The 6th International Workshop on Cybersecurity
Workshop on IoT Security: Smart Secure homes, 11th, September 2018

Kyushu University 100th 2011
知の新世紀を拓く

E-Learning Material Development Frameworks Based on Linked Data for IoT Security Education

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Kyushu University, JAPAN

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KYUSHU UNIVERSITY

India-Japan Project

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SECURITY IN THE INTERNET OF THINGS SPACE

Project Readers of India and Japan

Prof. Koji Okamura, Director of Cybersecurity Center, Kyushu University

Prof. Ranjan Bose, Department of Electrical Engineering, IITD

Research Period

– Oct. 2016 – Sept. 2021 (Japanese side)

- Working Package 5「**IoT Security Education**」
  - **Kyusyu University**

    Prof. Yoshihiro Okada, Director of ICER, Graduate School of ISEE

    Dr. Wei Shi, Research Associate of ICER

    Dr. Akira Haga, Research Associate of ICER

    Mr. Gao Tianho, Master course student
  - **Indian Institute of Technology, Delhi**

    Prof. Ranjan Bose, Department of Electrical Engineering

    Ms. Srishti Kulshrestha, Master course student

WP5「IoT Security Education」

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Activity Plan(5years milestones)

- **Collect and investigate various types of sensor data, Extraction of threat information from them and Store as Linked Data**

=> Quickly applying to e-Learning materials

=> Sharing with collaborated institutions

- **①Web based Viewer for educational materials supporting international standards formats**

=> Recording learner's activity data for Learning Analytics

=> Visualization tools of the activity data

- **②SPOC(Small Private Online Course) for IoT Security Education**

=> Education practice among collaborated institutions

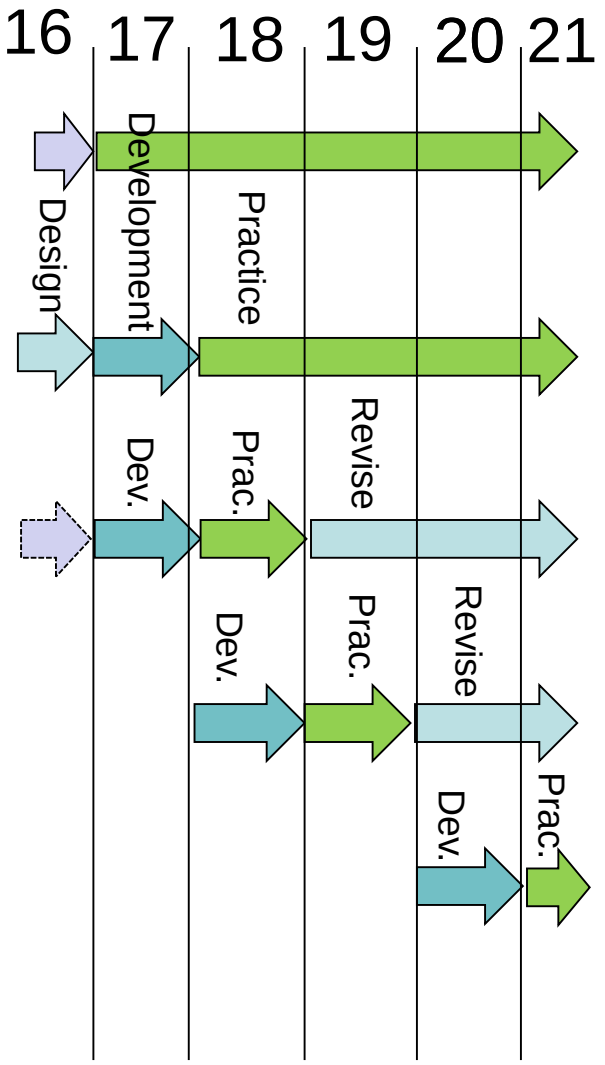
=> Brush up the contents

- **③MOOC(Massive Open Online Course) for IoT Security Education**

=> as Open Educational Resources

- **④Serious Games for IoT Security Education**

=> for students of Elementary, Junior and High schools



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Activities of fiscal year, 2016

1）Standardization of e-Learning materials formats

- Standardization forums : ①ADBook: IEEE Actionable Data Book project, ②CEN eTernity project, ③IMS ICE project, ④EDUPUB project
- Learning Analytics standards: Caliper

2）Design of web-based viewer of educational materials

- Web-based (HTML5, various mono media tags, WebGL, JavaScript)
- Linkage mechanism based on Linked Data Technology for mono media
- Enable Learning Analytics

3）Design of visualization tools for Learning Analytics

- Specification of learner's activity data(log data)
- Intuitive analysis manner
- Based on already developed tools, Time-tunnel and so on

4）To collect IoT security resources for e-Learning materials

- That will be used as workshop materials will be held for IoT security persons of companies and universities, and government officials

2）Design of web-based viewer of educational materials

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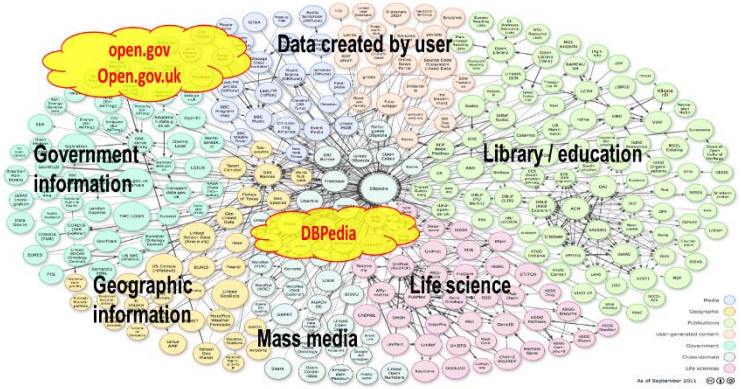
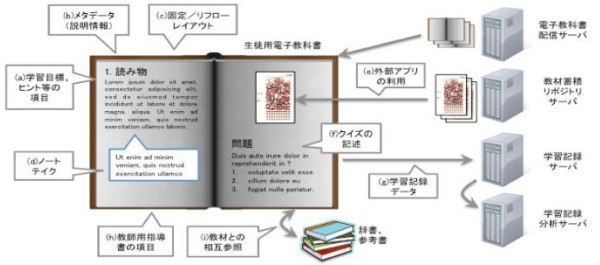
Linked Data Cloud

