FSI Machine Vision Training Programs

Table of Contents

Introduction to Machine Vision (Course # MVC-101)

MVC-101 is a short, basic introduction to the concepts and terminology of machine vision. It is typically run for about 30 minutes just prior to NeuroCheck / machine vision course # MVC-201, or EyeVision/ machine vision course # MVC-205.

This is a beginner course, intended for individuals who have had no exposure to machine vision.

Machine Vision and NeuroCheck overview (Seminar # MVC-102)

This is a 3 to 4 hour seminar, which presents an introductory overview of all areas important to the success of a machine vision application from inception through long-term ownership.

Includes an example project taken through inception, specification, solution, programming, startup, and long-term ownership, with the specific “nuts and bolts” of each step. In addition, a NeuroCheck-based technology discussion.

Machine vision equipment, technologies, tools, terminology, and concepts are also covered.

Includes a description of the types of functions that machine can fulfill and accomplish, the strengths and weaknesses of machine vision and how they apply in manufacturing processes. Also includes *A Manager’s Guide to Successful Machine Vision*.

668 Western Avenue • Lombard, IL 60148-2097 (630) 932-9380 • FAX: (630) 932-0016 www.fsinet.com

Machine Vision, EyeVision, and Eye Spector overview (Seminar # MVC-103)

This is a 3 to 4 hour seminar, which presents an introductory overview of all areas important to the success of a machine vision application from inception through long-term ownership.

Includes an example project taken through inception, specification, solution, programming, startup, and long-term ownership, with the specific "nuts and bolts" of each step. In addition, an EyeVision and EyeSpector based technology discussion.

Machine vision equipment, technologies, tools, terminology, and concepts are also covered.

Includes a description of the types of functions that machine can fulfill and accomplish, the strengths and weaknesses of machine vision and how they apply in manufacturing processes. Also includes *A Manager's Guide to Successful Machine Vision*.

Machine Vision & NeuroCheck Technical Training Course (#MVC-201)

This is our main and most popular NeuroCheck® course, which covers how to do automatic inspection applications using NeuroCheck-powered machine vision. This is a 1 3/4 day, "industrial strength" non-commercial course. Commonly used topics are covered in greater depth, and the more advanced or specialized topics are covered as overviews. There is substantial focus on the use of NeuroCheck software, and highly condensed sections cover other areas that are crucial to project success. Topics include:

- Brief general overview of machine vision technologies, architectures, evolution, and purposes.
- An overview and framework for successful machine vision project implementation. Strategies for mission and application definition that successfully fulfills the mission while avoiding unnecessary cost escalation. Feasibility studies, application review, review of scope questions and related implementation, and project management.
- Basic setup and navigation of NeuroCheck® software for implementing machine vision applications.
- NeuroCheck® software tools and their use, including image acquisition, asynchronous image acquisition, using NeuroCheck® 's extensive range of standard filters or custom filters for image processing, creating / applying look-up tables to images, image thresholding, defining, processing, sorting, screening, counting regions of Interest, template matching, thresholding, bar code reading, deriving object-level mathematical results (elsewhere), gauging color processing, Neural Net color classifications, Neural Net processor use, and Neural Classifier use. Creating and passing results of checks as ROI objects, image-level math, and other tools.
- Other NeuroCheck® system features which are utilized for machine vision applications. Password and multi-level security profiles. Creating and exporting spreadsheets and other output files and data, networking, Check Routine Wizards, operating modes (manual, test, live and automatic) and their uses. Configuring the user interface / automatic mode screen. Use of XML self-documentation capabilities.
- Brief introduction to Plug-Ins, and NeuroCheck Plug-In capabilities. If requested in advance, a section on how to install, enable and access plug-ins will be added.
- Implementation of example machine vision applications: Presence verification to check for proper assembly and forming of parts, character recognition, print quality inspection, robot guidance, pattern recognition, gauging, color analysis, surface analysis, and flaw detection.

