

Demonstration of “IDN-Toolbox”: A Software to Visualize and Analyze IDN (ILDA Digital Network) Streams

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Abstract — this demo presents continued work of the Laser & Light Lab at the Institute of Computer Science 4 of the University of Bonn based on earlier demo presentations and on standardization work of the International Laser Display Association (ILDA). The ILDA Digital Network (IDN) Stream Specification [7] has been published in 2015 as the first of a “family” of ILDA technical standards dealing with digital transmission of laser projection/picture data over local networks.

The demo presents our “IDN-Toolbox”, a software that is able to receive IDN streams with laser projection data and visualize the laser stream/frame data on a computer monitor. Two modes are possible: In the live mode, the software visualizes the incoming IDN stream’s laser data in real time. In addition, the incoming stream can be recorded in memory for offline analysis to be done after and independently of the original show playback. The LCN demo presents all modes of the IDN-Toolbox where the IDN stream data is coming from both IDN-capable laser show software and non-IDN-capable laser software using an analogue ILDA to IDN converter.

Key words – *IP-based network control; Laser projection; Local area networks; Multimedia & real-time streaming; Visualization and Analysis*

I. INTRODUCTION & MOTIVATION

Laser show systems can be considered to be among the most visible applications of lasers and probably the most entertaining ones. Introductory information on how laser shows work can be found in [8]. Some relevant basic information on these systems and their relation to the topic area of computer networks have been given in some demonstration papers of the same author, see [4] + [5] + [6].

Our NetSys 2015 demonstration [5] presented a multi-platform library for the software sending side according to the IDN stream specification. The experience gained contributed to the standardization process and finally, approved in the annual ILDA meeting in October 2015, the IDN Stream Specification became the first technical ILDA standard on IDN. In the IDN scenario, a computer with laser show software generates the data for laser projection and sends out a stream of UDP packets

over the local network according to the IDN Stream Specification. An IDN-capable receiver will receive the IDN stream and generates the necessary control signals for a laser projector (typically X- and Y-signal for redirection of the laser beam and color signals RGB for modulation of red, green and blue laser modules). In the best case, the IDN receiver is directly integrated into the laser projector. More details on the type of data that needs to be exchanged via IDN and on the network architecture in typical IDN scenarios can be found in [5].

Typically, laser shows will be used with more than one laser projector. In this case, several IDN streams flow through the local network. In current implementations of IDN, typical local network technologies like Ethernet or Wireless LAN are used, together with the IP + UDP/TCP protocol families on network and transport layer. Therefore, the IDN sender(s) and receiver(s) can be identified by their IP address.

Before the digital transmission of laser projection data over local networks was introduced (either IDN, or also proprietary other solutions, cf. [5]), the analogue ILDA Standard Projector (ISP, [7]) was the relevant specification on how to connect laser control interfaces with laser projectors in a vendor-independent way. Each laser projector was connected to a control-interface by an analogue cable with DB25 connectors (25 wires carrying the signals for X, Y, colors R, G, B and others), if necessary over long distances.

The IDN Stream Specification significantly helps in encoding of laser show data into digital data streams in a “system-independent” way. The upcoming standard for IDN File Transfer Format aims to describe the format for storage of IDN-Stream messages persistently in files. For non-IDN capable laser show systems, it is possible to use an analogue ISP-DB25 to IDN converter, such as the StageFeed ISP hardware (DexLogic, cf. [1]). StageFeed ISP is a network sender (FPGA-based), digitizing the (analogue) ILDA ISP-DB25 signals (several channels) and sending this digital data over an Ethernet based network according to the IDN stream specification.

The Laser & Light Lab [9] of the Institute of Computer Science 4 at the University of Bonn (in the following short “Uni-Bonn-LLL”) builds on conceptual and programming experience in networked environments for laser show projections systems, as was already presented with earlier LCN 2009 and LCN 2011 demos [2] and [3]. Currently, Uni-Bonn-LLL as a non-profit ILDA member contributes to the IDN development and proof-of-concept implementations, which were further demonstrated at LCN 2014 [4], NetSys 2015 [5], and NetSys 2017 [6].

II. SCOPE AND SIGNIFICANCE OF THE DEMO

The demo for LCN 2017 presents our “IDN-Toolbox”, a software that is able to receive IDN streams with laser projection data and visualize the laser stream/frame data on a computer monitor.

The usual operation of a laser show is to have a computer with a laser show software, have some connected laser control interface(s), and respective connections to one or more laser projectors. With IDN, the connection from the computer up to the laser projectors can be made over local area networks (e.g. Ethernet) carrying digital data streams of the laser projection data.

The IDN-Toolbox resembles one IDN receiver. This can be useful for several purposes, even without any laser projector being active. First of all, in the live mode the software visualizes the incoming IDN stream’s laser data in real time. This can just be used to check if the laser show system is generating correct data and to check if the network is working as expected. Additionally, in the live mode some features of analysis can be activated:

The individual points (X, Y coordinates, with colors R, G, and B) can be made visible without connecting lines. In a real laser projection, the moving laser beam always creates a visible line while moving from one to the next point. The point preview in IDN-Toolbox can be used to visualize the distances between consecutive points in the IDN stream/frame data.