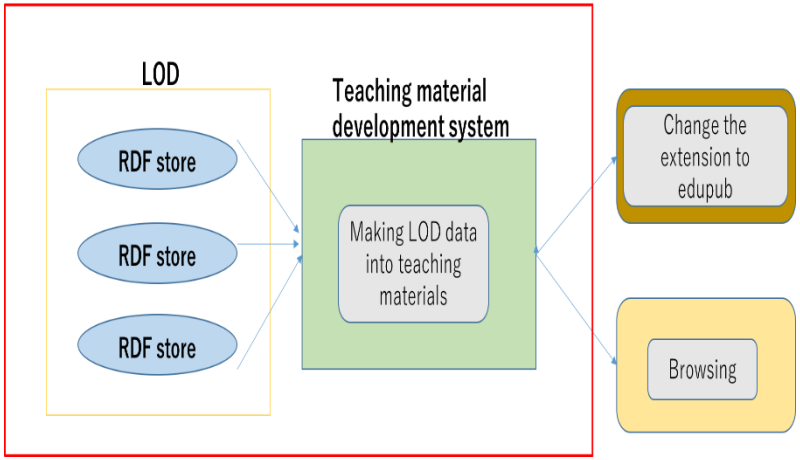


Electronic textbook standards



Specification of EDUPUB

Overview of system



System can be customized by acquired LOD

3）Design of visualization tools for Learning Analytics

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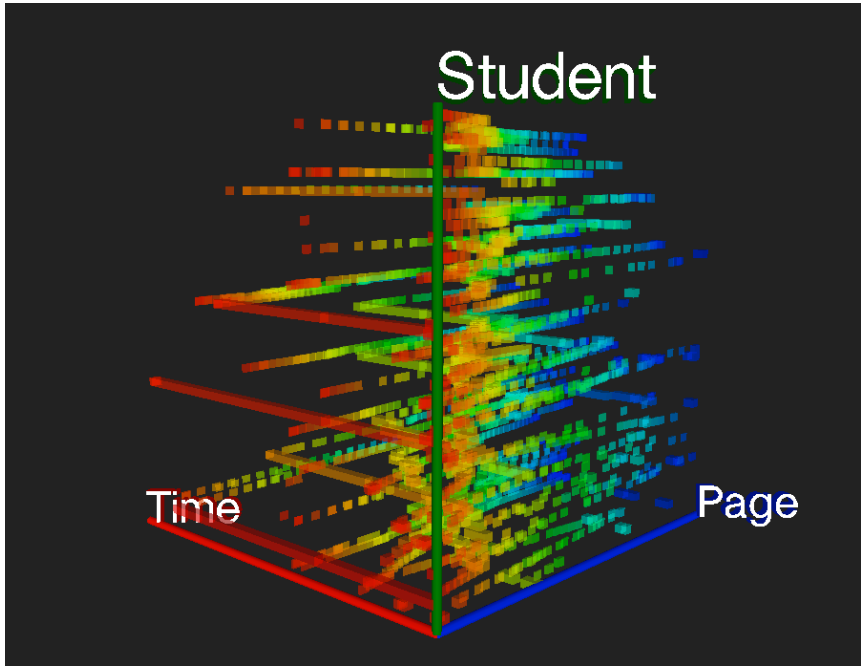
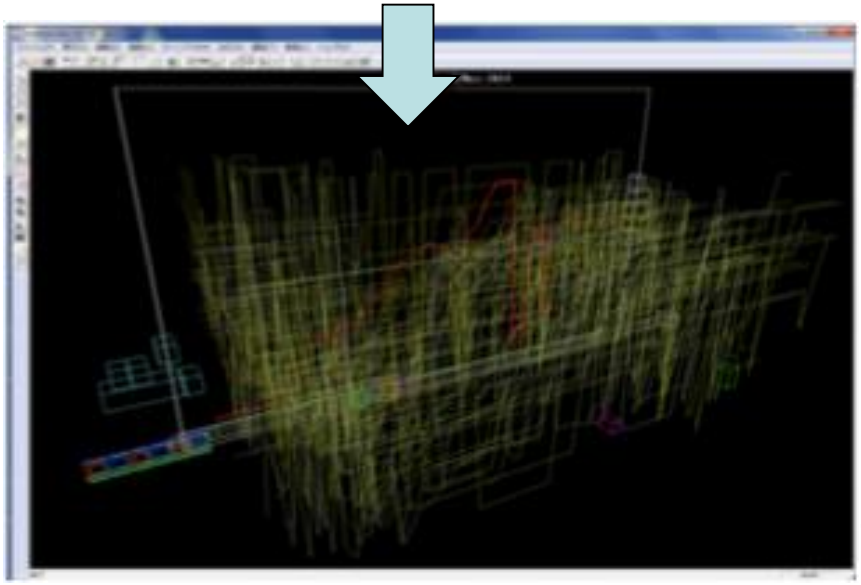
BookLooper

Cubic Gantt Chart, [Nakamura et al, 2015]





Time-tunnel, [Nakamura et al. 2017]

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Activities of fiscal year, 2017

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   - **Smart home as 3D-CG contents**
   - **Learning interactively IoT threats**

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Introduction of methodology and implementation

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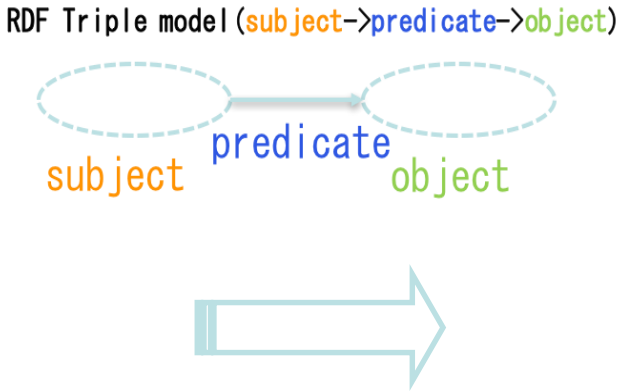
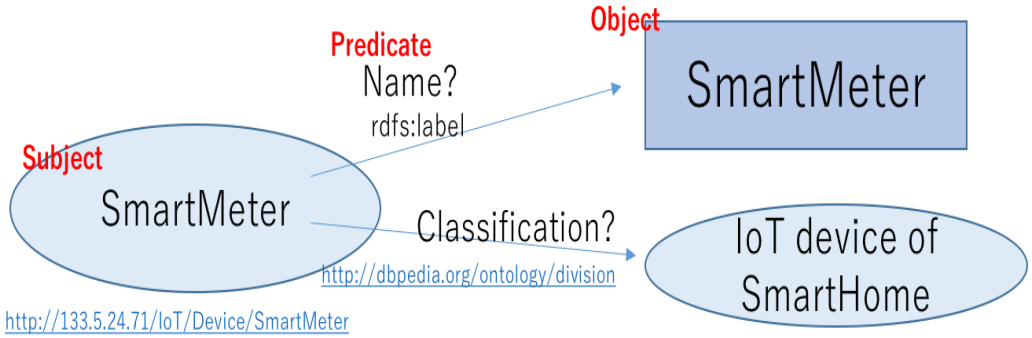
【1】Contextual knowledge management based on Linked Data

➢Linked Data - RDF(Resource Description Framework)

- A data model for representing information of resources in web.





Definition of a data entity(e.g. SmartMeter)

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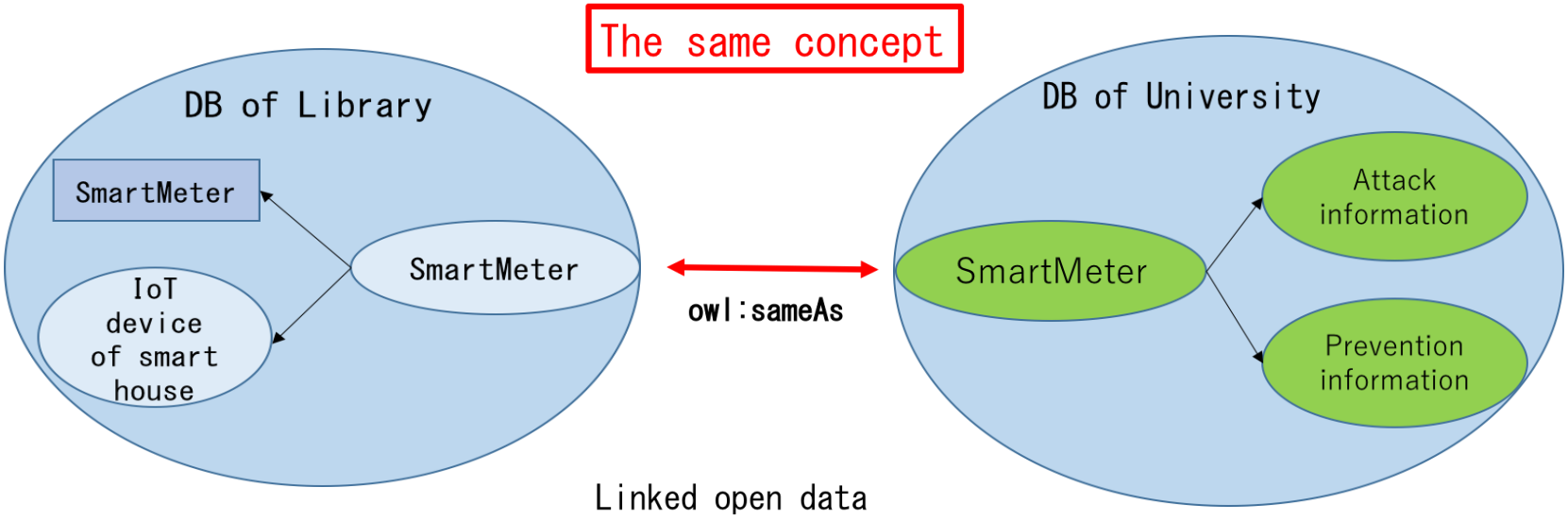
【1】Contextual knowledge management based on Linked Data

➢Link the same data entity saved in different database



Introduction of methodology and implementation

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【1】Contextual knowledge management based on Linked Data

➢Implementation of RDF server for IoT security information

- Design of RDF data – Manage IoT security information as RDF format

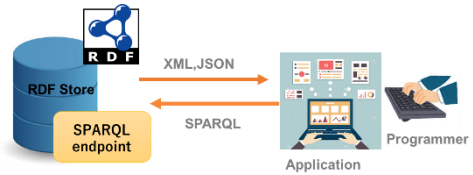
❑ IoT security information collection

❑ Schema table: Triples of conceptual design
❑ Instance table: Table data entered in Excel format
❑ Prefix table: Definition of the namespace to be used.