- Overview of principles and implementation concepts for triggering, and high-speed image acquisition. Overview parallel processing. If requested in advance, a detailed section on parallel processing is added.
- The 4 methods of discrete I/O control: global, check level, tool level and combining flow control with I/O tool insertions.
- NeuroCheck software & license media and administration.
- Introduction to NeuroCheck capabilities for unusual (non-default) program flow control, including non-sequential passage/linkage of input and output objects from and to tools, and conditional branching.
- Hardware overview of machine vision systems powered by NeuroCheck. Includes various approaches utilizing FSI pre-tested systems and pre-tested building blocks where compatibility issues have already been resolved. Overview of relevant image acquisition / camera specifications and selection including resolution, speed, and comparison of performance and operational characteristics of monochromatic, color and line-scan image acquisition. Brief overview of image acquisition, I/O hardware functions, plant-floor enclosure ratings, and relevant specifications.
- Machine vision lighting purposes, principles, and implementation. This briefly distills and covers the key points of this important and extensive topic. It covers the objectives of machine vision lighting, and how they are often the opposite of just "lighting it up". Next is an introduction to the fundamental illumination scenarios, their uses and how they are created. This includes the geometry of the workpiece, the imaging equipment and the lighting equipment, and the geometric relationship between these three. Review of types of light sources that are inside lighting products, and the types and terminology of lighting products. Finally, examples are given which combine all of the above principles.
- Machine Vision lens types and selection. Standard and specialized lenses. Brief overview of this extensive topic.
- "Run" mode operation including design of user screens.

An extensive notebook, NeuroCheck CD, and a training course CD with example images, problems and solutions are provided to each participant.

NeuroCheck 6.1/6.0 versions cover the universal I/O and data interchange architecture, including the data format converter and registers.

The duration of the MV-201 course is 1 ¾ days. MVC-201 is focused on NeuroCheck 5.1, 6.1 or a blend of them depending on the request of participants; please indicate your preference when signing up. Due to the large amount of material that will be covered, this is not a hands on course.

Hands-On NeuroCheck Practice (Course #MVC-204)

This is a ¾-day course with hands-on NeuroCheck programming practice for approximately 10 basic applications. Includes extra coverage of those areas that are of greatest interest to the attendees. Also includes practice on other aspects of setup. Pre-requisites are MVC-201 and for full hands-on participation, a notebook computer with a CD drive; otherwise partial hands-on participation is still available.

A NeuroCheck CD and a training course CD with example images, problems, and solutions are provided to each participant.

EyeVision and Machine Vision Technical Training (Course # MVC-205)

This is the Primary EyeVision software course. It covers all of the commonly used aspects and tools of the EyeVision software in all factory built vision units (Smart Sensors, Smart Cameras, and PowerEye systems). Basic universal hardware aspects are covered, as well as a condensed overview of other topics crucial to machine vision success (including lighting design and optics). This is a 1 ¾-day course

This is our main and most popular EyeVision course, which covers how to do automatic inspection applications using EyeVision-powered machine vision, including EyeSpector smart cameras and PowerEye vision systems. This is a 14 hour (1 ¾ day) "industrial strength" non-commercial course. Commonly used topics are covered in greater depth, and the more advanced or specialized topics are covered as overviews. There is substantial focus on the use of EyeVision software, and highly condensed sections cover other areas that are crucial to project success. Topics include:

- Brief general overview of machine vision technologies, architectures, evolution, and purposes.
- An overview and framework for successful machine vision project implementation. Strategies for mission and application definition that successfully fulfills the mission while avoiding unnecessary cost escalation. Feasibility studies, application review, review of scope questions and related implementation, and project management.
- Basic setup and navigation of EyeVision® software for implementing machine vision applications.
- EyeVision® software tools and their use, including image acquisition, asynchronous image acquisition, using EyeVision® 's standard filters or custom filters for image processing, image thresholding, defining, processing, sorting, screening, counting regions of Interest, template matching, thresholding, bar code reading, deriving object-level mathematical results (elsewhere), gauging color processing, and color classifications. Creating and passing results of tools as objects, image-level math, and other tools.
- Other EyeVision® system features which are utilized for machine vision applications. Creating and exporting output files and data, networking.
- Implementation of example machine vision applications: Presence verification to check for proper assembly and forming of parts, character recognition, print quality inspection, robot guidance, pattern recognition, gauging, color analysis, surface analysis, and flaw detection.
- Overview of principles and implementation concepts for triggering, and high-speed image acquisition. Overview parallel processing. If requested in advance, a detailed section on parallel processing is added.
- The methods of discrete I/O control.
- EyeVision® software & license media and administration.
- Introduction to EyeVision® capabilities for unusual program flow control, including non-sequential passage/linkage of input and output objects from and to tools, sub-routines, and conditional branching.
- Hardware overview of machine vision systems powered by EyeVision®.Includes EyeSpector and EyeCheck smart cameras and various approaches utilizing FSI pre-tested systems and pre-tested building blocks where compatibility issues have already been resolved. Overview of relevant image acquisition / camera specifications and

selection including resolution, speed, and comparison of performance and operational characteristics of monochromatic, color and line-scan image acquisition. Brief overview of image acquisition, I/O hardware functions, plant-floor enclosure ratings, and relevant specifications.

- Machine vision lighting purposes, principles, and implementation. This briefly distills and covers the key points of this important and extensive topic. It covers the objectives of machine vision lighting, and how they are often the opposite of just "lighting it up". Next is an introduction to the fundamental illumination scenarios, their uses and how they are created. This includes the geometry of the workpiece, the imaging equipment and the lighting equipment, and the geometric relationship between these three. Review of types of light sources that are inside lighting products, and the types and terminology of lighting products. Finally, examples are given which combine all of the above principles.
- Machine Vision lens types and selection. Standard and specialized lenses. Brief overview of this extensive topic.

An extensive notebook, EyeVision® CD, and a training course CD with example images, problems, and solutions are provided to each participant.

The duration of the MV-205 course is 1 ¾ days

EyeVision – Advanced Topics (Course #MVC-206)

This course covers the special and more complex EyeVision tools (relating to factory built units) which were not covered in MVC-205. This is a 3/4 day course. MVC-205 is a pre-requisite.

Hands on EyeVision Practice (Course #MVC-218)

Hands on EyeVision practices using approximately 10 basic applications. Includes extra coverage of those areas that are of greatest interest to the attendees. Also includes practice on other aspects of setup. Pre-requisites are MVC-205 and (for full hands-on participation) a notebook computer with a CD drive. This is a ¾ day course.

Industrial Machine Vision Course 221 (#MVC-221)

This 2 day (16 hour) course covers the machine vision principles, practices, programming, systems, hardware, software, applications, implementation, technologies, physics, and project management which are crucial to success. Here are examples of areas covered:

- Overview of machine vision system architectures, configuration, and terminology.
- Objectives, principles, and engineering of machine vision lighting and illumination. Machine vision lighting purposes, principles, and implementation. This briefly distills and covers the key points of this important and extensive topic. It covers the objectives of machine vision lighting, and how they are often the opposite of just "lighting it up". Next is an introduction to the fundamental illumination scenarios, their uses and how they are created. This includes the geometry of the workpiece, the imaging equipment and the lighting equipment, and the geometric relationship between these three. Review of types of light sources that are inside lighting products, and the types and terminology of lighting products. Finally, examples are given which combine all of the above principles.
- Machine vision light sources. Strengths, weaknesses, terminology, and application parameters of machine vision light sources.
- Lenses and optics. Purpose, principles, types, specifications and selection.

- “A Manager’s Guide to Successful Machine Vision”. Covers project inception through successful long-term ownership. This covers the “secrets” of the FSI “Assured Path to Success™)” roadmap, which has doubled the success rate of machine vision applications from 50% to 100%. This includes development of an application specification optimized to reduce cost while accomplishing the require mission. It covers effective methods and sequencing of the other steps including selection of equipment and technologies, creation of the physical and programming solutions, testing and hardening, documentation and planning for successful long-term ownership.
- Machine vision software and programming. This section uses example software engines to provide visuals and specifics in all of the covered areas. This class covers:

    - Inspection program
    - Image processing tools
    - Gauging (including high accuracy edge modeling, static and dynamic calibration, gauging rules),
    - Color analysis
    - Neural net processing
    - Classification
    - Image transformations
    - Filtering
    - Gauging
    - Image calibration
    - Gauging tools
    - Bar code
    - Data-matrix reading
    - OCR
    - OCV
    - Edge detection algorithms
    - Re-sampling
    - Print quality inspection
    - Sub-pixeling resolution
    - Robot guidance
    - Surface analysis
    - Template matching
    - “Location” programming for inspection of product where the position and orientation varies
    - Unrolling images.
    - System level programming function such as GUI’s,
    - Discrete and data I/O,
    - Security
    - Effective
    - Software
    - Image
    - Programming documentation
    - Image storage on triggered application

- Reference images
- Operating modes
- Program architecture including program flow and passage of parameters

- Adaptation to the full range of line speeds using (where needed) direct hardware triggering, strobe synchronization and parallel processing.
- Imaging and imaging resolution. Introduction imaging parameters and technologies. Progressive, interlaced, rolling, area and line scan imaging processer covered. Gray scale, single and three chip color imaging. Brief coverage of imaging outside of the visible band including near-IR, IR, UV, UV florescence, and X-Ray. Introduction to spatial and array resolution.
- Adaptation to factory floor conditions.
- 3D Imaging. Covers the various underlying technologies and their architecture, strengths, weaknesses and usage in machine vision.
- Introduction to false rejects in automatic inspection systems. Analysis, including the relationship with zero defect automatic inspection. Strategies and specification.
- Machine Vision accuracy and how to achieve it. Begins with a framework, which dispels common misconceptions.
- The latest trends, advances, and emerging technologies in machine vision. For example, Deep Learning, Machine Learning, hyperspectral imaging.

The course does not cover the manufacture of machine vision units and systems, although it does cover the architecture of such. Nor does it cover lower (library and code) level machine vision programming.

Hands on Remote NeuroCheck or EyeVision Practice (Course #MVC-223)

Supervised, structured remote practice on NeuroCheck and/or Eye Vision. Pre-requisites: MVC-201 for NeuroCheck or MVC-205 for EyeVision. This is structured as a sequence of “assignments” tailored to the student, which are completed according to the student’s available time. Upon completion, each is reviewed and discussed.

Machine Vision Lighting, Illumination and Solution Physics (Course # MVC-230)

Machine vision “lighting” is actually the design of the illumination and its interaction with the workpiece and imaging process to enable the programmatic solution. Weakness in handling this area is one of the two most common causes of unsuccessful machine vision applications.

This 2-day (16 hour) course provides solid foundation in the relevant physics and scientific areas and upon that foundation teaches the purpose, methods, technologies, equipment and physics of solving practical machine vision problems.. This includes all elements in the entire lighting solution “chain” relevant to this from generation of the illumination, transmittal to the workpiece, interaction with the workpiece, through processing elements such as optics to conversion to an electronic image. Coverage in each area is selected and weighted based on the end objective which is accomplishment of machine vision.

Examples of concepts covered:

- A foundation in the physics of light and the other parts of the electromagnetic spectrum relevant to machine vision. (IR, UV, X-Ray).
- A foundation in the interaction between light and workpieces with respect to machine vision.
- Common machine vision math, types, and units of mathematical measurements.
- "Lighting" as actually a spatial solution involving the lighting, the workpiece and the imaging system, with a purpose of creating reliable differentiation as needed for the intended imaging and programming approach.
- Identifying and avoiding common errors and misconceptions regarding machine vision lighting.
- Lighting for color analysis. The various meanings of color including human perception and spectral content for imaging systems.
- Characterization of light sources by parameters such as generation method, geometry of emissive area, long term stability, life expectancy, efficiency / heat generation, environmental tolerance, collimation, polarization, coherence, units of energy output and energy output density, cost, cycling and control capabilities. A discussion of the various choices and technologies within each of these parameters. Evaluation of light sources and light source selection strategies based on these parameters.
- Simple low cost powerful lighting / spatial solutions for common machine vision objectives.
- Unusual lighting solution strategies for special circumstances.
- Lighting strategies for ultra-high accuracy gauging, surface inspection, high speed processes, UV florescence for coating inspection
- Lasers for 2½D and 3D imaging and analysis.
- Differences in lighting design for Deep Learning and Machine Learning based machine vision.

