Introduction to Katto Lab Network Group

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About Network Area

— Main research Area —
- ✓ Point Cloud Steaming
- ✓ Point Cloud Compression
- ✓ Video Streaming
- ✓ Information Oriented Network
- ✓ Hart Rate Estimation

—Recent Key Word—
Point Cloud Compression, Point Cloud Streaming, Point Cloud Classification, Point Cloud Object Detection, Indoor Location estimation , PointNet, Hololens, Lidar, Unity, 360-degree streaming, MPEG-DASH, AR, VR, Hart Rate estimation , IoT etc…

Point Cloud

- ## What is point cloud
  - Point cloud refers to data composed of a collection of points
  - 3D data with basic positional information in X, Y, Z and color

- ## What point cloud can do?
  - ・Wide area surveying combined with drones and other equipment is possible.
  - ・Easy to understand visually due to its three-dimensionality
  - ・Simulations can be performed using 3D models.

[1] 点群データ(ポイントクラウド)とPC-MAPPING, https://www.mapcom.tokyo/mapcomworldtopics/topics23/
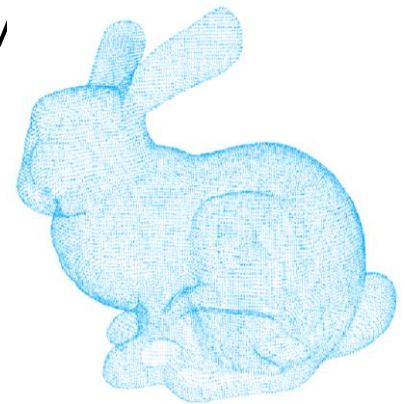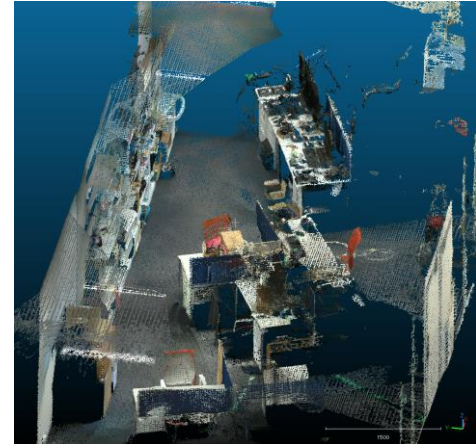
What is Video Streaming?

– **Streaming using HTTP is common**
  – HTTP Live Streaming
  – MPEG-DASH

– **MPEG-DASH**[1]
  – Encode a single video content at different bitrates

  – Divide into segments

  – Change the bit rate of the delivered video to reduce video interruptions

[1]
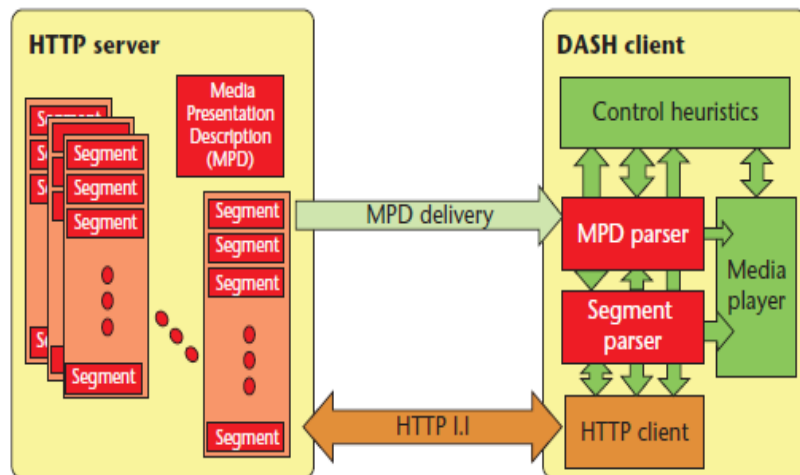
[1] "The MPEG-DASH Standard for multimedia streaming over the internet", Anthony Vetro, Mitsubishi Electric Research Labs.

What is IoT?

Internet of Things : Connecting things to the Internet and exchange information

✓Using cloud computing and mobile networks

✓It has many issues such as security, network configuration, and power

Application	• Perform various tasks such as anomaly detection
Cloud Computing	• Data storage, analysis, visualization
Wireless Sensor Networks	• Data collection and transmission

Ex1:Indoor of moving objects using LiDAR Location Estimation
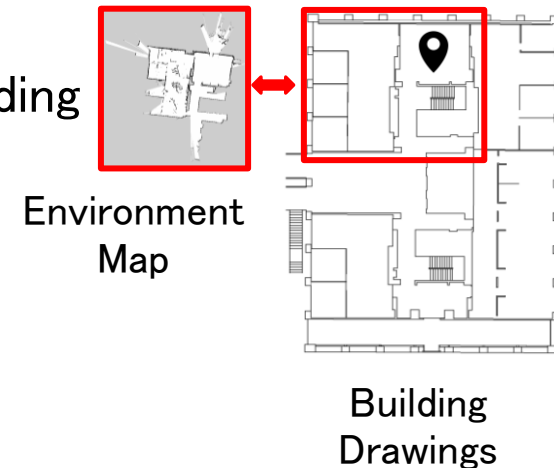
- LiDAR Sensor

  Measures distance to an object by emitting a laser beam and measuring the time of flight until the reflected light returns.