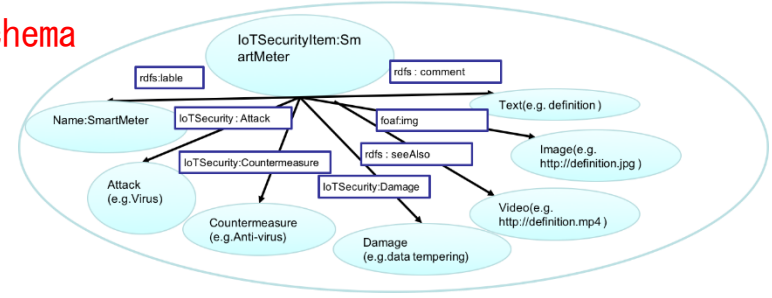
```
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
@prefix IoTSecurity: <http://133.5.24.71/IoTSecurity/> .
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
@prefix dbpedia: <http://dbpedia.org/resource/> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
```

http://133.5.24.71/IoTSecurity/Attack
IoTSecurity:Attack

Prefix



Schema



http://133.5.24.71/IoT/Device/SmartMeter

Instance

RDF store schema

1. IoT systems, devices, sensors
2. Attacks can be perpetrated on such IoT spaces.
3. Preventive measures can be taken to thwart such attacks.
4. Damages could be caused by such attacks
5. Textual explanation of IoT threats information.
6. Illustrated explanation of IoT threats information.
7. Video explanation of IoT threats information.

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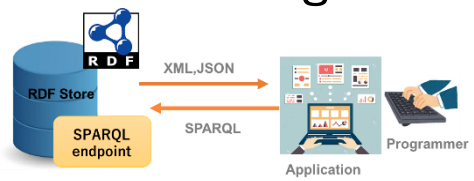
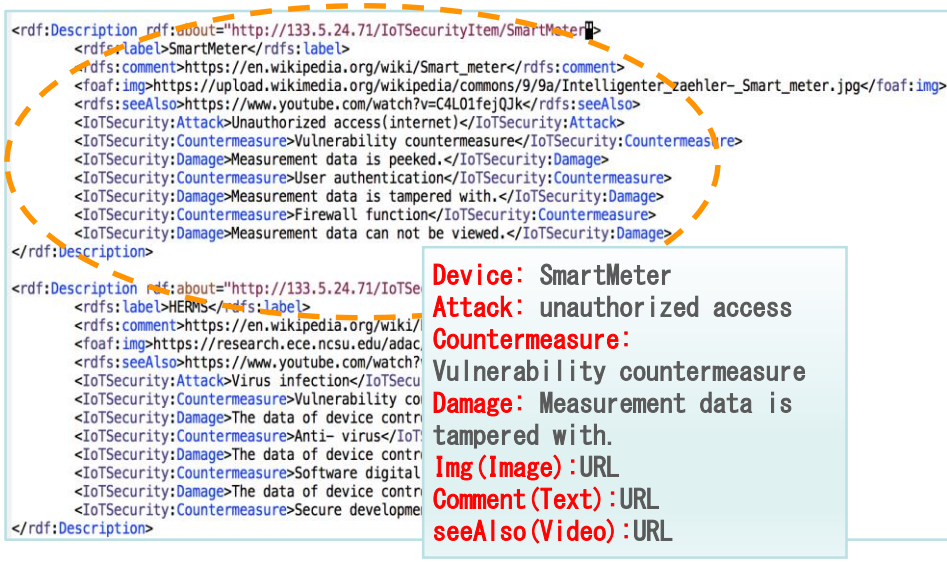
【Q1.】Data collection for the contents of teaching materials

【Method1】Utilization of Linked Data



➢Implementation of RDF server for IoT security information

- Generation RDF file – manage IoT security information as RDF format



Designation of RDF skeleton of IoT security.

Exported RDF file of IoT security.

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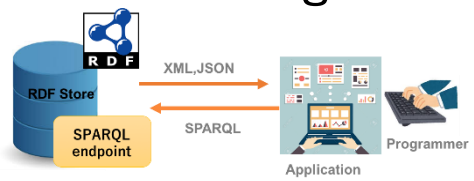
【Q1.】Data collection for the contents of teaching materials

【Method1】Utilization of Linked Data



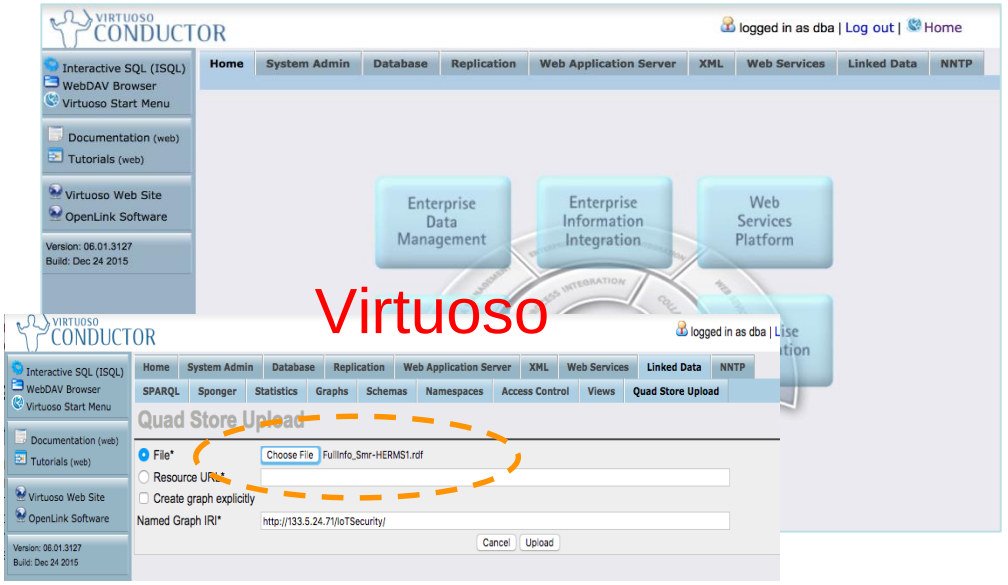
➢Implementation of RDF server for IoT security information

- Registration of RDF file

```
<rdf:Description rdf:about="http://133.5.24.71/IoTSecurityItem/SmartMeter">
        <rdfs:label>SmartMeter</rdfs:label>
        <rdfs:comment>https://en.wikipedia.org/wiki/Smart_meter</rdfs:comment>
        <foaf:img>https://upload.wikimedia.org/wikipedia/commons/9/9a/Intelligenter_zaehler-_Smart_meter.jpg</foaf:img>
        <rdfs:seeAlso>https://www.youtube.com/watch?v=C4L01fejQJk</rdfs:seeAlso>
        <IoTSecurity:Attack>Unauthorized access(internet)</IoTSecurity:Attack>
        <IoTSecurity:Countermeasure>Vulnerability countermeasure</IoTSecurity:Countermeasure>
        <IoTSecurity:Damage>Measurement data is peeked.</IoTSecurity:Damage>
        <IoTSecurity:Countermeasure>User authentication</IoTSecurity:Countermeasure>
        <IoTSecurity:Damage>Measurement data is tampered with.</IoTSecurity:Damage>
        <IoTSecurity:Countermeasure>Firewall function</IoTSecurity:Countermeasure>
        <IoTSecurity:Damage>Measurement data can not be viewed.</IoTSecurity:Damage>
</rdf:Description>

<rdf:Description rdf:about="http://133.5.24.71/IoTSecurityItem/HERMS">
        <rdfs:label>HERMS</rdfs:label>
        <rdfs:comment>https://en.wikipedia.org/wiki/Energy_management_system</rdfs:comment>
        <foaf:img>https://research.ece.ncsu.edu/adac/wp-content/uploads/2015/10/total_prj.jpg</foaf:img>
        <rdfs:seeAlso>https://www.youtube.com/watch?v=Vi-16b00Pn8</rdfs:seeAlso>
        <IoTSecurity:Attack>Virus infection</IoTSecurity:Attack>
        <IoTSecurity:Countermeasure>Vulnerability countermeasure</IoTSecurity:Countermeasure>
        <IoTSecurity:Damage>The data of device controlled by HEMS is peeked.</IoTSecurity:Damage>
        <IoTSecurity:Countermeasure>Anti- virus</IoTSecurity:Countermeasure>
        <IoTSecurity:Damage>The data of device controlled by HEMS is tampered with.</IoTSecurity:Damage>
        <IoTSecurity:Countermeasure>Software digital signature</IoTSecurity:Countermeasure>
        <IoTSecurity:Damage>The data of device controlled by HEMS can not be viewed.</IoTSecurity:Damage>
        <IoTSecurity:Countermeasure>Secure development</IoTSecurity:Countermeasure>
</rdf:Description>
```

