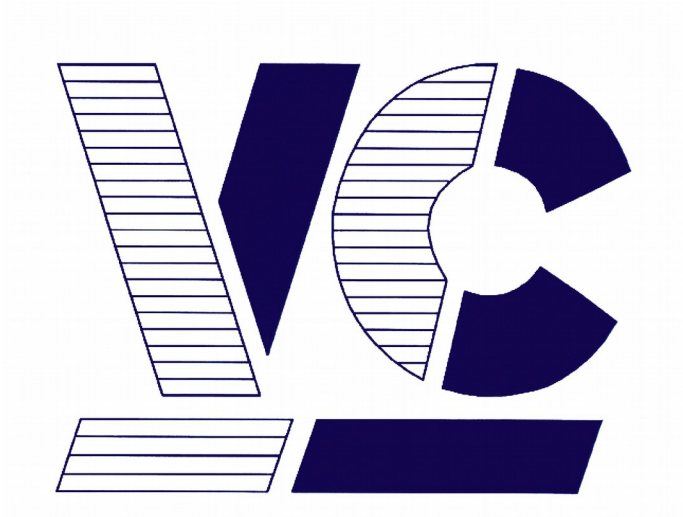
It's no trick...
it's a vision system



Vision Components ®

The Smart Camera People

VC 3D Laser Scanner

Version 50

Manual

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Foreword and Disclaimer

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References

Since the VC4XXX smart camera family employs a TI processor, the programming environment and functions for the VC20XX cameras can be used for this camera.

Further References under "Support + Download" on www.vision-components.com:

„Support News" – for up to date information on VC Software and Documentation.

„Knowledge Base / FAQ" - searchable Database with latest software developments, frequently asked questions and demo programs.

"Download Areas" for all documentation and Software downloads – refer to the following table:

Description	Title on Website	Download Area
Schnellstart VC – Deutsche Version dieses Handbuches.	**Schnellstart VC Smart Kameras**	**Registered User Area** ▸ **Getting Started VC SDK TI**
Introduction to VC Smart Camera programming	**Programming Tutorial for VC20XX and VC40XX Cameras**	**Registered User Area** ▸ **Getting Started VC SDK TI**
Demo programs and sample code used in the Programming Tutorial	**Tutorial_Code**	**Registered User Area** ▸ **Getting Started VC SDK TI**
VC4XXX Hardware Manual	**VC4XXX Smart Cameras Hardware Documentation**	**Public Download Area** ▸ Hardware Documentation VC Smart Cameras
VCRT Operation System Functions Manual	**VCRT 5.0 Software Manual**	**Registered User Area** ▸ Software documentation VC Smart Cameras
VCRT Operation System TCP/IP Functions Manual	**VCRT 5.0 TCP/IP Manual**	**Registered User Area** ▸ Software documentation VC Smart Cameras
VCLIB 2.0 /3.0 Image Processing Library Manual	**VCLIB 2.0/ 3.0 Software Manual**	**Registered User Area** ▸ Software documentation VC Smart Cameras

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1 Introduction

Vision Components introduces the VC nano 3D, an ultra-compact machine vision system that can be freely configured for 3D and 2D inspection tasks, providing a cost-efficient solution for a wide range of applications. Measuring merely 140 x 70 x 35 mm, its housing includes an intelligent camera and a line laser with up to 100 mW performance which enables the real-time recording of images at a scan rate of up to 400 Hz according to the triangulation method. The images can be analyzed by the DSP processor of the Smart Camera which has a computing power of 5,600 MIPS. Additionally, images can also be analyzed

1.1 General features

- Scan rate: up to 400 Hz
- Laser: Class 1 / 2, wave length 635 nm, power 30 mW / 100 mW
- Interface: 2 x Input, 4 x Output à 400 mA, 100 Mbit Ethernet
- Processor: high-end DSP, 5,600 MIPS
- Supply Voltage: 24 V +/- 20%
- Dimensions: 140 x 70 x 35 mm, ca. 400 gr.

