Final report

Immersive Reality IoT Device Integration Pilot

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Abstract

MLA and Saab Australia delivered a proof-of-concept digital farm twin, demonstrating the benefits of using virtual technology to undertake remote farm management. This project demonstrated the ability of owners, investors and property managers to use this technology to remotely make effective, efficient and accurate decisions in the management and operations of one or multiple properties.

Saab is a mixed reality expert with extensive experience in developing platforms and products that run on Microsoft HoloLens. This project leveraged the capabilities of Saab's existing InDepth™ platform to efficiently import and integrate a variety of data sources to produce the digital twin. This digital twin used the existing tools and capabilities to:

- Import 3D geospatial data of the farm and surrounding area;
- Integrate with live Internet of Things (IoT) sensors on property for key infrastructure assets;
- Show recorded data on livestock and their movements; and
- Cycle through satellite imagery for a range of datasets.

This project confirmed that users are able to collaboratively view a remote property and understand the current state of its assets in order to make informed decisions. This type of capability enables users to make effective decisions on property management without needing to travel to the property.

Executive summary

Background

Mixed reality is a rapidly evolving technology and has a range of applications, including data visualisation, assisting with tasks and augmenting the real world with relevant information. The focus of this project was to provide a demonstration of an integration of Saab's existing InDepth™ product with IoT device feeds and map data from the Carwoola property. Carwoola was chosen following deployment of a range of IoT devices. From this demonstration, an understanding of the benefits and limitations of providing this mixed reality visualisation would be determined.

The audience for this demonstration was MLA staff who would then be informed of the mixed reality capability and potential use cases, allowing them to utilise this technology and a digital twin type of capability into the future.

Objectives

The main aims of the project were:

- Integrate the existing InDepth™ product with IoT devices from Carwoola;
- Import map data for Carwoola; and
- Provide MLA staff with a demonstration of the mixed reality capability.

The project achieved all of the objectives.

Methodology

This project was a software integration with some development focused activity. As such, the methodology used was to implement the software integration and data importing activities leveraging the knowledge and existing work from previous work that Saab has undertaken.

For each of the IoT device providers, an integration was undertaken to query their REST API for retrieving the latest information from the device. This would poll data periodically and generate graphs of historical data.

Results/key findings

This project was able to demonstrate that a digital twin of a property can be achieved by leveraging the existing InDepth™ capabilities and undertaking integration to pull specific information into the system. Maps are able to be imported from a range of datasets, allowing users flexibility in determining the best dataset for them and re-use of any existing data they have.

Viewing the data in shared holographic 3D experience does provide different insights for users that a traditional 2D display are unable to provide, even when displaying the data in 3D. InDepth™ also provides a common view of datasets from a range of providers, which are often only available on disparate dashboards provided by each vendor. This alleviates the issue where, if a user wishes to query device data from different vendors, they need to deal with multiple dashboards.

Benefits to industry

Industry will gain insights and understanding of benefits that can be achieved with:

- Creating a single dashboard for a range of IoT devices;

- Using mixed reality to enable collaboration between users; and
- Viewing and exploring digital twins of property(s) in 3D.

Future research and recommendations

Saab recommends that the following areas could be beneficial for future research to provide benefits to member organisations:

- Utilisation of mixed reality for remote assistance with maintenance and repairs of equipment;
- Expanding this project to use a cloud based server and allow collaboration between remote users; and
- Use an integration solution (such as IoT Hub) for providing a single integration point of IoT devices so users and other systems such as InDepth™ only need to query a single source for data.

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1. Background

1.1 Mixed reality

Mixed reality is a blending of the physical and digital environments and enables users to experience co-located, shared holographic experiences. Mixed reality (MR) differs from virtual reality as a virtual reality environment typically obscures the user's view of the real world and visually fully immerses them within the virtual environment. Using MR ensures that users are able to retain their external context and view and interact naturally with elements of the real world, including people and physical objects. Saab is a developer of mixed reality solutions and uses the Microsoft HoloLens as the platform. HoloLens is an untethered head mounted display that runs Windows 10 Holographic and uses inside-out tracking to retain spatial awareness of the environment it is in.