Exported RDF file



Storage of RDF file

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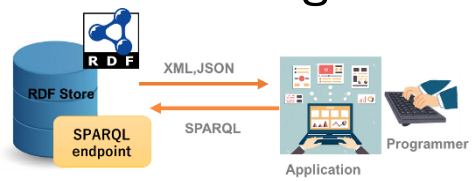
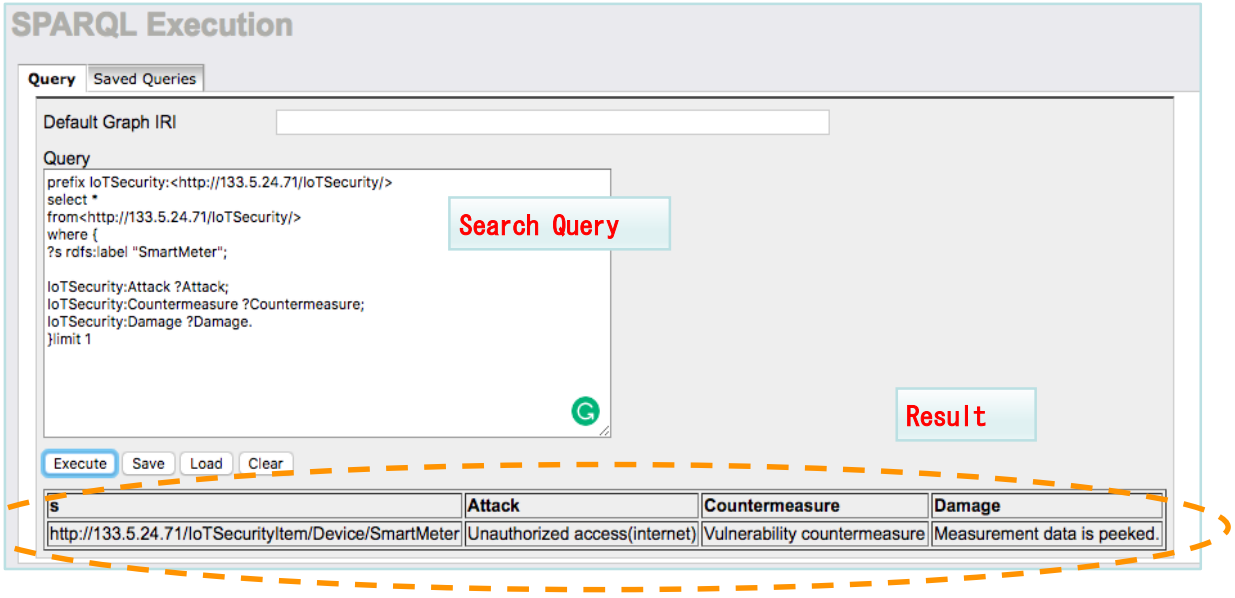
【Method1】Utilization of Linked Data



➢Implementation of RDF server for IoT security information

- Retrieval data in SPARQL endpoint(Virtuoso)



Retrieval of RDF file

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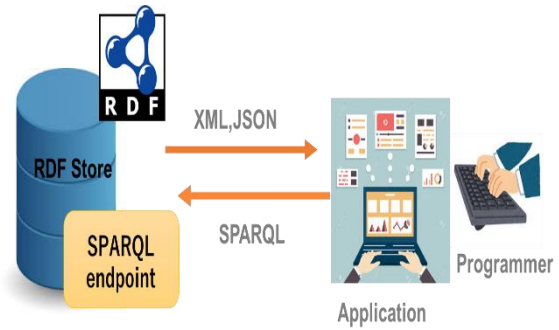
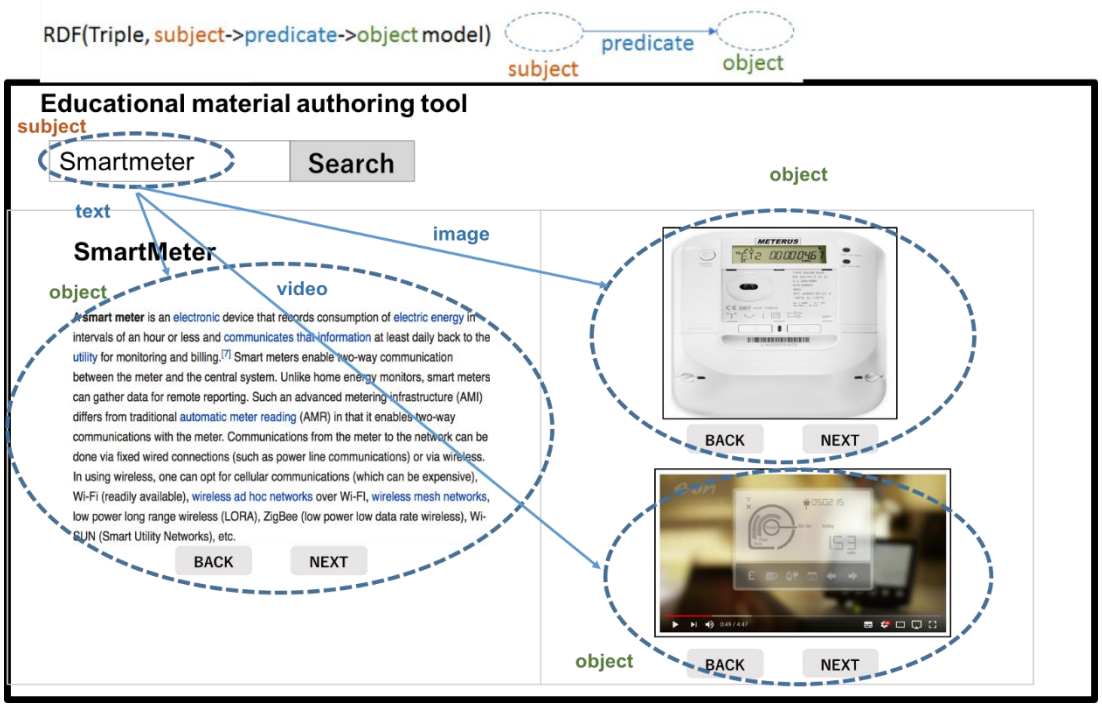
【2】Implementation of Web application-The authoring tool for developing IoT Security educational material





