1394 – Best Solution for Machine Vision Applications

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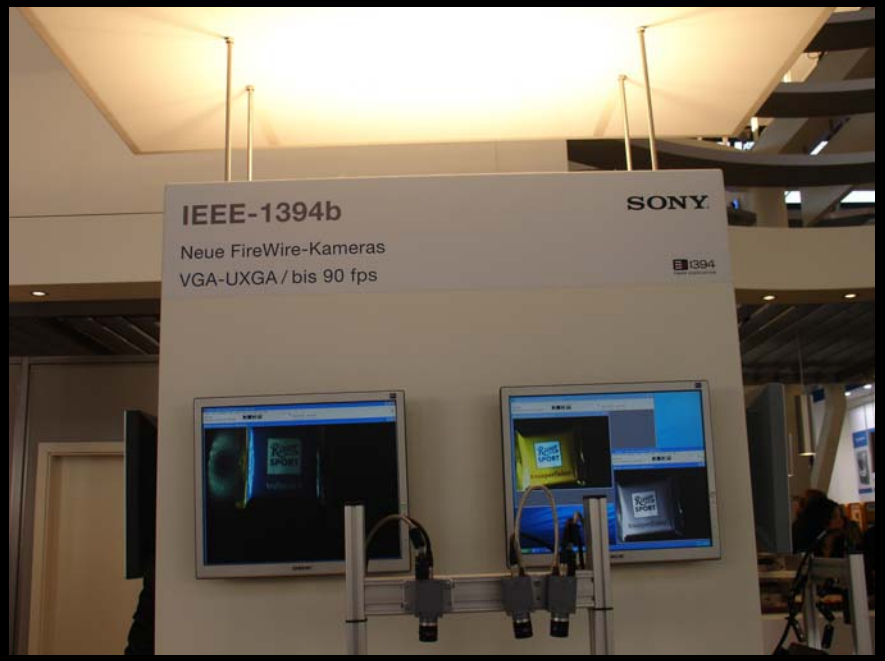
Machine Vision Applications

- Computer based, precise and non-invasive visual techniques for a wide range of manufacturing activities, such as inspection, assembly and many other tasks.
  - Pharmaceuticals
  - Aerospace
  - Food
  - Automotive
  - Electronics
  - Semiconductor



Machine Vision Trends

- Machine Vision (MV) systems are the preferred means of acquiring and analyzing visual information.
- Integration of a number of disciplines.
- Multiple cameras of MV system communicate with each other.
- Most industry-standard solutions include the following levels.
  - a physical transport mechanism.
  - a higher - level communications protocol.

Separating Transport and Protocol Layer Functions

- IEEE1394/IIDC architecture separates the transport layer from protocol layer for camera control parts.
  - IEEE1394 driver has the low-level configuration and timing details.
  - No need for manual setting certain parameters.
  - Human interface only at the API (application programming interface) for the IIDC standard.
- GigE has no such clear separation.
  - GigE system has less adequate quality of service (QoS).
  - The GigE system designer must manage low-level parameters such as packet size to ensure adequate performance.
  - The Fraunhofer Institute reported that, in a GigE vision system, both data rates and CPU loading are significantly impacted by need of configuration.

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Interoperability

- No standard Microsoft Windows (XP, Vista) system driver for GigE Vision.
  - hardware is dependent upon vendor-specific drivers and software for its configuration.
  - Problems occur when combining hardware from more than one supplier.
  - Makes it difficult to attain maximum performance even from a single-vendor solution.
- Using GigE Vision network drivers and a 3rd party filter driver is not possible to achieve optimum performance.
- Many GigE cameras are not accessible via the GenICam layer.
- Some interoperability features have not been implemented in the GigE Vision standard.
  - Data sent from one camera can only be acquired by one computer due to lack of UDP (User Datagram Protocol) multicast functionality.

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Device Discovery

- Initiation is automatic and quicker in IEEE 1394.
  - A bus reset and enumeration cycle that automatically generates an identifier for each device on the bus for connecting a new device.
  - The enumeration cycle takes up to two seconds.
  - The device is subsequently controlled via DCAM/IIDC.
- Devices are identified via their IP address in GigE Vision.
  - Takes around 10-20 seconds through the use of either fixed IP, DHCP (dynamic host configuration protocol) or auto-IP techniques.
  - The developer must use vendor-specific control software to set the IP configuration technique the camera should employ.