1.2 InDepth

InDepth™ is a product from Saab Australia, which has been under active development since 2016 and delivered into projects for Defence, Mining and Petroleum applications a number of times since late 2016. The key features of InDepth™ that this project leveraged were:

- Co-located, shared holograms
- Viewing map and data in true 3D
- InDepth™ spectator application for viewing the information on a Windows 10 PC
- Integrating with live data from external systems
- Importing 3D geospatial data
- Timeline view of information
- Perspective view, allowing users to walk the map at up to 1:1 scale, sized up to 100m x 100m.
- Ability to filter information on and off as desired
- Simulator to inject data into the system

As a mature product, InDepth™ provided an ideal platform to quickly import the data and use that as a means for collaborating around a digital twin of a property.

1.3 Internet of Things devices

There has been a lot of investment and growth in the capabilities of Internet of Things (IoT) devices over the last decade or so. This growth has helped reduce the costs of devices and enable property owners to leverage their capabilities to provide efficiencies. These include the ability to check water levels remotely, saving on travel time to/from a trough/tank/etc to check the water level. Often sensor manufactures will provide users with a dashboard of information to allow them to see the status of the devices from a mobile device or PC.

As properties begin to leverage devices or expand on the devices they are using, this will typically result in users needing to check a number of discrete dashboards, with different formats and means of providing the data. InDepth™ is able to bring the information from all of the integrated IoT devices together into a single application, giving users access to the data in a common format.

2. Objectives

As mixed reality is a quickly evolving technology, staying informed of how this technology can assist industry is a challenge. The Microsoft HoloLens was first released in 2016 and then the second version in 2019. This has provided a big step in capability and options available to users. Combining this with the investment and platform capabilities from Saab has enabled MLA to undertake a project to determine how viewing a farm in as a co-located, shared holographic experience can benefit industry.

This project sought to investigate if and what benefits could be achieved through:

- Integrating the existing InDepth™ product with IoT devices from Carwoola;
- Importing map data for Carwoola; and
- Providing MLA staff with a demonstration of the mixed reality capability.

A demonstration of the system was delivered to MLA in their Brisbane office, providing staff with a co-located, 3D holographic experience of the integrated data sets, IoT data feeds and simulated data.

3. Methodology

Saab worked with MLA to determine the IoT devices that would be integrated into InDepth™ in the project, targeting providers that had one or more IoT devices at Carwoola. Once this was determined, Saab then liaised with the IoT device providers to obtain their Application Programming Interface (API) and logon credentials for the devices on property. The API and credentials were essential for Saab to be able to develop the solution.

Once the required data was obtained, Saab leveraged existing integrations to develop adapters, which queried each of the devices at Carwoola to obtain their live data. From the data received, Saab then determined an appropriate 3D visual model to represent the devices within InDepth™ and the layout of the 2D cards that would display the information received from the devices.

As the devices would reliably respond to queries, Saab did not have to persist data and was able to run a query when users started the system and have the data available to users when required.

IoT devices typically expose a RESTful API, which is a well-used architectural pattern providing reasonably consistent semantics for querying data. Although this was the first IoT device integration performed by Saab when the project commenced, it was able to leverage experience from a range of other integrations to ensure this was successfully developed.

To import the geospatial data of Carwoola, Saab was able to leverage its existing tool suite and data sources to produce the datasets used. Saab had a range of publically available map data that covered Australia and then the area around Carwoola at a higher resolution. Using data provided by MLA partners, Saab imported the timeline of analysed satellite data and a drone scan from some fields to produce the required visualisations.

4. Results

4.1 InDepth

Saab was able to work with the device and data providers to successfully complete the work of the project and demonstrate InDepth™ showing:

- A 3D representation of the Carwoola property sourced from public data;
- Map data from a drone scan of some specific fields at Carwoola;
- Different data interpretations (such as Normalised Difference Vegetation Index, Total Standing Dry Matter and Fractional Cover) from satellite imagery of Carwoola;
- Live integration of a range of IoT devices from three device providers;
- Display of the IoT device information in a series of 2D cards placed around the users in the real world;
- Enable users to filter the display of the IoT devices and their card information on and off as desired;
- Display of historical data, using graphs, of device information;
- Display of recorded livestock movement using a simulator to playback the data;
- Display of simulated data to show how the status of sensors can be visualised on the map, such as a gate showing as being open or closed;
- Ability to automatically cycle through the display of the interpreted satellite imagery; and
- Enable users to view the property as a walkable map at 100m x 100m in size;

4.2 Demonstration

The final demonstration was able to showcase InDepth™ in the MLA Brisbane office and demonstrate how users can view the live data from the property from remote locations. Using the unique visualisation InDepth™ provides, users were able to view the farm in 3D as well as the information from the live IoT Devices, recordings and simulated data.