1.2 Standard accessories for VC 3D nano

- LAN cable 6-pin C6/C4, 5 m long (Product no. VK000149)
- Power/PLC cable 12-pin C6/C4, 5 m long (Product no. VK000008)

2 Working with the VC 3D Laser Scanner Software

Vision Components offers three software packages for an easy setup and hardware check:

2.1 Laser Scanner Camera Demo Program (LaserScanner_Main_VXX.c)

The demo program includes the main function calls of the Laser Scanner library and an example for TCP/IP connection to the outer world. It shows, how to use the parallel image acquisition and processing and provides a menu to change all sensor parameters as well as the debug parameters.

2.2 Laser Scanner Library (VC3D LaserScanner VXX.lib)

The library includes the high performance detection of the laser line and the main calibration functions for the system. Additional there are filters and different detection modes implemented. The individual calibration parameters are stored in the Laser Scanner camera flash memory (Cxxxxxxx or LensCal).

2.3 Laser Scanner Windows PC Program

The Windows PC program displays the results of the Laser Scanner camera. It allows an easy setting of all scanner parameters. You can use the program to show the real 2D image from the sensor as well as the measured 3D data. It works together with the standard TCP/IP protocol from the Laser Scanner demo program.

3 VC 3D Laser Scanner Camera Demo Program

In the software package you will find the LaserScanner_Main_VXX program as an executable file (vc3d_xx.cex) for the camera and the source code (.c) as well. Please download the demo file to the camera and start it. If necessary, change the source code and adapt the TCP/IP connection to your requirements.

After starting the camera file the following messages appears:

```
Set own task 'loader' to prio 8! (oldprio=8)
  Checking    VCLib Licence: OK.
  Checking ColorLib Licence: OK.
  Checking   ExtLib Licence: OK.

Linked with following library versions:
VCLIB   : 314_1 VCLIB   Version=314  SubVersion=1  Date:Dec 11 2014  Time=16:46:59
VCRTLIB : 530_9 VCRTLIB Version=530  SubVersion=9  Date:Jan 10 2013  Time=16:06:31
```

```
Compiled with following header versions:
FLIB.H  : 314.0
VCLIB.H : 314.1
VCRT.H  : 531.0

VC/RT OS   running  with Version: 530.13

Compiled at Feb 10 2015 12:24:19 Camera=6211

Sensor parameter file fd:/VC3DPar.001 doesn't exist. Error -1001.
Missing 31 user parameter setting(s). Default parameters will be used.

Kanatani Calibration Ready.
Tsai     Calibration Ready.

Reading Product Setting File fd:/ProdPar.001 successful.

New stream socket created at port 1096

--- VC 3D Laser Scanner Version: Main=49 / Lib=49 / Product=49 ---

Press ENTER for hand operated scan
Press  ESC  to quit program
Press  'm'  to change parameter
Press  's'  to save BMP image for debug
Press  'r'  to read BMP image for debug
```

Especially in multitask mode, it is sometimes necessary to adjust the task priorities. The demo file shows all important commands to settle it. Low values means high priority. The standard priority is 8.

The next three lines indicates that all VC Libs are properly initialized (value 0). Please check your VC library license code, if you will get a different value, for example -5.

The next lines reports the version number of all used libraries and header files as well as the camera operation system. It also shows the compilation date and time of the demo file.

If the calibration file is missing on the sensor flash memory, the demo file still works but could not calculate the detection results in [mm]. Instead it gives the laser line position in pixel. You can verify with the shell command “dir -x”, if the file “Cxxxxxxx” (xxxxxxxx = camera SNR) or "LensCal.002t" exists. Please contact Vision Components in order to receive the calibration file.

Customers settings can be stored on the flash memory as well. The software will start with the new parameter values. If the file “`VC3DPar.txt`” is not available, the demo file starts with the standard parameter setting. You can store your settings inside the menu 'm'. It is possible to change the VC3DPar.txt file with an editor.

All new 3D sensor will have the accurate Kanatani calibration. For this sensors the Tsai calibration file is not necessary.

Only in the product version of the 3D scanner the Product Setting File fd:/ProdPar.001 will be read.

The standard TCP/IP connection will be at port 1096. You can change the port number inside the source code.

```
// TCP / IP
#define SERVER_PORT         1096    /* scanner communication port */
```

Next line shows the program version and a short menu.