NeuroCheck Plug-In Course (#MVC-291)

This is a 2-day course.
Content:

Creation of Plug-ins
Utilization of Already-Developed Plug-Ins

Pre-requisites:

Completion of MVC-201
Fluent on writing DLL's with C++ (only a brief review of key areas on this is included)
Instructor approval (based on above 2 items)
Bring Notebook computer with C++ loaded, and CD ROM drive

Customized Training, with MVC-301 Type Customization (#MVC-301)

This condensed, customized training selects material from any of our standard courses except MVC-291.

Usually it is designed to include the material most relevant to a particular application. The standard length of this course is 1 day. Shorter and longer variants are available.

Customized Training, with MVC-302 Type Customization (#MVC-302)

This condensed, customized training, which includes material, that is not in our standard courses, including more specialized and in-depth variants of material, which *is* in our standard courses.

When the training is *not* in conjunction with an FSI Solution/system, the stages before the training are:

1. Brief discussion about the general nature of the desired material.
2. Proposal & order
3. Detailed discussion about the tools or topics to be covered
4. Preparation of the course

When the training *is* in conjunction with an FSI Solution/system, the stages before the training are:

1. Proposal & order
2. Preparation of the course

The length of the course is flexible; a typical length is 1 day.

Suggested / Popular Courses for NeuroCheck-Powered Machine Vision Training

The most common and popular way to obtain NeuroCheck training is to take course # MVC-201, and (often) to follow it by MVC-204.

Suggested / Popular Courses for EyeVision and EyeSpector-Powered Machine Vision Training

The most common and popular way to obtain EyeVision and EyeSpector training is to take course # MVC-205, and (often) to follow it by MVC-218.

Course Schedule

MVC-101	*	*	*
MVC-102	**	**	**
MVC-103	**	**	**
MVC-201	**2/24/20 – 2/25/20**	**5/26/20 – 5/27/20**	**8/24/20-8/25/20**
MVC-202	**	**	**

MVC-204	**2/25/20 – 2/26/20**	**5/27/20 - 5/28/20**	**8/25/20 - 8/26/20**
MVC-205	**2/19/20 – 2 /20/20**	**06/22/20 - 6/23/20**	**10/19/20 -10/20/20**
MVC-206	**	**	**
MVC-221	**	**	**
MVC-230	**	**	**
MVC-218	**2/20/20 – 2/21/20**	**6/23/20 – 6/24/20**	**10/20/20 - 10/21/20**
MVC-291	**May 2020****	**November 2020****	**May 2021****
MVC-301	***	***	***

Locations for Scheduled Training Courses

Scheduled trainings are held at our near our factory in the Chicago area. However, if you are the first sign up for a scheduled course, prefer our Greenville SC location, and sign up 2 persons, we will move that course to our Greenville SC office.

On-Site, Remote Skype and Customized Training

Ask us for a quotation for on-site, Skype or customized training. `The most economical customized training is a selection of material from current courses. Impromptu customization is also economical. Advanced preparation of new material (such as application-specific material) is also available for additional charge. On-site training generally provides a cost saving for larger amounts of attendees.

* Available on the first day of each MVC-201 and MVC-205 course.

** Please contact FSI for scheduling.

***Scheduling will be triggered by and arranged for your company specifically.

Registration & Details

Please contact your FSI Machine Vision representative or FSI for detailed pricing and registration information. Here is a general overview of pricing:

- MVC-101, MVC-102 & MVC-103 are free.
- MVC-201, MVC-202 MVC-204, MVC-205, MVC-206, MVC-218, MVC-221 MVC-230 and MVC-301 are economically priced.
- MVC-291 is a specialized course with substantially higher pricing.
- On-site and remote Skype training is quoted based on your requirements.