Prototype system of authoring tool for IoT Security

Introduction of methodology and implementation

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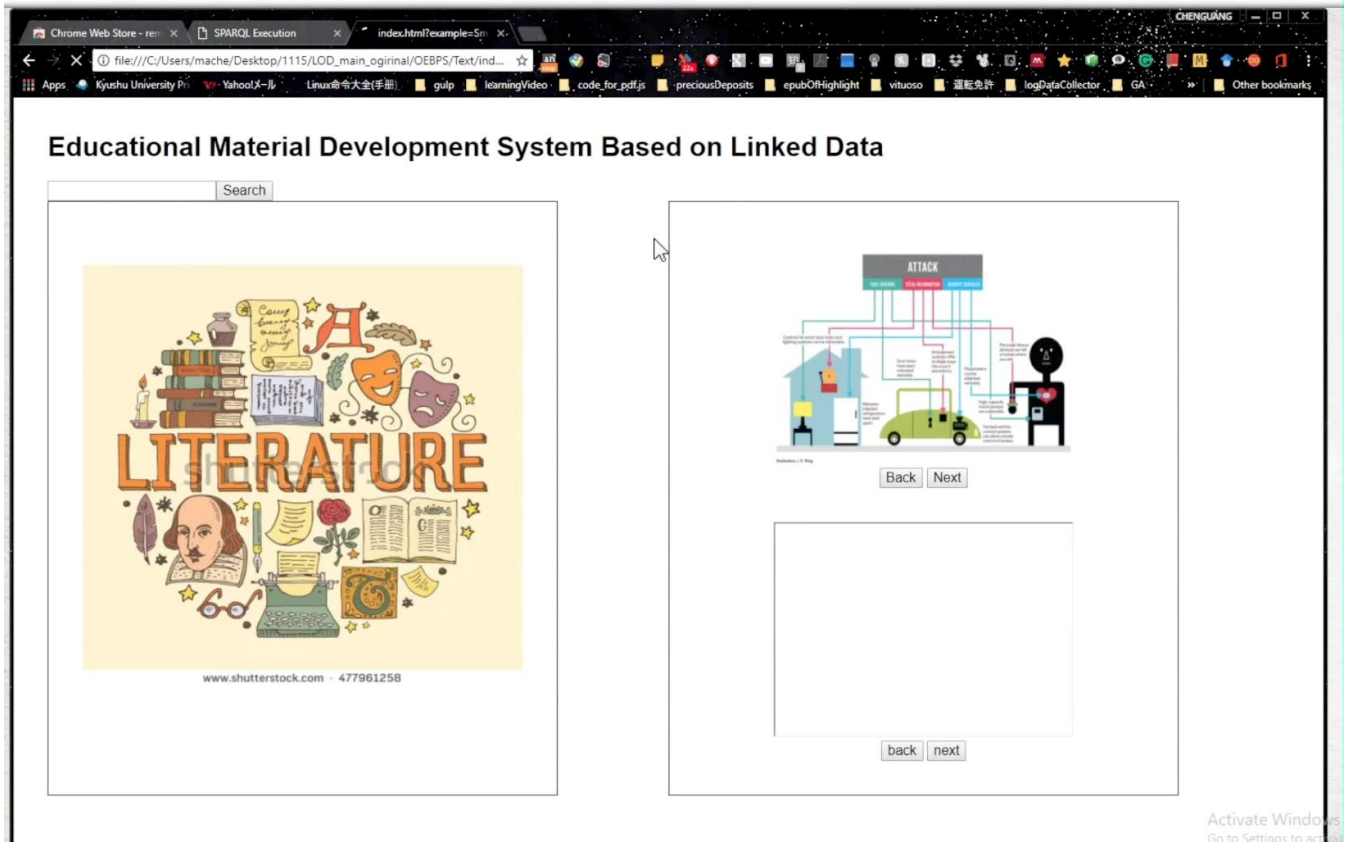
【2】Implementation of Web application-The authoring tool for developing IoT Security educational material



Demo of authoring tool for IoT Security

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Activities of fiscal year, 2017

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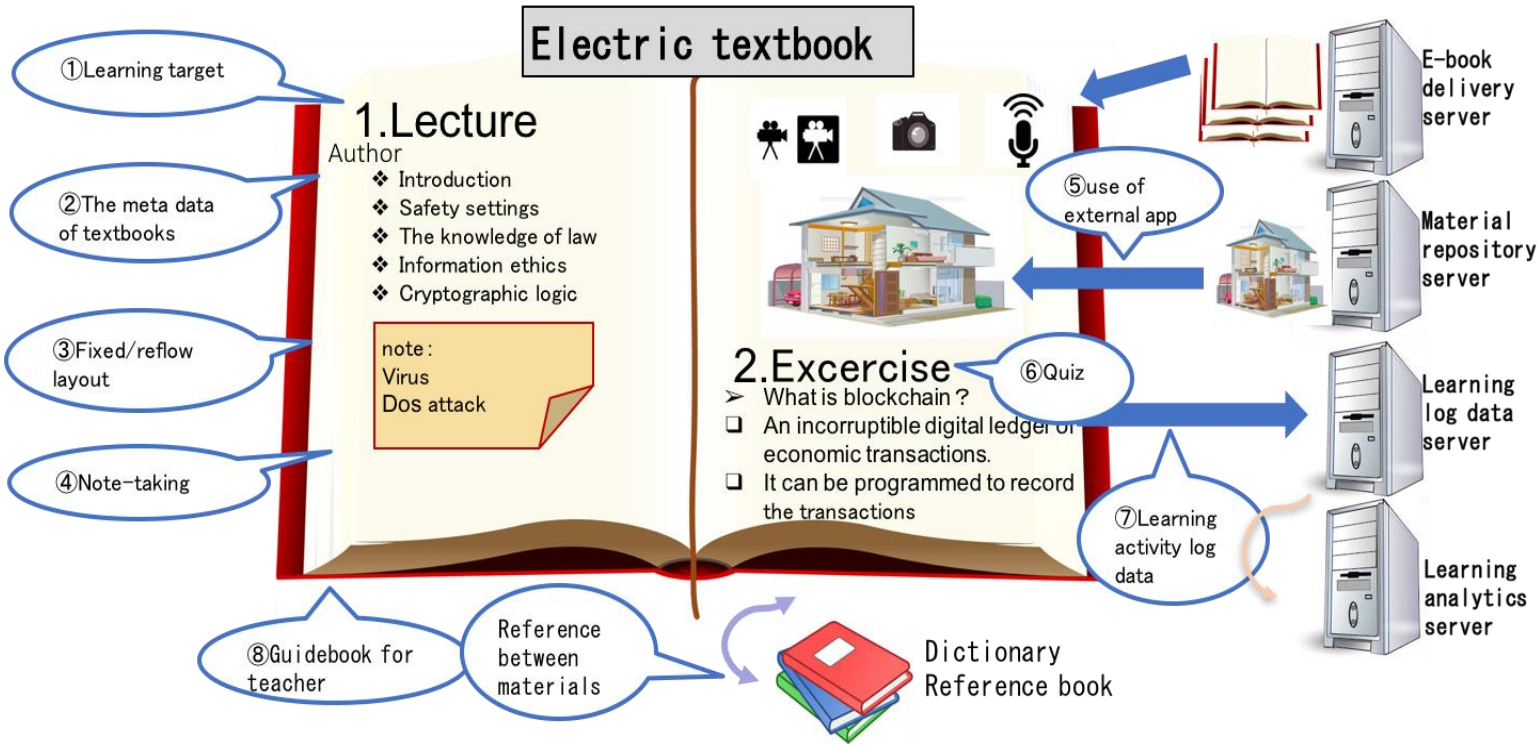
【3】Implementation of a web-based viewer for educational materials designed as ePub format of IoT Security supporting Learning Analytics