3.1 Menu “m” (main menu)

The menu gives you the possibility to change all sensor parameters manually. An other way to change the parameter is with the PC Windows Client. All the parameters are described in the documentation “Laser Scanner Protocol & Parameters”.

```
--------------------------------------------------------------------------------
Setup Parameter
--------------------------------------------------------------------------------
l:   live-picture
p:   set standard parameter
e:   set expert parameter
s:   save sensor parameter
r:   read sensor parameter
d:   debug parameters
t:   read product parameter
--------------------------------------------------------------------------------
q:    quit Menu
```

3.2 Menu “p” (standard parameter menu)

```
Reset image acquisition = 0  [0 - 0]
Set Laser: 0=OFF 1=ON = 1  [0 - 1]
Set Trigger: 0=OFF 1=PosEdge 2=NegEdge -1=AutoTrigger -2=AutoTrigPos -3=AutoTrigNeg = 0  [-3 - 2]
Set ROI Area X [Pixel] = 0  [0 - 1277]
Set ROI Area Y [Pixel] = 224  [0 - 1021]
Set ROI Area DX [Pixel] = 1280  [6 - 1280]
Set ROI Area DY [Pixel] = 799  [6 - 1024]
Set Nr_Lines: -1=endless X=NrImages = 0  [-1 - 10000]
Set Data Mode = -1  [-1 - 8]
Set Exposure Mode: 0=FIX_EXPOSURE 1=AUTO_EXPOSURE 2=DOUBLE_EXPOSURE = 0  [0 - 3]
Set Shutter [us] = 500  [5 - 500000]
```

3.3 Menu “e” (expert parameter menu)

```
Set GAINVAL = 64  [0 - 1023]
Set Methode = 0  [0 - 2]
```

Set Algorithm (0=I16 / 1=F32) = 0 [0 - 1]
RLC Threshold = 48 [1 - 254]
Image Sub Sample = 0 [0 - 2]
Step Dx [Pixel] = 1 [0 - 0]
Min. Laser Width [Pixel] = 1 [1 - 100]
Max. Laser Width [Pixel] = 30 [1 - 100]
Ethernet Line Package Nr = 1 [0 - 100]
Ethernet Send No Wait Mode = 1 [0 - 1]
Laser Detection Filter = 0 [-8 - 8]
Median Filter: 0=no filter 1=3x1 2=5x1 3=7x1 4=9x1 = 0 [0 - 4]
Speckle Filter: 0=no filter 1=3x3 2=5x5 3=7x7 4=9x9 = 3 [0 - 4]
Skip no laser detections points = 1 [0 - 1]
Command transfer mode (0=Binary / 1=ASCII) = 0 [0 - 1]

3.4 Menu “d” (debug parameter menu)

The menu “d” gives you additional information about the scanner and offers a fast way for debugging the software. You have the opportunity to find memory leaks, display the measure time or shutter time. You also can display the position of the laser line detection. In order to debug the TCP/IP host communication please select the necessary values.

Debug Print: 1=Memory 2=fps 3=Shutter 4=ImgAdr 5=TCP/IP 6=ImgToWorld 7=ProdRes 8=ParSet = 0 [0 - 8]
Debug Draw: 1=LaserCenter 2=LaserDetection 3=ProductResults = 0 [0 - 3]
Debug Commands: Bit0=Host->Cam Bit1=Cam->Host Bit2=Data = 0 [0 – 7]

4 VC 3D Laser Scanner Library

The VC 3D Lib enables the real-time recording of images according to the triangulation method. The images can be analyzed by the internal DSP processor of the Smart Camera which has a computing power of 5,600 MIPS.

The lib works on all VC 3D Laser Scanner cameras with the standard license code:

```
LsPar->LicenceCode1   = 0x674F27A1;
LsPar->LicenceCode2   = 0x2E05F267;
```

Before you can use the lib on other VC cameras, please initialize both license codes in the structure. You will get the license code from Vision Components. Every camera needs a different license code. In case of wrong initialization, you can use the compiled program for 90 minutes or a maximum of 10000 scans.

The lib offers a wide variety of settings. They are mainly described at the documentation “Laser Scanner Protocol & Parameters”.

Use the following functions from the Library:

4.1 Function ScannerInit()

```
I32  ScannerInit        (LsParameter *LsPar, I32 Mode);
```

Call the function ScannerInit(LsPar, MEM_INI) at the beginning of your program and ScannerInit(LsPar, MEM_DEINI) at the end in order to allocate and release necessary memory. The function should be called only once in your program.

