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| Title            | IoT・クラウド・AI連携による農業機器遠隔操作の研究                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Sub Title        | Research on remote control of agricultural equipment with IoT, cloud, and AI collaboration                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Author           | 松本, 佳宣(Matsumoto, Yoshinori)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
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| Abstract         | <p>本研究は、環境情報をセンサ・IoT技術により測定・収集して、クラウドサーバー上で時系列データ表示と警告を行い、かつネットワークのドメインも越えた場所から農業遠隔操作が可能なシステムを実現・実証する事を目的としている。一年目は、福島復興プロジェクトに参加して、放射線情報をセンサ・IoT技術により測定・収集して、クラウドサーバー上で時系列データ表示するシステムを製作した。また、得られたセンサ情報を位置情報と連動してデータ解析して長期減衰予測モデルを用いて放射線の減衰と住民のリスク管理などを行い、これらの成果を1件の国内学会と1報の英語論文として共著としてまとめた。これらの技術成果は、本研究の目的のクラウド操作により農業を労働集約から知識集約に転換する基礎知識となり、IoT ( Internet of Thing ) 技術の新分野開拓となった。今回、地方自治体や他大学研究者との連携が行えたことで、農業機器遠隔操作の研究を行う上で必須なフィールドワーク場所が確保できたことも大きな成果となった。遠隔操作に関してはスマートフォンアプリを操作することで、Arduinoクラウドを通じて、バルブのONとOFFによって灌水を行う事を実現できた。従来の研究では、ローカルエリアネットワーク ( LAN ) を利用してWiFiスマートデバイス ( プラグ、スイッチ、ライトなど ) を制御・監視していたが、新しいArduino IoTクラウドを利用することで、屋外でもLANのドメインを超えて自由にPythonコードによって遠隔操作を実現できた。土壌水分センサに関しても、容量型土壌水分センサの値の較正を行い低価格にセンサ数値に応じ自動灌水が実現できるようになった。土壌水分だけでなく田んぼの水位測定ができるセンサも試作・測定を行い、従来の超音波水位センサを上回る精度が実現できた。これにより安価で使い勝手とコーディングに適した遠隔操作環境を確立できたため2年目は装置の社会実装を行う予定である。</p> <p>The purpose of this research is to realize and demonstrate a system that measures and collects environmental information using sensors and IoT technology, displays time-series data and warnings on a cloud server, and enables remote control of agriculture from locations beyond the network domain. In the first year, we participated in the Fukushima reconstruction project, and created a system that measures and collects radiation information using sensors and IoT technology, and displays the time-series data on a cloud server. In addition, we analyzed the obtained sensor information in conjunction with location information and used a long-term attenuation prediction model to analyze the data, and conducted radiation attenuation and risk management for residents, etc. These results were co-authored as one domestic academic conference and one English paper. These technological achievements served as basic knowledge for converting agriculture from labor-intensive to knowledge-intensive through cloud operations, the objective of this research, and opened up a new field of Internet of Thing (IoT) technology. Another major achievement of this project was the collaboration with local governments and researchers from other universities, which enabled us to secure a fieldwork location, which is essential for conducting research on remote operation of agricultural equipment. As for remote control, we were able to realize irrigation by turning valves on and off through the Arduino cloud by operating a smartphone application. In previous research, WiFi smart devices (plugs, switches, lights, etc.) were controlled and monitored using a local area network (LAN), but by using the new Arduino IoT Cloud, it was possible to realize remote control of these devices outdoors using Python code freely beyond the domain of the LAN. Remote control could be realized. In the case of soil moisture sensors, the values of capacitive soil moisture sensors have been calibrated to enable low-cost automatic irrigation according to sensor values. In addition to soil moisture, a sensor capable of measuring the water level in the rice paddies was also developed and measured, and its accuracy surpassed that of conventional ultrasonic water level sensors. The second year will be spent on social implementation of the device, since a remote control environment suitable for low cost, ease of use, and coding has been established.</p> |
| Notes            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Genre            | Research Paper                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| URL              | <a href="https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=2023000010-20230209">https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=2023000010-20230209</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

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2023年度 学事振興資金（個人研究） 研究成果実績報告書

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |    |                                                                        |        |                        |                          |              |
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| 研究代表者                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 所属 | 理工学部                                                                   | 職名     | 教授                     | 補助額                      | 100千円<br>(C) |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 氏名 | 松本 佳宣                                                                  | 氏名（英語） | Yoshinori Matsumoto    |                          |              |
| 研究課題（日本語）                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |    |                                                                        |        |                        |                          |              |
| IoT・クラウド・AI連携による農業機器遠隔操作の研究                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |    |                                                                        |        |                        |                          |              |
| 研究課題（英訳）                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |    |                                                                        |        |                        |                          |              |
| Research on remote control of agricultural equipment with IoT, cloud, and AI collaboration                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |    |                                                                        |        |                        |                          |              |
| 1. 研究成果実績の概要                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |    |                                                                        |        |                        |                          |              |
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| 2. 研究成果実績の概要（英訳）                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |    |                                                                        |        |                        |                          |              |
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| 3. 本研究課題に関する発表                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |    |                                                                        |        |                        |                          |              |
| 発表者氏名<br>(著者・講演者)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |    | 発表課題名<br>(著書名・演題)                                                      |        | 発表学術誌名<br>(著書発行所・講演学会) | 学術誌発行年月<br>(著書発行年月・講演年月) |              |
| Rakotovao Lovanantenaina Omega, Yo Ishigaki, Sidik Permana, Yoshinori Matsumoto, Kayoko Yamamoto, Katsumi Shozugawa and Mayumi Hori                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |    | Low-Cost Sensor Deployment on a Public Minibus in Fukushima Prefecture |        | Sensors 2024, 24, 1375 | 21 February 2024         |              |

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| 浅野 大輔，松本 佳宣，石垣 陽，時吉<br>正憲，西山 恭平，長峰 春夫 | 現場向けIoT式可搬・屋外型放<br>射線モニタリングシステムの<br>製作 | 日本原子力学会<br>2024年春の年会 | 2024.3.28 |
|---------------------------------------|----------------------------------------|----------------------|-----------|