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Data Rates, Determinism, Latency and Quality of Service

- GigE's l000 Mbps is attractive for high-bandwidth applications.
  - Maximum practical bus load proved to be 750 Mbps.
  - Causing jitter problems for cameras.
- GigE Vision is lack of quality of service (QoS) features
  - Partial bandwidth to be reserved for re-sends and control signaling.
  - Operation on collision detection intrinsically increases the latency for Gig E vision system.
- IEEE 1394b has less latency and more deterministic.
  - Isochronous takes up to 80% of the total system bandwidth (640 out of 800 Mbps).
  - Asynchronous bandwidth is available for control packets and other data.
  - IEEE 1394/IIDC systems can achieve the expected performance without tweaking of system parameters.

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Cable Length, CPU Load, Camera Loading

- GigE Vision extends standard UTP copper cable up to 100 meters.
- IEEE 1394b can extend 1394b signal over fiber over 500 meters.
- The low-level GigE Vision configuration protocol requires longer CPU loading than DMA-driven IEEE 1394 protocol.
- GigE Vision system's loading increased approximately linearly with the number of cameras in the system.
- IEEE 1394 system demonstrates approximately even levels of loading in the multiple camera system.
- 1EEE1394 IIDC devices are generally powered over cable with a maximum of 45W of power with voltage of up to 30V.