4.2 Function ScannerDetection()

I32 ScannerDetection (LsParameter *LsPar, image *ImgArea);

The function ScannerDetection() detects the position of the laser line at maximum speed. It works on the image structure ImgArea.

The laser line search area is defined as:
ImageAssign(&ImgArea, ScrByteAddr(0, 0), LsPar->ImgDX, LsPar->ImgDY, ScrGetPitch);

The results from the function will be transferred to the structure parameters:

```
// laser line positions
I32  LaserPoints;     (number of detected laser points)
I32  *pLaserPosZ;     (center of the laser line position z, accuracy factor 64)
I32  *pLaserPosX;     (laser line position x, accuracy factor 64)
U8   *pLaserVal;      (average brightness at the laser line position x)
```

Notice that the array *pLaserPosZ and *pLaserPosX for the laser position have a sub pixel accuracy and are multiplied with the factor 64 in order to get sub pixel accuracy. Both values (x and z) can be used to calculate the attitude in real word coordinates. The laser brightness at that position is stored in the array *pLaserVal.

4.3 Function ImgToWorldCoord()

void ImgToWorldCoord (LsParameter *LsPar, I32 Nr, I32 *restrict pImgX, I32 *restrict pImgZ, float *restrict pWorldX, float *restrict pWorldY);

With the function ImgToWorldCoord() you can convert the sub pixel values in the array pLaserPosX and pLaserPosZ to real world coordinates in mm, if Kanatani or Tsai calibration is available. If the calibration file is missing, the function doesn't change the values.

If the parameter pWorldY is equal to NULL, the world coordinates will be stored in pWorldX like x0, z0, x1, z1, x2, z2, ...

4.4 Function WorldToImgCoord()

void WorldToImgCoord (LsParameter *LsPar, I32 Nr, float *restrict pWorldX, float *restrict pWorldZ, float *restrict pImgX, float *restrict pImgY);

The function WorldToImgCoord() converts mm coordinates into pixel values. Just the opposite way of the funktion ImgToWorldCoord(). Use this function, if you know the dimensions of your measure target

and you want to calculate the necessary image region (ROI). This function is not time optimized and takes more processor time.

5 VC 3D Laser Scanner connection to Windows

We recommend to use our new “VC3D Smart Shape” PC program as a Host client.

The software works together with the VC 3D Laser Scanner Cameras from Vision Components and the camera demo program vc3d_XX.cex. The cameras are based on Texas Instruments DSP's. A large variety of different Laser Scanner Camera types and resolution are available.

5.1 Camera Hardware Connection

A 100 Mbit TCP/IP connection is necessary in order to communicate with the camera. You can directly connect the scanner camera to a TCP/IP Hub or just use a TCP/IP cross cable for a direct camera connection to your PC. A cross cable is available from Vision Components.

The scanner camera listen to the TCP/IP Port 1096. This port number can be changed in the camera source code. The standard IP address of the laser camera is 192.168.0.65. The IP address could be different, if there is a “#IP” file on the camera flash memory (fd:\). You will find an example of the #IP file and some instruction how to select a different IP address in the camera demo files of vision components. Additional settings for gateway or MASK are possible.

Example:
IP: 192.168.178.65
MSK: 255.255.255.0

5.2 PC Connection

First you have to start the Laser Scanner camera software (vc3d_XX.cex) if the shell autoexec file is not available. Then start the VC 3D PC program and try to establish a TCP/IP connection to the camera. Choose the right IP and port address and press the Connect Button of the VC 3D PC application.

If the standard IP doesn't work and if you don't know the IP adress of the camera, please follow the instructions of the VCNet Recovering Tool from Vision Components.

6 Windows program “VC 3D SmartShape”

The VC 3D PC SmartShape is a MS Windows PC program for displaying the results from the Laser Scanner camera. It allows an easy setting of the scanner parameters.

We recommend to use this new VC3D Smart Shape PC program for all VC 3D Laser Scanners. Please follow the program description in the documentation “VC 3D SmartShape Manual.pdf”.

7 Windows program “VC 3D PC Client” - old version

The “VC 3D PC Client” is replaced by our new host client “VC 3D SmartShape”. Please use the new client for sensor settings.