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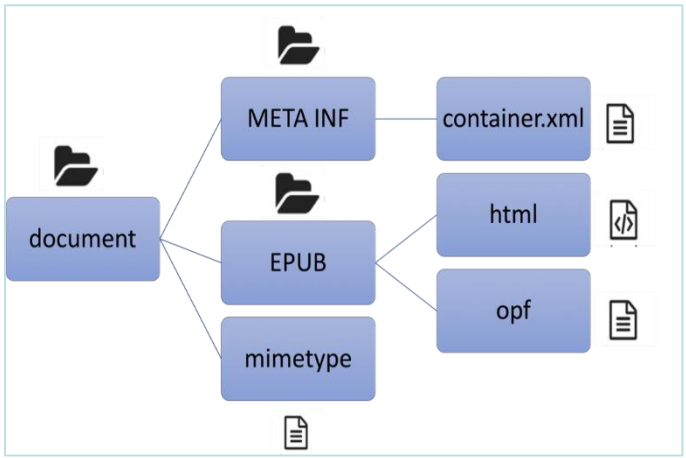
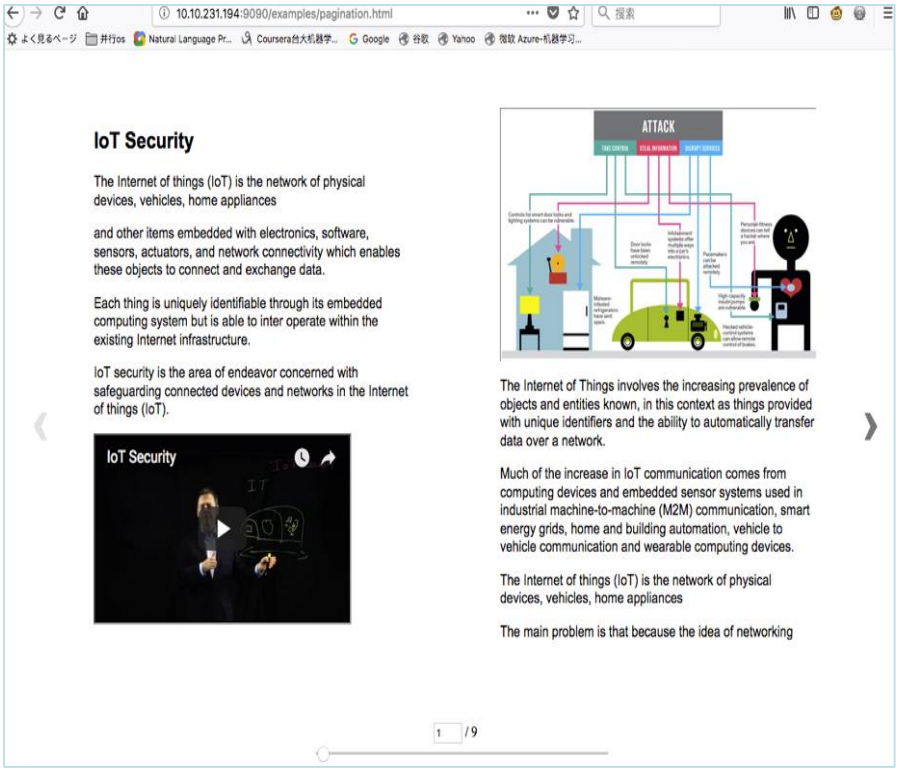
【3】Implementation of a web-based viewer for educational materials designed as ePub format of IoT Security supporting Learning Analytics





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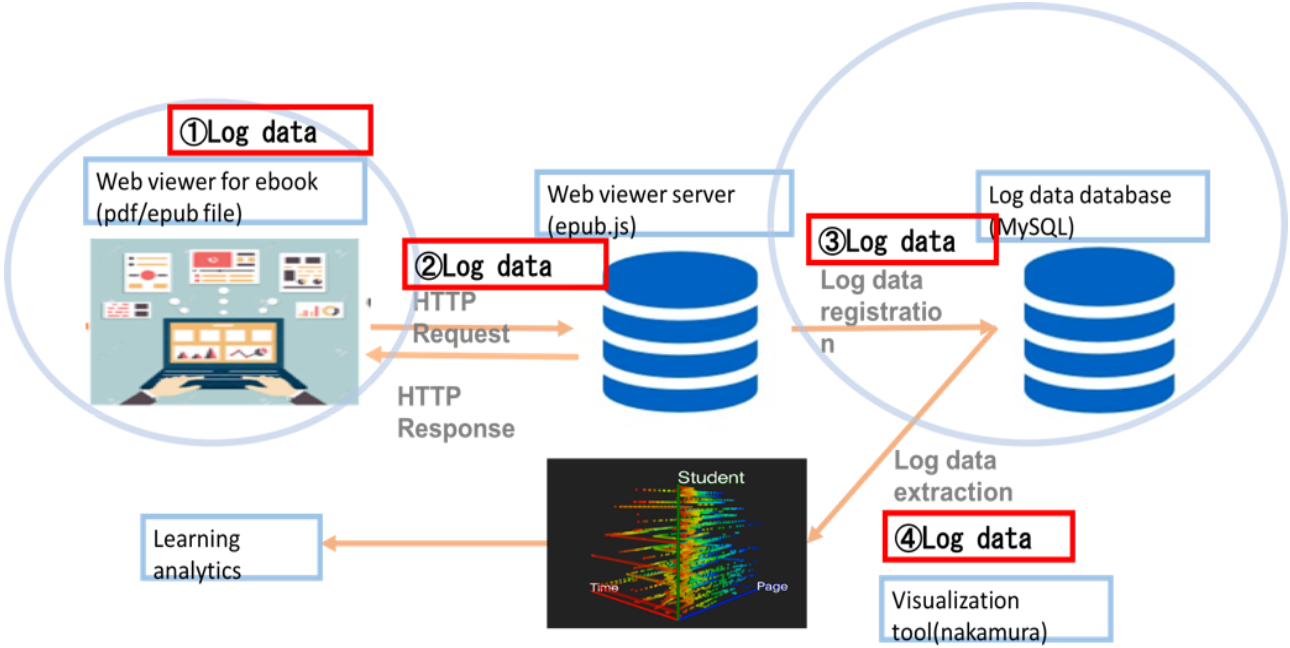
【3】Implementation of a web-based viewer for educational materials designed as ePub format of IoT Security supporting Learning Analytics



Introduction of methodology and implementation

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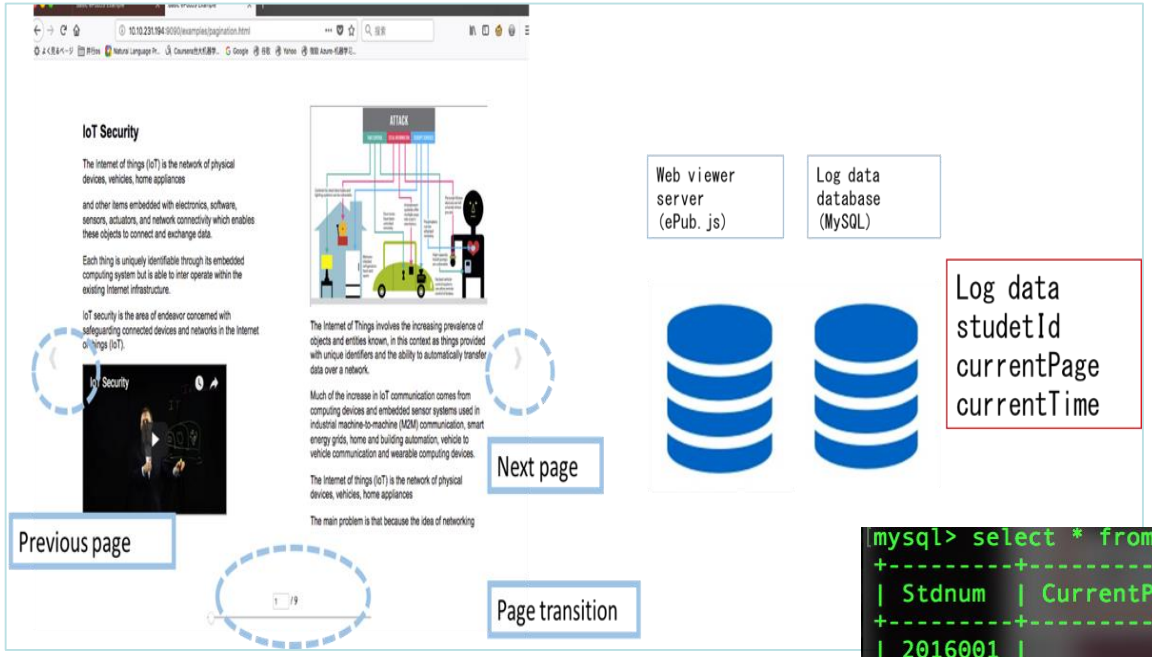
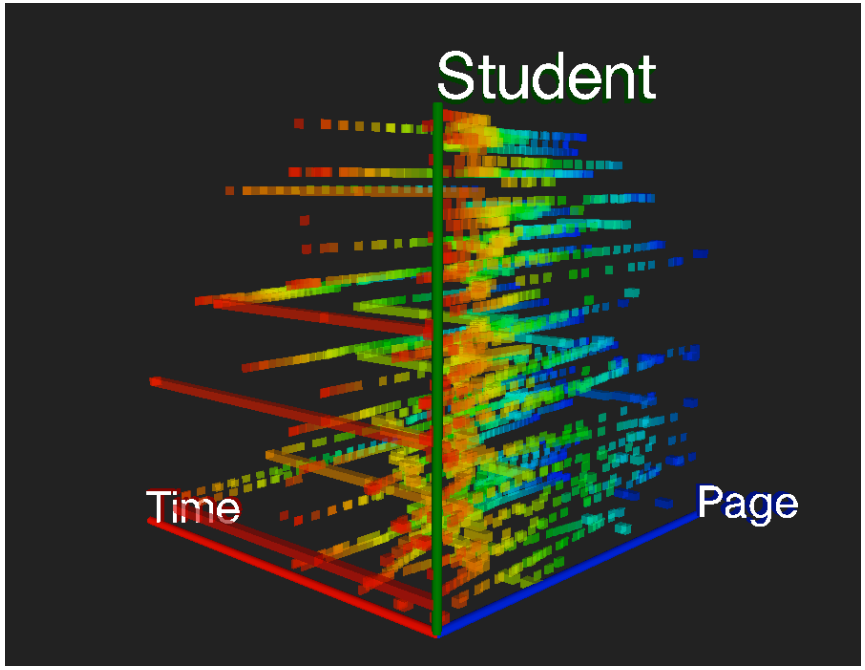