The images below were taken at the MLA office in Brisbane during the demonstration from a HoloLens. Darryl Heidke appears in the images.

Image above shows Carwoola and IoT devices plus recorded livestock locations with Darryl Heidke.

Image above shows Carwoola plus a graph and information cards with Darryl Heidke.

Image above shows Carwoola with IoT Devices, simulated livestock and some information cards.

4.3 COVID-19 impact

As with a range of activities, this project was impacted by COVID-19 during 2020. Although the majority of the work was undertaken in Q3/early Q4 of 2019, some data was not available until after travel restrictions had come into force for a lot of Australia. As such, the final demonstration could not be undertaken until the restrictions around travel between states and visiting different facilities had been lifted. The project was still able to be completed within the project timeframe.

5. Key findings

5.1 InDepth

This project was able to demonstrate that InDepth™ is able to provide and immersive 3D visualisation for multiple users. The key findings from the project were:

- InDepth™ was able to be leveraged to provide the product that the required integrations of devices and data required;
- Viewing a property in true 3D is able to provide a unique perspective for users;
- Data from a range of IoT device providers can be integrated into a single platform to remove the need to users to check multiple dashboards for information from different device vendors; and
- Users are able to gain a different understanding of a property when viewing the data within InDepth™.

6. Conclusion and recommendations

6.1 Applications for this project

Utilising InDepth™ as a visualisation platform for a digital twin of a property does provide users with a unique perspective that cannot be achieved through traditional screens, including viewing 3D information on a flat screen.

The main use case for the system is envisaged to be off site briefings/site visits for larger properties or property groups. These users would be able to provide more informative briefings on the current state as well as future plans for the property(s) to a range of interested parties and potential stakeholders. This could involve use cases that exist in the current climate of travel being restricted due to COVID-19, including assisting in property sales and briefing remote owners/investors on the property.

In its current form, it is unlikely that it would be of significant benefit to workers on a property to use when starting a shift or beginning work on the property. This is due to the costs of a headset (currently around $5,500 AUD) and it being ruggedized to be used in the field by workers on the property. As the hardware develops, through programs such as the US Army Integrated Visual Augmentation System (IVAS) program (https://blogs.microsoft.com/blog/2021/03/31/army-moves-microsoft-hololens-based-headset-from-prototyping-to-production-phase/) it is likely to be ruggedized such that it can support use on a property.

The price for the hardware can also be justified as the adoption and use cases for mixed reality increase. As HoloLens runs using Windows 10 Holographic, a range of existing Windows 10 compatible software as well as other HoloLens specific applications, such as Guides (https://dynamics.microsoft.com/en-au/mixed-reality/guides/) and Remote Assist (https://dynamics.microsoft.com/en-au/mixed-reality/remote-assist/) are able to use the same headset. Like the mobile phone and tablet, Saab assumes that over time, wearable headsets will become widely adopted and used by a range of occupations for everyday tasks.

As InDepth™ continues to evolve, more data is able to be visualised when available. This includes viewing a 3D model in isolation, at a range of sizes and scales and being immersed within a 360 video/image taken from the property. InDepth™ is under active development and will continue to develop.

As well as the uses for InDepth™, this project has been able to demonstrate that mixed reality is a platform that complex, immersive applications can be built within to provide more immersion and understanding for users.

6.2 Potential future R&D

Some further R&D could be undertaken for enhancing the benefits to users. These include:

- Integration of the IoT devices with an integration hub such as the Azure IoT Hub to provide a common dashboard for devices;
- Use a cloud service for hosting the server for keeping users synchronised, which would enable easier remote collaboration by users;
- Integrate the headset with GPS data to enable users to see data in situ while working on the property;
- Integration with devices that are able to provide live video feeds from the property;

- Expanded use of livestock monitoring systems to enable the use of live data for livestock movements and status; and
- Integration with more data analytics tools to provide an immersive visualisation of the information generated by the tools.

6.3 Adoption activities

The following activities could help drive adoption of the technology within industry:

- Undertake an activity to assist with the sale/stakeholder engagement of a remote property that is problematic to travel to due to COVID-19 and/or other reasons;
- Work with a property to integrate IoT devices that are used as part of the workflow for determining tasks and investigate how this type of visualisation is able to streamline their workflows; and
- Use Azure or another cloud service to host the server software to enable remote collaboration for a property.