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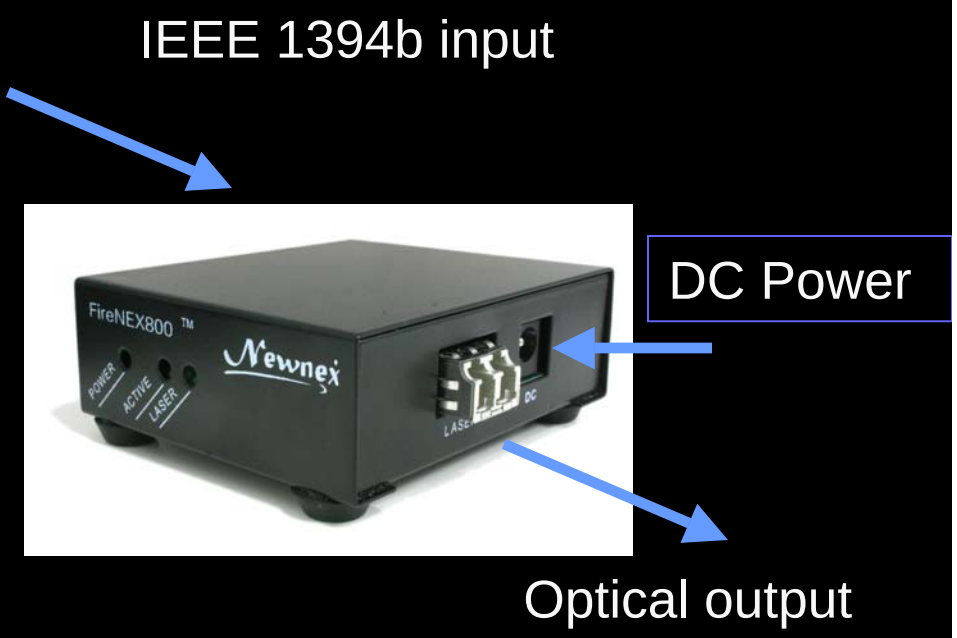
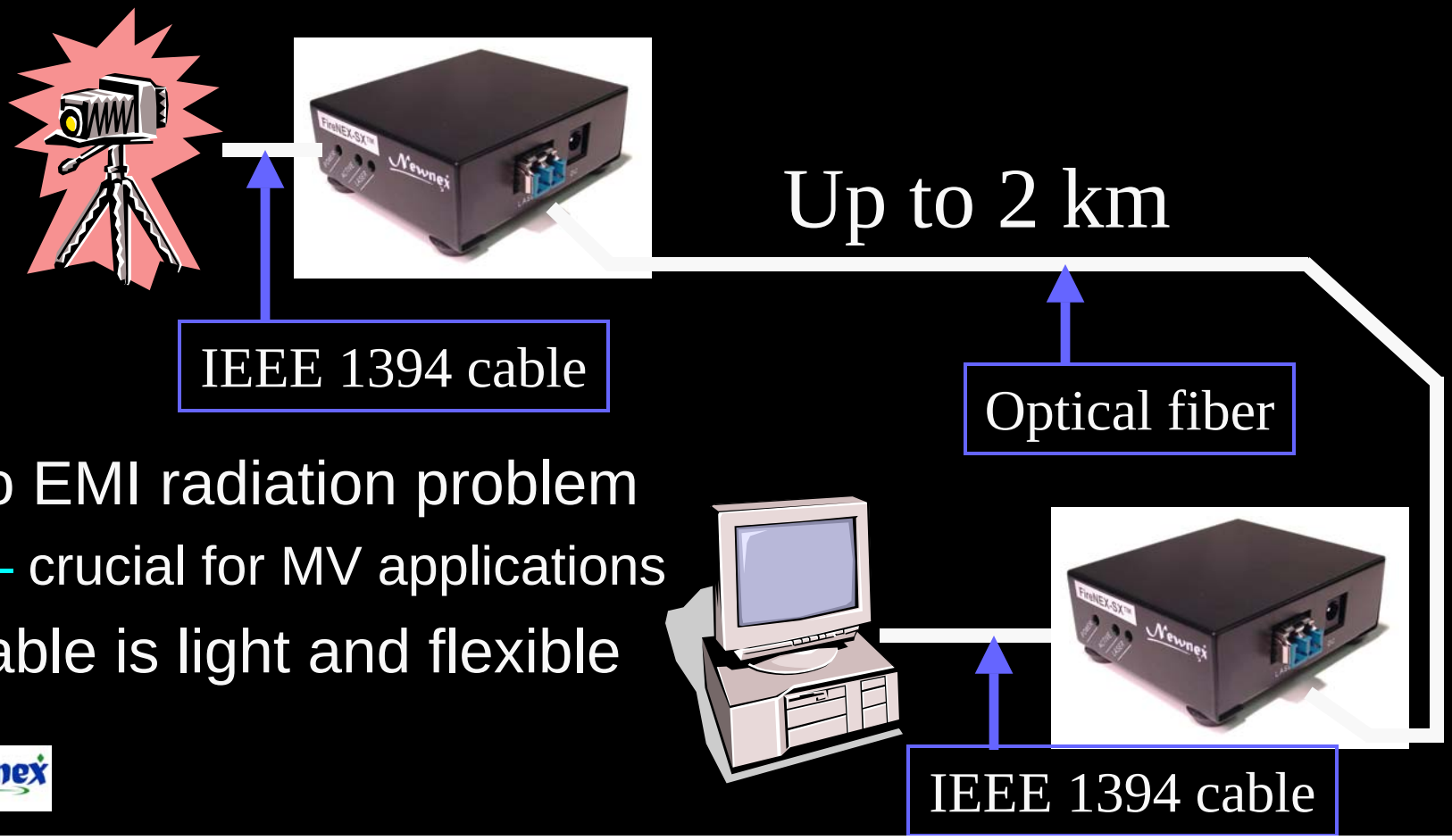
1394b Long Haul Connection for Machine Vision

- Demonstration of IEEE 1394b signal extended over fiber at 500 meters at S800 for machine vision application.



Benefits of 1394b over Fiber Repeater

- High data rate: Gbps
- Long range: multi-km
- Low bit error rate: 10^{-9} to 10^{-11}



- No EMI radiation problem
  - crucial for MV applications
- Cable is light and flexible

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Other 1394b Long Haul Connections for Machine Vision from Newnex

Now:

- 1394b over Cat5 repeater
  - Existing Cat5/5e/6 cable
  - Up to 100 meters
  - Bus powered
  - S400

Roadmap:

- S1600 and S3200 optical repeater
- S800 1394b over coax

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Conclusions

- GigE Vision offers higher data rate and longer copper cable length.
- Fraunhofer IPMS and Sony study shows GigE Vision less suitable for use in machine vision applications.
  - GigE Vision is less readily to the transmission of real-time data due to lack of quality of service (QoS).
  - GigE Vision needs more CPU loading than IEEE 1394.
- IEEE 1394/IIDC allows integrators to work via an API at a high-level, whereas GigE Vision/GenICam requires low-level configuration and so GigE is more difficult to demonstrate interoperability between vendors.
- IEEE1394 is still the preferred solution for most of today's machine vision applications.

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Thank you!

Acknowledgement to

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