Additionally, the so called blank lines can be visualized with a color that can be specified by the user. In the real laser projection, the laser beam is “blanked” (all colors R, G, and B set to zero) while moving from one object to another in a complex projection (e.g. one red square and one green triangle with some distance between each other). The blank line visualization can be useful to check the order of objects in a complex projection.

The second main mode of the IDN-Toolbox is useful for an offline analysis of the received IDN stream data: The incoming stream can be recorded in memory, and additionally can be stored to hard disk and reloaded for later analysis. In the offline mode, the point display mode and blank line visualization are available as with the live mode.

Furthermore, in the offline mode it is possible to generate a histogram of point repetitions: The laser show software is able to repeat specific points of some shapes to make the moving laser beam slow down while drawing the shape. Typically the corner points of a square or triangle are repeated to prevent a distortion of the projected shape when the laser beam moves too fast. For some laser effects, intentionally so called “hot

spots” are projected: Intense laser beams should be visible in mid-air, e.g. combined with lower intensity colored beams connecting these points. The point repetition/duration histogram can be used to identify such “hot spots” which might be dangerous in terms of laser safety (in particular in public places with so called “audience scanning”, where the laser beams are intentionally directed into the audience area, which should be done in a safe and legal way).

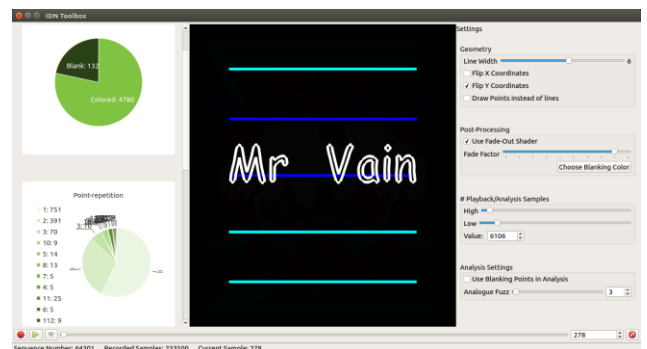
Another analysis feature is to generate a histogram of distances between consecutive points in the IDN stream. Usually, the distances between points are small to result in a smoothly moving laser beam when drawing a figure. However, for blanking lines a laser show software may only insert a small number of points for a larger distance (X and Y typically have 16 bit resolution), resulting in large step sizes between consecutive points, locally increasing the speed of the laser beam, which may overload or even harm the electromagnetic scanning systems of a laser projector. This histogram of point distances reveals whether the IDN point sequence shows a smooth, regular pattern or if there are some irregularities.

The LCN demo presents all modes of IDN-Toolbox (live mode visualization, recorded/offline visualization with specific analysis features) where the IDN stream data is coming from both IDN-capable laser show software and non-IDN-capable laser software using an analogue ILDA to IDN converter. The latter case may be considered as particularly interesting, because a comparable analysis of the laser stream data would only be possible in a complex measurement setup using digital multi-channel oscilloscopes.

In a separate project, Uni-Bonn-LLL has developed a so-called “dissector” plug-in for Wireshark which then is able to analyze and display the content of IDN stream packets in the Wireshark GUI (in the typical text-based style of showing content of known packet types, like TCP or UDP header, etc.). Wireshark with IDN dissector will be used as an additional means to visualize the packet flow activity in the local network with our LCN 2017 demo.

III. SOME SCREENSHOT PREVIEWS OF IDN-TOOLBOX

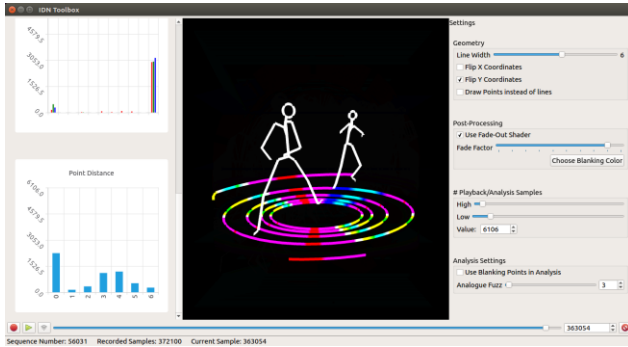
In the following, there are some previews of the IDN-Toolbox software.



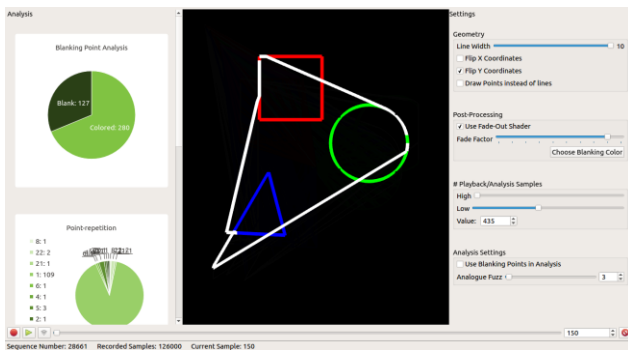
The center pane shows the visualization of the received IDN stream data, in this case coming from a graphics laser show with readable text.