[3]

- Indooe Location estimation

  ① Creation of environmental maps from LiDAR data and odometry information

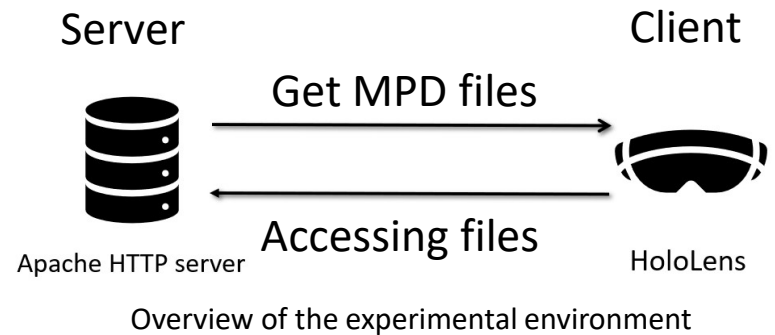 ② Estimates current location by checking against building plans, etc.

Environment Map

Building Drawings

[3] HOKUYO, UST-30LC/LCN, https://www.hokuyo-aut.co.jp/search/single.php?serial=201

Ex2: Evaluation of live video distribution characteristics on MR devices

・MR(Mixed Reality)

   :Integrate AR and VR

・ Adaptive control with MPEG-DASH

・Live 360-degree video streaming

・QoS, QoE Evaluation

Server   Client

Get MPD files

Accessing files

Apache HTTP server   HoloLens

Overview of the experimental environment

Conceptual diagram of a meeting utilizing MR applications

MR device (HoloLens)

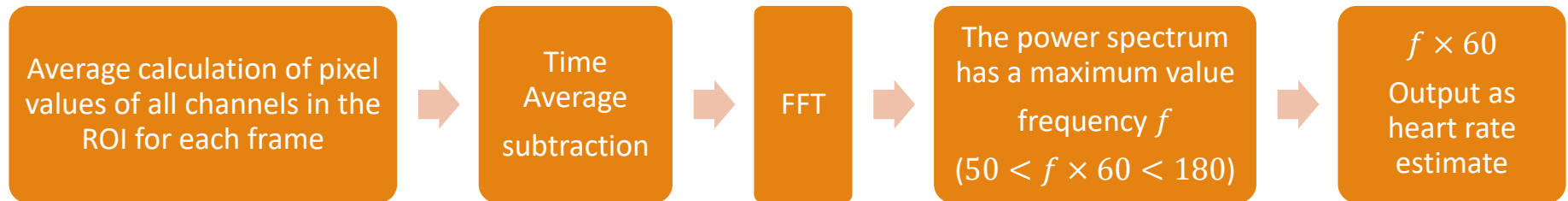# Ex3: Video Streaming control using reinforcement learning

・ Android application to collect communication quality data

・ Learning efficient video distribution control using reinforcement learning based on collected data

・ Implementation of video delivery control using reinforcement learning in a real environment

[2]

[2]H. Mao, *et al.*, "Neural adaptive video streaming with pensieve," ACM SIGCOMM 2017.
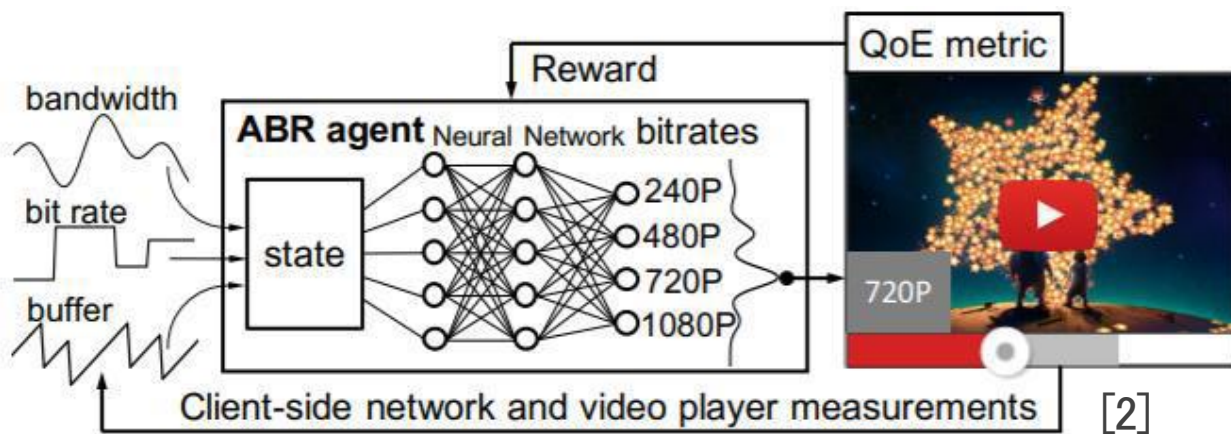
Ex4:Evaluation of the accuracy of non-contact heart rate estimation using video images