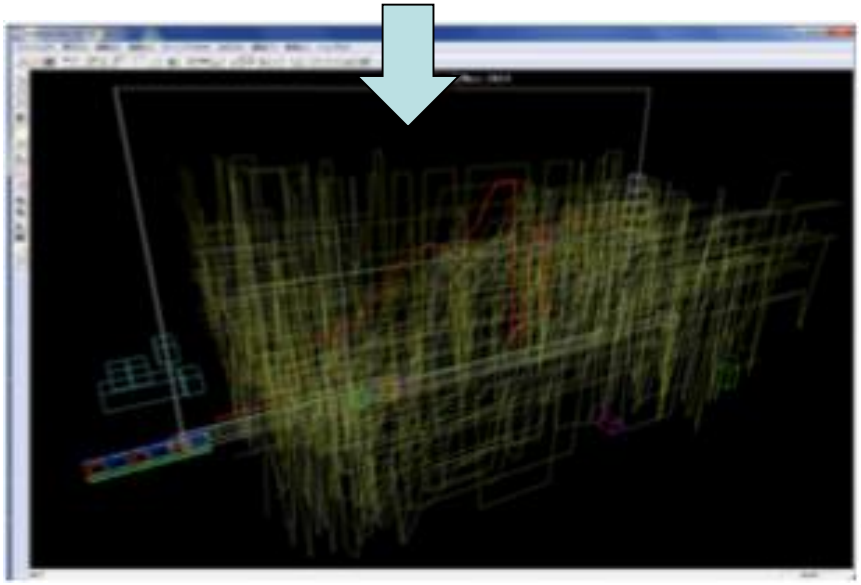

```
mysql> select * from RLOG;
+---------+-------------+-------------+
| Stdnum  | CurrentPage | CurrentTime |
+---------+-------------+-------------+
| 2016001 |           1 |         723 |
| 2016001 |           2 |         723 |
+---------+-------------+-------------+
2 rows in set (0.00 sec)
```

Visualization tools for Learning Analytics

BookLooper

Cubic Gantt Chart, [Nakamura et al, 2015]





Time-tunnel, [Nakamura et al. 2017]

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Web-based educational 3D contents for IoT security

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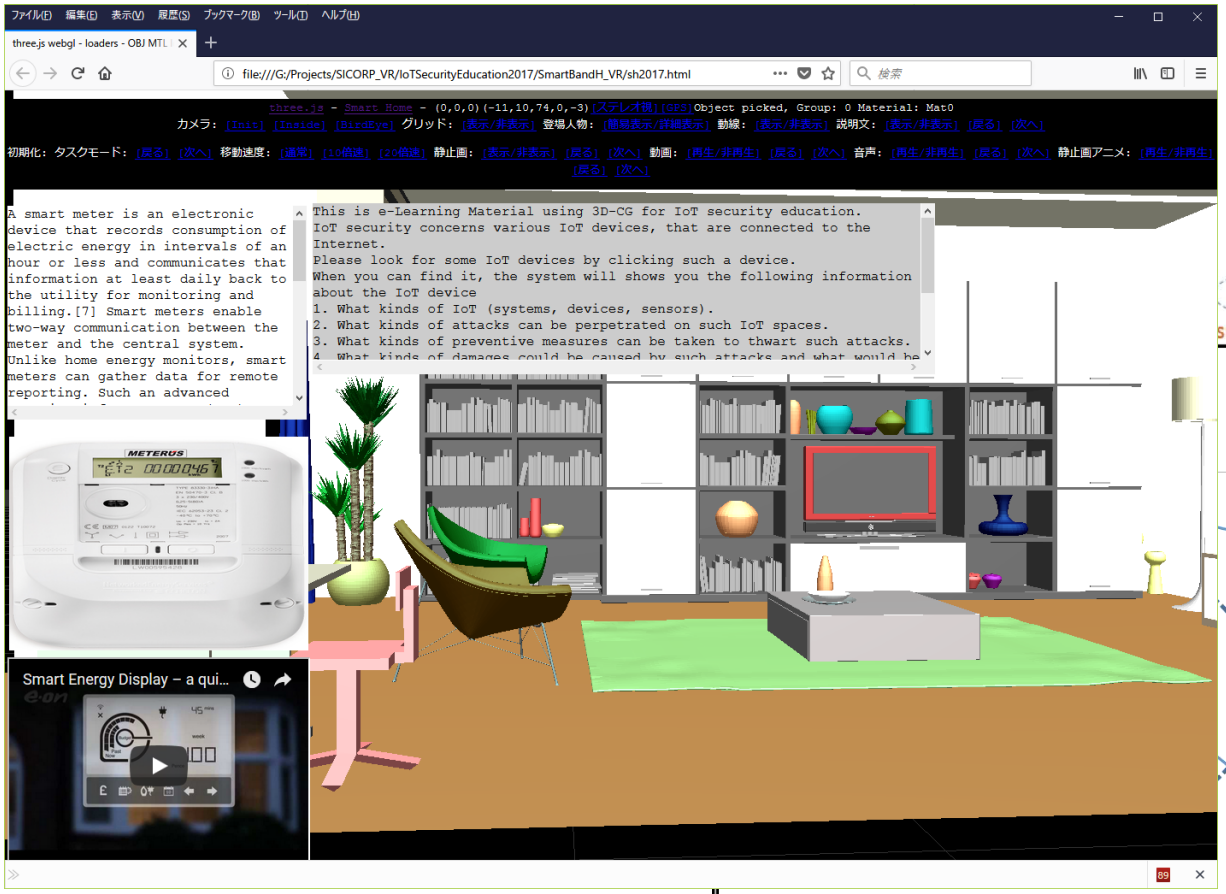

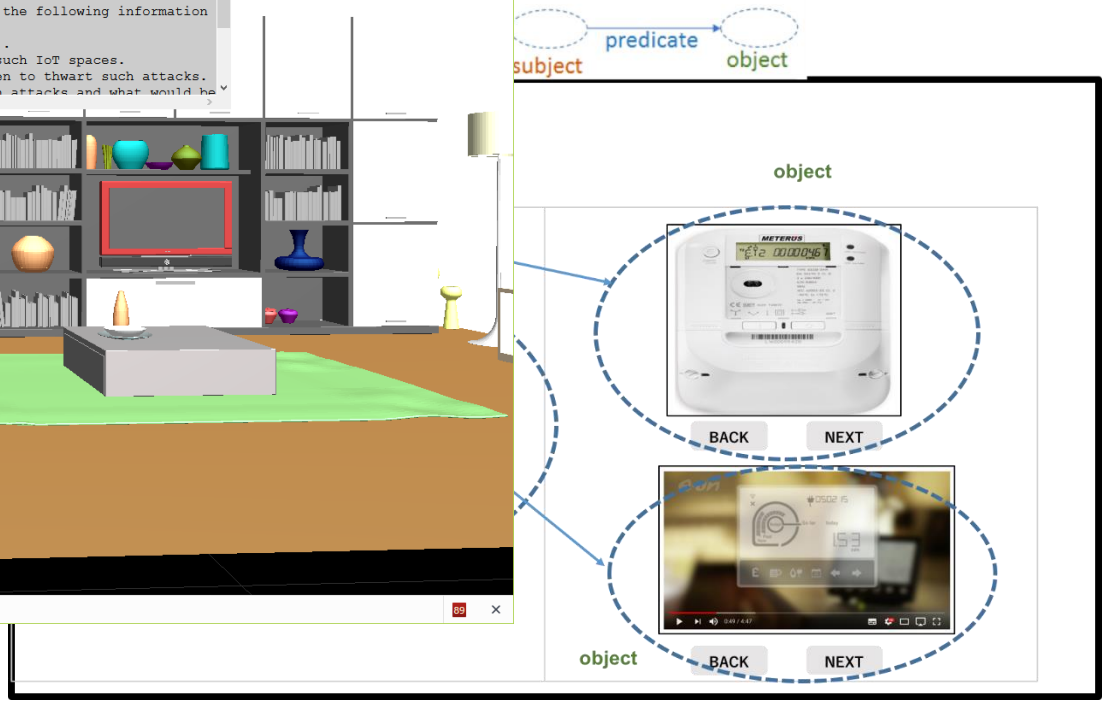

Demo

Prototype system of authoring tool for IoT Security

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Activities of fiscal year, 2018