The pane on the right hand side allows to change some parameters for the live visualization as well as selecting the amount of IDN stream samples to be considered in the offline analysis.

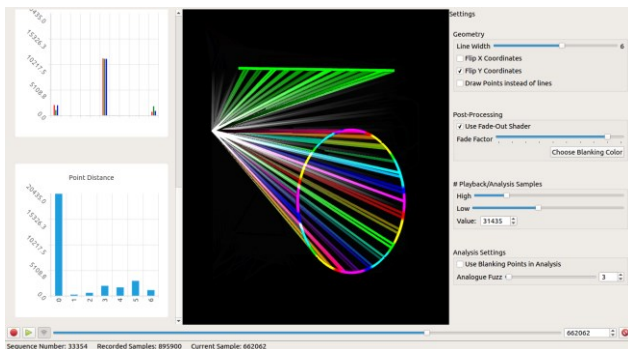
The left hand side pane presents the data of the analysis modules. Here, it shows the amount of blanked and colored points in the analyzed sample set (top circle diagram) and the analysis of the point repetitions (bottom circle diagram).



This preview shows another sample set, and the analysis view on the left-hand side pane has been scrolled down to show a histogram of color intensity values and the above mentioned histogram of point distances. In this case, there are no irregularities in the laser stream data.



This preview shows the above mentioned blank line visualization with three simple shapes.



This preview shows an additional visualization of the laser beams in mid-air, which also would be visible with a real laser projection and artificial haze or fog in the air.

IV. CONCLUSION AND FUTURE WORK

The IDN-Toolbox is a software that is able to receive IDN streams with laser projection data and visualize the laser stream/frame data on a computer monitor. The basic operation with live and offline mode and IDN streams coming from both IDN-capable software and non-IDN-capable laser show systems have been showcased in the LCN 2017 demo.

Currently, the IDN-Toolbox is only available as a Linux implementation. However, for the development and in particular the graphical elements we used the Qt cross-platform application framework. One of the next upcoming working items is the finalization of porting the IDN-Toolbox for the Windows operating system.

Furthermore, the IDN-Toolbox has been designed in a modular way: It may be extended by additional analysis features implemented in separate modules. Or the receiving IDN module may convert the incoming IDN stream data and pass it to another application.

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REFERENCES

- [1] DexLogic Hardware and Software Solutions (ILDA member), Karlsruhe, Germany, <http://dexlogic.com> (last accessed Aug. 24, 2017)
- [2] Matthias Frank, Network based real-time control of a laser show projection system, IEEE LCN 2009 demo publication, Zurich, October 2009, <http://www.ieee.lcn.org/prior/LCN34/lcn34demos.html> (last accessed Aug. 24, 2017)
- [3] Matthias Frank, An Experimental Architecture of IP-based Network Control of Laser Show Projection Systems, IEEE LCN 2011 demo publication, Bonn, October 2011, <http://www.ieee.lcn.org/prior/LCN36/lcn36demos.html> (last accessed Aug. 24, 2017)
- [4] Matthias Frank, Demonstration of Bandwidth Demand and Jitter Properties of a Software Sender/Scheduler for the (proposed) ILDA Digital Network, IEEE LCN 2014 demo publication, Edmonton, September 2014, http://www.ieee.lcn.org/prior/LCN39/Program_demos.html (last accessed Aug. 24, 2017)
- [5] Matthias Frank, A Multi-Platform Library for a Software Sender for the (proposed) ILDA Digital Network, demo publication at the International Conference on Networked Systems, NetSys 2015, Cottbus, March 2015, <https://www.netsys2015.com/program/demonstrations/> (last accessed Aug. 24, 2017)
- [6] Matthias Frank, A Framework for Recording and Replaying IDN (ILDA Digital Network) Streams on PCAP Basis, demo publication at the International Conference on Networked Systems, NetSys 2017, Göttingen, March 2017, http://netsys17.uni-goettingen.de/?page_id=870 (last accessed Aug. 24, 2017; will appear online in the IEEE Xplore Digital Library)
- [7] ILDA, ILDA Technical Standards – International Laser Display Association, Orlando/Florida, USA, <http://www.ilda.com/technical.htm> (last accessed Aug. 24, 2017)
- [8] Laser F/X International, How Laser Shows Work - Introduction, <http://www.laserfx.com/Works/IndexWorks.html> (last accessed Aug. 24, 2017)
- [9] Laser & Light Lab, Institute of Computer Science 4 (ILDA member), University of Bonn, Germany, <http://ill.net.cs.uni-bonn.de/> (last accessed Aug. 24, 2017)