Detects faces from video images and sets a region of interest (ROI)

➢ Flow of heart rate estimation

| Average calculation of pixel values of all channels in the ROI for each frame | → | Time Average subtraction | → | FFT | → | The power spectrum has a maximum value frequency f ($50 < f \times 60 < 180$) | → | $f \times 60$ Output as heart rate estimate |

➢ Example of accuracy evaluation
➢ Evaluation of the effect of the environment at the time of video capture on estimation accuracy
  ➢ Angle of face, angle of camera
  ➢ Facial movement
  ➢ Assessing the impact of data used for estimation on estimation accuracy
    ➢ Combination of each RGB channel to be used
   ➢ ROI Location
    ➢ Image compression
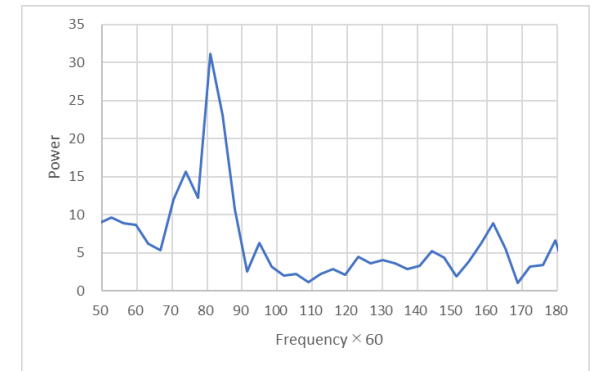
Heart Rate Estimate
80.9

Ex5: Classification of Point Cloud Data Using Deep Learning

▪ Point Cloud Data

‣A Collection of 3D points (with geometry and image infomation) that represent 3D contents

‣ Autonomous car, digital twin, AR/VR etc.

‣Investigation of a learning method that enables classification of incomplete data (data with noise and occlusion) from actual sensors.

→ Evaluation of classification accuracy by applying various processing to training data

input

Using Deep Learning
Point Cloud Classifier

output

: chair

: not chair

: not chair
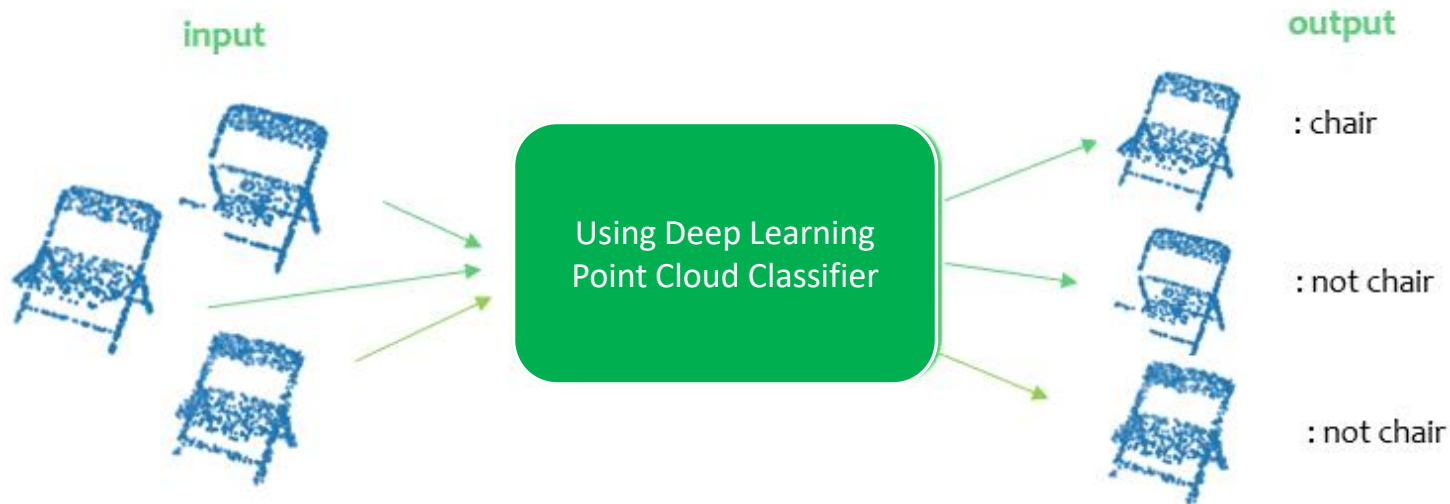
Ex6: Evaluation of packet loss in real-time Point Cloud Streaming and Error Concealment

・Point Cloud: Remote Conference・ VR/AR.

