognizedPlate) - LP that was recognized
\$(TriggeredPlate) - Source LP that recognized plate was matched against
\$(TriggeredPlateTag) - Tag corresponding to source LP that recognized plate was matched against

If you need to execute multiple or conditional commands upon trigger, you can use windows command script as a wrapper. Consider example of basic command script usage below. Software is configured to execute command script upon trigger, with following arguments: "\$(Camera)" "\$(TriggeredPlate)" "\$(TriggeredPlateTag)". Script will evaluate 3rd parameter, a TriggeredPlateTag, to determine what action to perform and can also forward some additional information to external programs called.

Example contents of wrap.cmd file:



```
rem Sample logging:
set LOGPATH="c:\cmd-test.log"
echo %DATE% %TIME% Received arguments: %* >> "%LOGPATH%"

rem Set variables
set CAMERA=%1
set TRIGGERED_PLATE=%2
set TAG=%3
rem Path of an optional file to log actions

rem Remove quotes from arguments
set CAMERA=%CAMERA:"=%
set TRIGGERED_PLATE=%TRIGGERED_PLATE:"=%
set TAG=%TAG:"=%

rem Perform conditional action depending on received arguments
if /I "%TAG%" == "" (
    rem Action to perform if Tag is empty
    echo Opening gate for "%TRIGGERED_PLATE%" >> "%LOGPATH%"
    OpenGate.exe
) else if /I "%TAG%" == "alert" (
    rem Action to perform if Tag equals to "alert"
    echo Alert for "%TRIGGERED_PLATE%" >> "%LOGPATH%"
    ShowAlert.exe
) else (
    rem Can perform default action here
    echo Unknown action "%TAG%" for "%TRIGGERED_PLATE%" >> "%LOGPATH%"
)

rem Perform constant action not depending on received arguments
echo. >> "%LOGPATH%"
```