7.1 Installation

For the Laser Scanner Version 37 or higher you have to use the PC Client Version 37 or higher.

An installation for the Window Program “VC3D PC Client VXX.exe” is not necessary. Just call the exe file and connect the Laser Scanner via 100 Mbits TCP/IP to the camera.

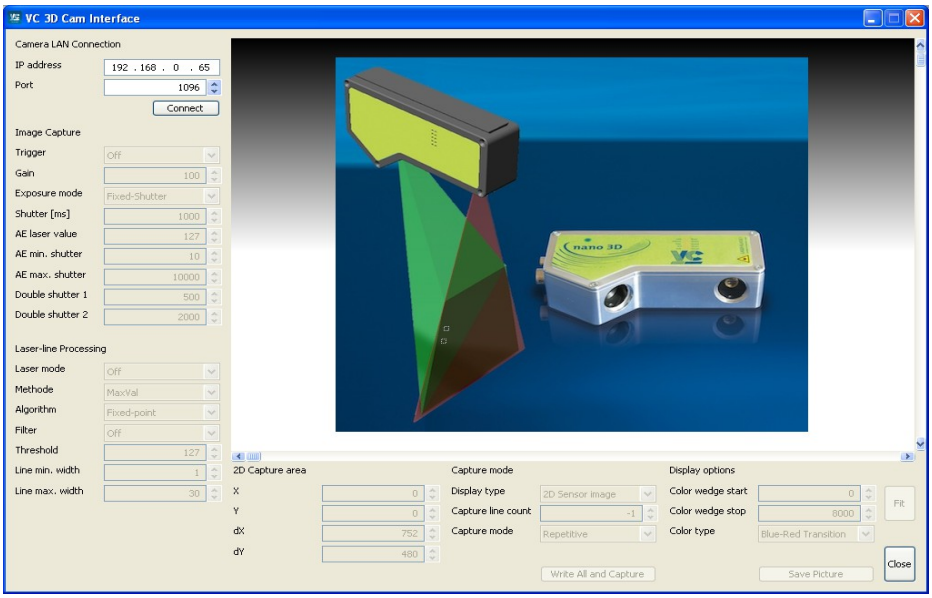
If you don't have installed the Visual C++ Runtime Environment, you additional need some dll files in order to start the application. Please copy the following files in the same directory as your exe file:

- msvcr100.dll
- msvcp100.dll
- mfc100u.dll

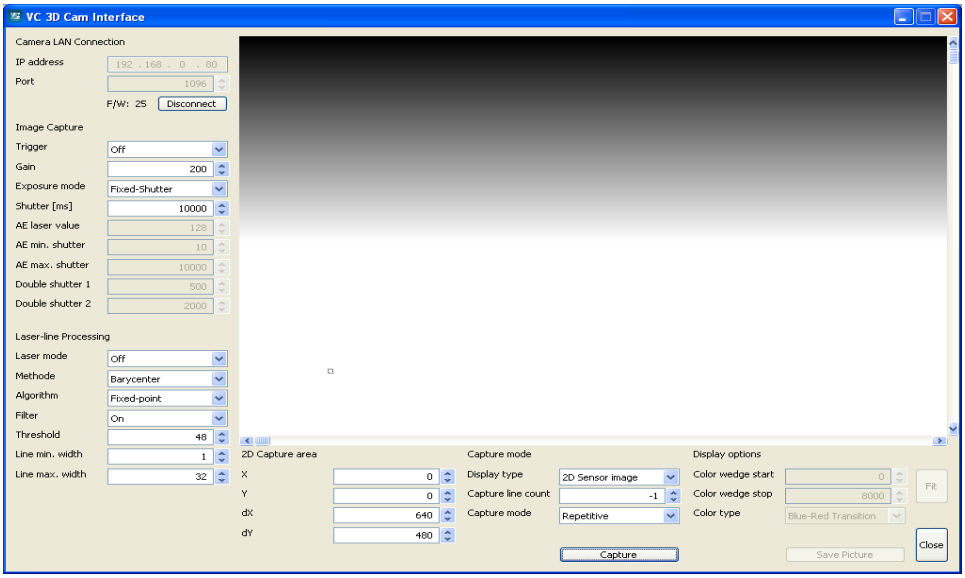
You will find all necessary files to run the software in the “VC3D LaserScanner VXX Windows Client.zip”.