・Packet losses in streaming of point cloud impact reconstruction quality. →Error Concealment Technology
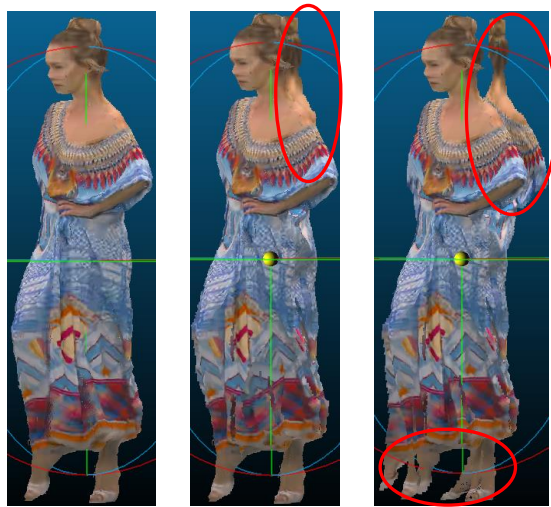
(a) Non-Loss   (b) 1% Loss   (c) 2% Loss

Example of reconstructed point cloud with error
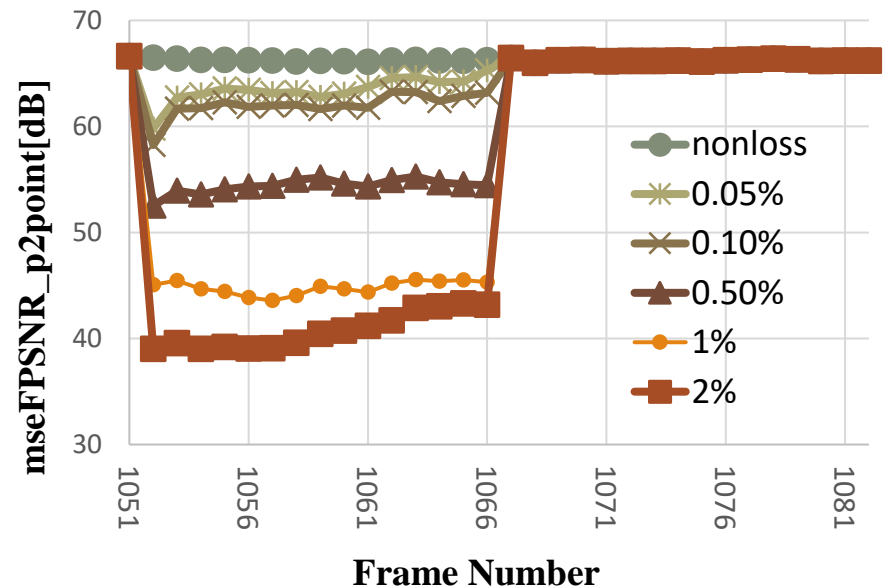
Example of PSNR Variation Due to Error Propagation Caused by Packet Loss

Ex7: 3D Point Cloud & AI for safe autonomous driving

・Fast Object Detection Without 3D CNN Using PointPillars

・Missing Small and Distant Objects Remains a Challenge

・New Activation Functions "βMish & SGSmeLU" Capture Even Small Features

  ・Experiments Confirmed Performance Beyond the Baseline, Aiming for Safer

  Autonomous Driving.

Computational Efficiency and Comparisons with Other Methods for Practical Deployment.

Let's study together in the network group!

- ✓ **Examples of Recent Research Themes in the NW Field**
- ✓ Evaluation of packet loss in real time 3D point cloud streaming
- ✓ Improvement of the 3D point cloud object detection method PointPillars using activation functions and Transformers
- ✓ Evaluation of the accuracy of point cloud by Generative AI
- ✓ Characterization of live distribution of video in MR devices
- ✓ Evaluation of non-contact heart rate estimation accuracy in various situations
- ✓ Examination of adaptive rate control method using Q learning
- ✓ Characterization of live distribution of video in MR devices
- ✓ Evaluation of non-contact heart rate estimation accuracy in various situations
- ✓ Efficient transfer method of sensor information using ICN and its evaluation
- ✓ Evaluation of the accuracy of extended methods that take occlusion into account point cloud classification models