# Cybermedia Center

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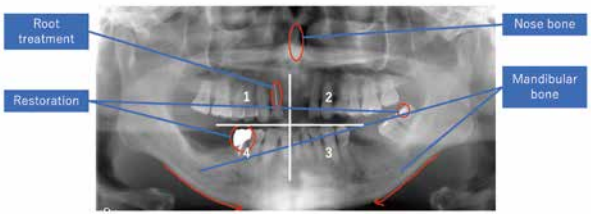
# Development of AI models for analyzing dental panoramic radiographs
# MPI communication logging module with BlueField-2 Data Processing Unit

## Development of AI models for analyzing dental panoramic radiographs

### Background

Panoramic radiographs are commonly used in dental diagnosis. According to a survey (M. A. Bruno, et. al., 2015), in dentistry, 60 – 80 % of misdiagnosis are due to human misinterpretation of diagnosis images. **Automatically analyzing panorama radiographs is expected to assist diagnosis.**




Example of dental panoramic radiograph

Tooth numbering according to the FDI notation system is a basic task for dental diagnosis. However, it's sometimes very difficult for dental experts to identify the numbers in the case of bad data quality.

FDI two-digit notation

| Upper right | | | | | | | | Upper left | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 48 | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 |
| Lower right | | | | | | | | Lower left | | | | | | | |

### Problem

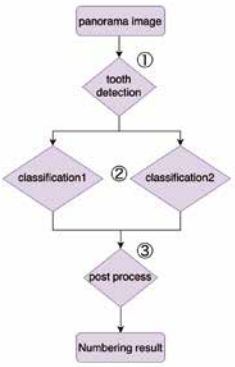
Many studies utilize the datasets with biased distributions regarding data quality. Open datasets have also similar bias. However, the data collected from Department of Oral Rehabilitation and Geriatric Dentistry including Implantology, Osaka University Dental Hospital contains many images of patients in more severe conditions. **This can negatively impact the judgments of experts, and also decrease the performance of machine learning.**

### Proposed approach

We proposed a hybrid method combining deep learning and domain knowledge-aware approach for tooth numbering of the Osaka University Dental Hospital dataset.

The effectiveness of our proposed method were evaluated using the Osaka University Dental Hospital dataset. **With our dataset, it is obvious that the proposed approach improved the accuracy and has best performance compared to existing works.**

We are also developing a new deep learning model applicable for datasets with various conditions of teeth on **SQUID.**




Flowchart of the proposed approach

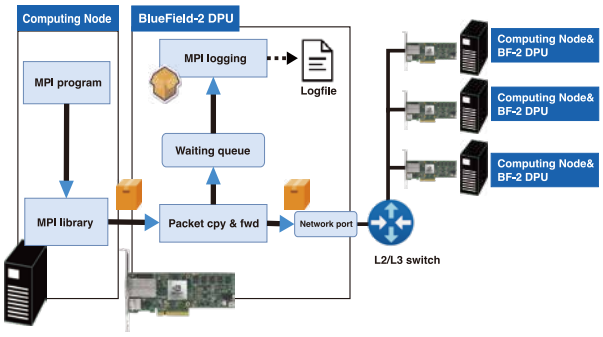
## MPI communication logging module with BlueField-2 Data Processing Unit

### Background

- Monitoring MPI-level activities to debug and optimize MPI application.
- Data Processing Unit (DPU), which executes networking processes instead of a computing node, has appeared.

### Proposal

MPI-communication logging module performing on BlueField-2 DPU device. DPUs allow the logging processes without negatively affecting MPI applications and CPU usage on computing nodes.



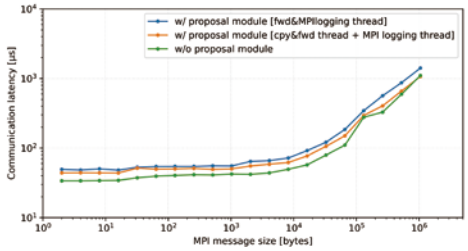

### Architecture

- MPI communication logging process
  - Specifying MPI communication packet with deep packet inspection.
  - Log fields: (src_ip, dst_ip, MPI_func_type, src_rank)
- Packet copying and forwarding process
  - To reduce the latency, when a packet arrives at a DPU, this process copies the packet and immediately forwards it to a network port.

### Results

- The proposed module doesn't increase CPU utilization on a computing node.
- Communication latency overhead for an MPI_Send operation is less than 100us.

MPI communication latency

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