7.2 First Steps

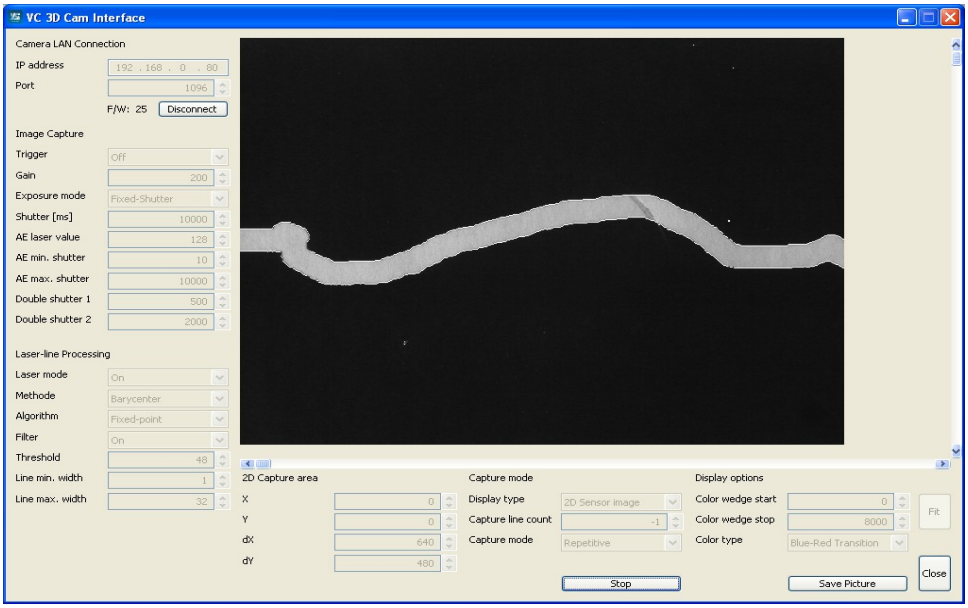
1) Start the VC3D PC Software (VC3D PC Client VXX.exe) and if necessary change the IP and Port settings. Than press the button “Connect”.



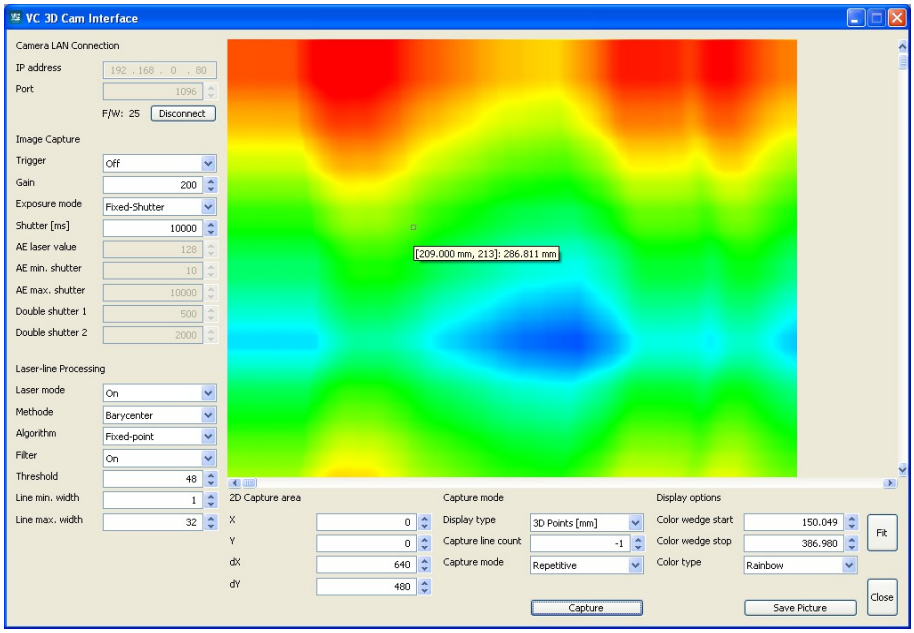
2) After a successful connection to the scanner camera, the tool reads all camera setting parameters.