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2) **E-Learning material development by automatically generating quizzes based on Linked Data**

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2) **E-Learning material development by automatically generating quizzes based on Linked Data**

E-Learning materials using 360VR images/videos based on Linked Data for IoT security education

1) *Fundamental mechanism*

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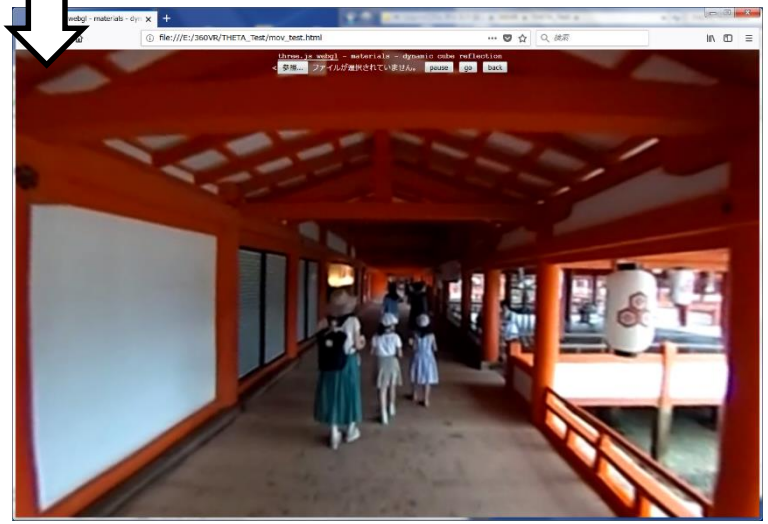
RICHO: Theta
Two fish-eye lenses camera

1) Record

Two fish-eye images/videos

2) Transform using dedicated software

Equirectangular image/video



3) Web-based equirectangular image/video viewer using WebGL and Three.js

E-Learning materials using 360VR images/videos based on Linked Data for IoT security education

2) Example under construction

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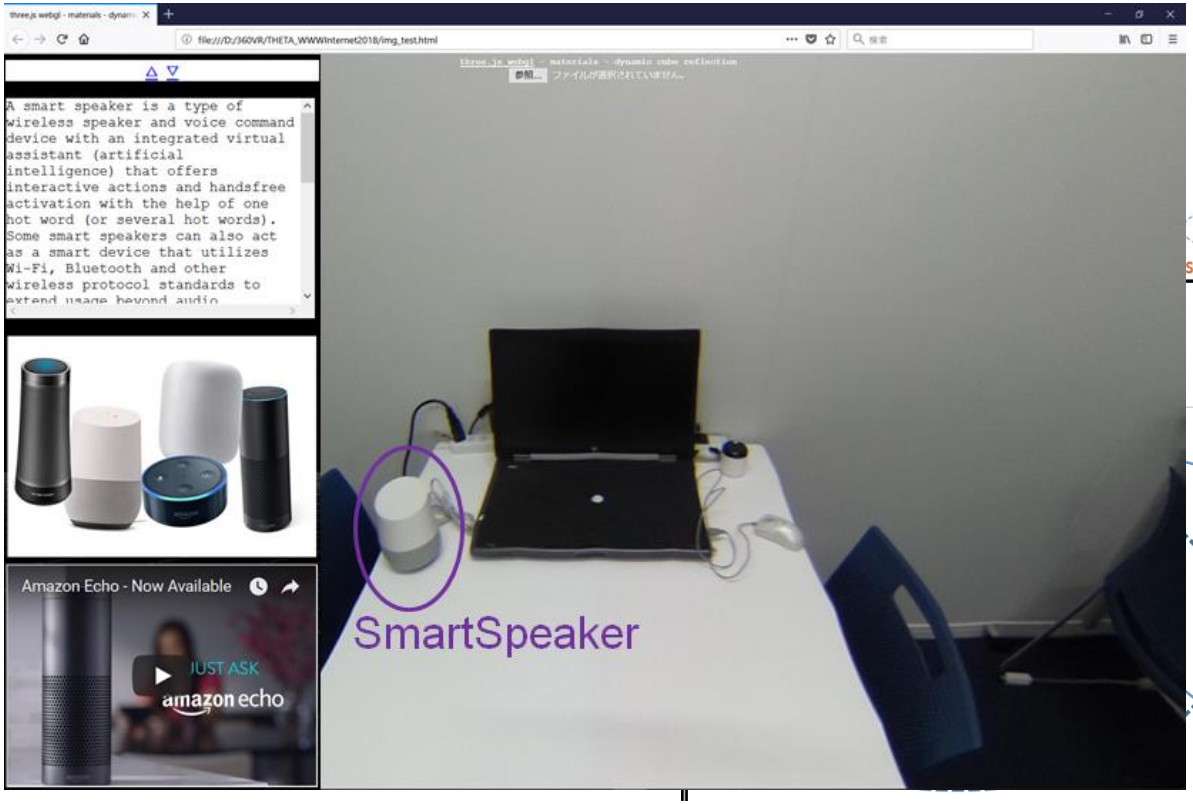
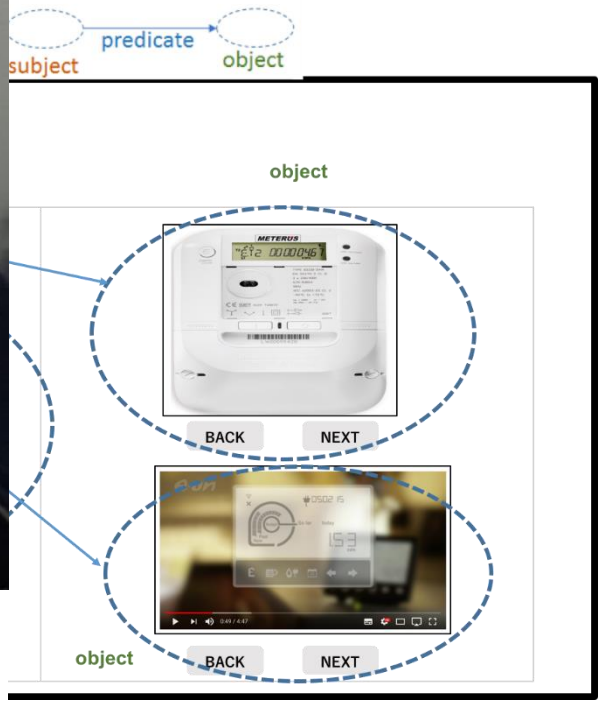


Web-based equirectangular image/video viewer as e-learning material for IoT security education

Demo



noring tool for IoT Security

WP5「IoT Security Education」

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1) **Educational material development framework**
   - **Database** of IoT threats information as Linked Data
   - **Authoring tool** for educational materials of IoT security
2) **Learning Analytics framework for IoT security education**
   - **Web-based educational material viewer** (HTML5, various mono media tags, JavaScript)
     - => ePub.js + Learning Analytics
   - **Visualization tools for Learning Analytics**
     - Based on already developed tools, Time-tunnel and so on
3) **Web-based educational 3D contents for IoT security**
   - **Smart home as 3D-CG contents**
   - **Learning interactively IoT threats**

Activities of fiscal year, 2018

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Conclusion

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Activities of fiscal year, 2018

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Thanks for your attention!