3) Choose Lasermode “ON” and Display Type “2D Sensor image”. Then press “Capture”. You will get an live image of the sensor scene. Please adjust shutter time sensor position for a stable detection image. Stop the capture mode in order to change the parameters.



4) Select “3D Points [mm] in order to get an attitude profile of your scan. You can select different color types and set the range of the false color display.



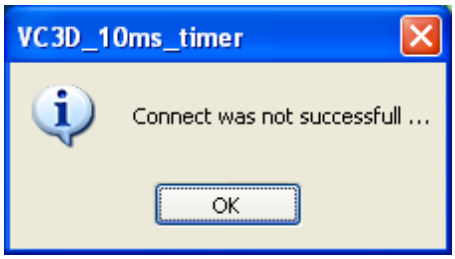
5) Place the cursor inside the transferred image in order to get additional information like position and brightness (2D image) or attitude (3D image) at this position.

7.3 Parameter Adjustment

Please stop the capture mode before you change any parameters (Button “Stop”).

7.4 Error Messages

7.4.1 Connection Error



Please check the hardware connection to the camera. You have to use a cross over cable, if you connect the camera directly to the PC. Make sure, that the IP address and port is correct and the camera software is running.

8 Important Remarks

8.1 Laser Power Module

The demo file “LaserScanner_Main_VXX.c” is compiled for the standard laser power of 30mW. If you ordered a high power laser version of 100mW please change the define in the demo file to the correct value.

```
#define LASER_POWER   30 // 30 mW or 100 mW
```

Then compile the demo file. The define value will change the current in the function SwitchLaser() to the correct value.

Since Version 40 just use 100mW. It will be controlled by voltage and a change is no more necessary.

8.2 Double Exposure

In double exposure mode the scanner takes two images. The first image is the main image and will be taken at the shutter time DoubleShutter[0]. The second image, with the shutter time DoubleShutter[1], will be taken directly after the first image. If a laser detection at any x position is not possible in the first image, it will try to find the laser in the second image for that x positions only.

Double Exposure mode reduce the scan rate!

The first image can be triggered by hardware or auto trigger as well as in free running mode. The second image will always be triggered directly after the first one. It doesn't wait for hardware or auto trigger.

Please note, that Double Exposure doesn't work correctly at the xr Laser Scanners due to a different shutter time procedure. If you want to use Double Exposure, please select a yr or higher model.

8.3 Fast Floating Point Calculation

For fast floating point calculation use the TI FastRTS fast floating point library. If you need the FastRTS please contact VC.

The use is really simple:

(1) copy fastrts64x.lib into \ti\c6000\cgtools\lib
(2) include the line "-l fastrts64x.lib" in cc.cmd

that's it. Your floating point applications will run about factor 2 - 3 faster

9 New Version Changes

A short history of the changes is documented in the head of the file LaserScanner_Main_VXX.c. Please have a look for more information.

Version 49:

Main Program
- Sensor ROI can be defined by pixel values (ROI_X,...) as well by mm values (ROI_X_MM,...)
- Bugfix for high attitude transfer in pixel (wrong values in mode SkipNoLaserPoints)
- start with LsPar->METHOD = 2 (Bayer Speckle Filter)
- wait for full image transfer in MODE 1 and 6 (image transfer mode)

LIBRARY
- Bugfix in function ImgToWorld_ROI() - wrong calculatio of the ROI_MM

Version 50:

Main Program
- command CMD_MODE 9 implemented in order to transfer mm profile including product results
- command CMD_CMD_SAVE_PRODUCT_DATA implemented to store product settings

It's no trick... it's a vision system

Visit the Vision Components site **www.vision-components.com** for further information and documentation and software downloads:

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Products	Product Overview:
VC Smart Camera Overview	**VC44XX High End Camera Series** **VC40XX Standard Camera Series** VC4016 / 18 Entry Level Cameras VC4002L Line Scan Camera **VCSBC Single Board Cameras** **VC20XX Smart Cameras** **VCSBC Board Cameras** **VCM + Viscube Camera Sensors**
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VC Software Development Kit Ti:	VCRT Operating System VCLIB Image Processing Library
VC Special Libraries:	M200 Data Matrix Code Finder VCOCR Text Recognition Library Color Lib
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RMA Number Form	Form for Allocation of Repair Numbers.

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