Integrating Control of Remote Systems in ArcGIS Runtime for Surveillance

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Abstract:

The main advantage of ArcGIS Runtime applications is that they can integrate with any standalone as well as networked hardware systems and add value to map details. The objective of this custom application is to integrate surveillance device control within a standalone desktop-based GIS application, providing control from a remote location while utilizing the viewing capabilities of the device. This leverages all functionalities of GIS to enhance the usability of the device from a remote location. While the feed from the device is rich in details, the integration with maps gives the user the location of device and information from beyond the field of view of the device. The control of devices used for surveillance in sensitive areas from a remote location allows the user to take decisions on the fly, while viewing it within a GIS application. Real-time viewing and

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recording capabilities enable the user to monitor the zones 24 x 7. ArcGIS Runtime gave us the flexibility to load offline data as well, which is significant for applications which involve high level of security and would be offline in the military zones, while not enforcing the user to stay online to perform any analysis either. The option to have base map or certain data offline widely increases the usability of the application. The map can also be of any spatial reference, to which the device's location is projected. The view angle of camera, controlled from the application, will be reflected on the map, giving enhanced spatial accuracy and decision-making capability. The device needed a flexible, stable and portable software controller, which was tailor made with ArcGIS Runtime application.

Introduction

Surveillance devices, placed at remote locations, programmed to be controlled through commands from the runtime application, provide a strategic advantage in areas that are sensitive. This application can be used in various defense use cases which requires unmanned surveillance and monitoring. The application enables physical control of such devices while viewing the overall surroundings of the device on the map as well as streaming and recording the video streams from the device. This application can be extended to any discipline that requires mapping based on continuous monitoring. The device needed a flexible, stable and portable solution which was tailor made using ArcGIS Runtime SDKs.

Architecture

The runtime application is designed to accommodate the GIS components, communication channel to the remote devices as well as the video streaming from it. While the feed from devices is rich in data, the integration with maps gives the user the location of devices and details of surroundings. The application enables the user to see the device's view angle on map along with the video feed of the zone. It gives a better sense of the zone and helps in strategic decision making.
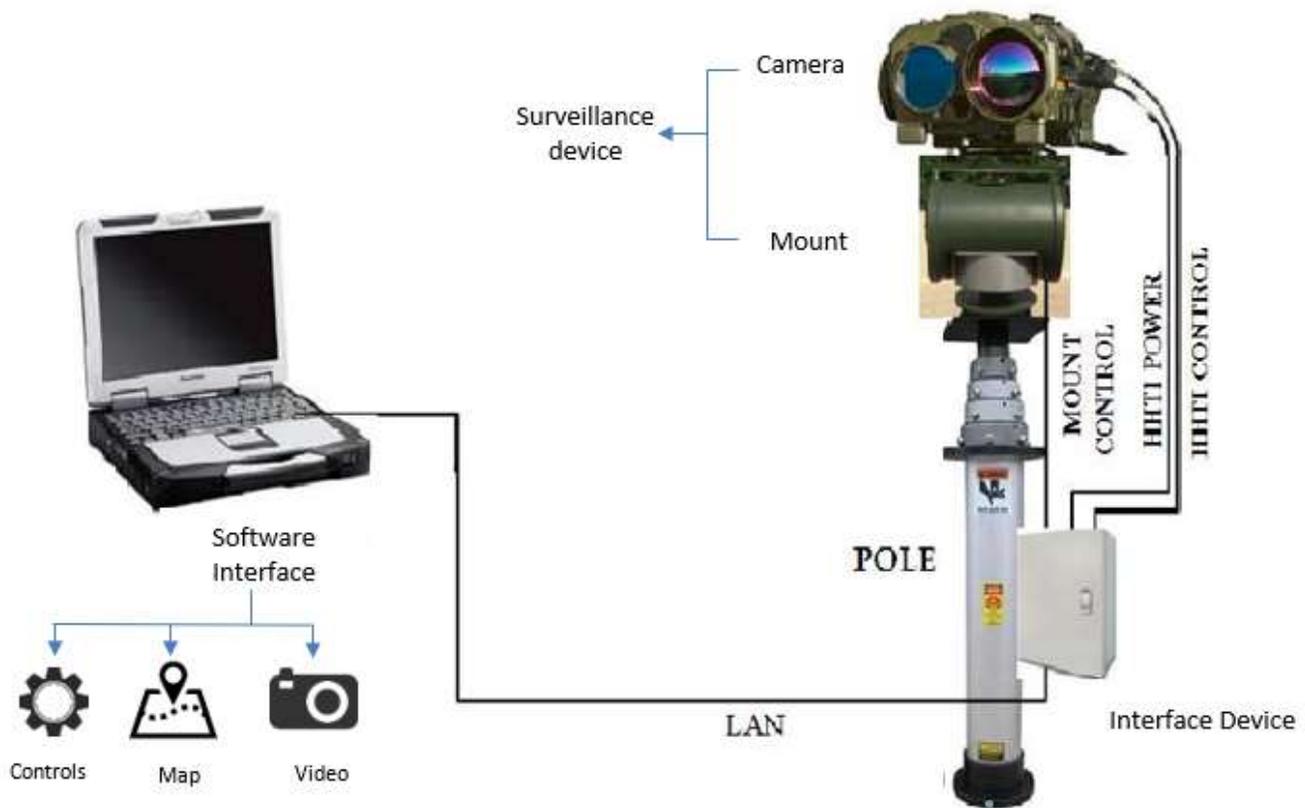

Fig: 1 – Architecture of Hardware and Software

Software Architecture:

The application is built with ArcGIS Runtime SDK 100.1 and the UI was designed using Java FX. Video feed from the device was streamed to the application by using VLC API. For sustained usages in areas with no network connectivity, the application is designed to work completely offline with all the data stored within the device in which it is installed.
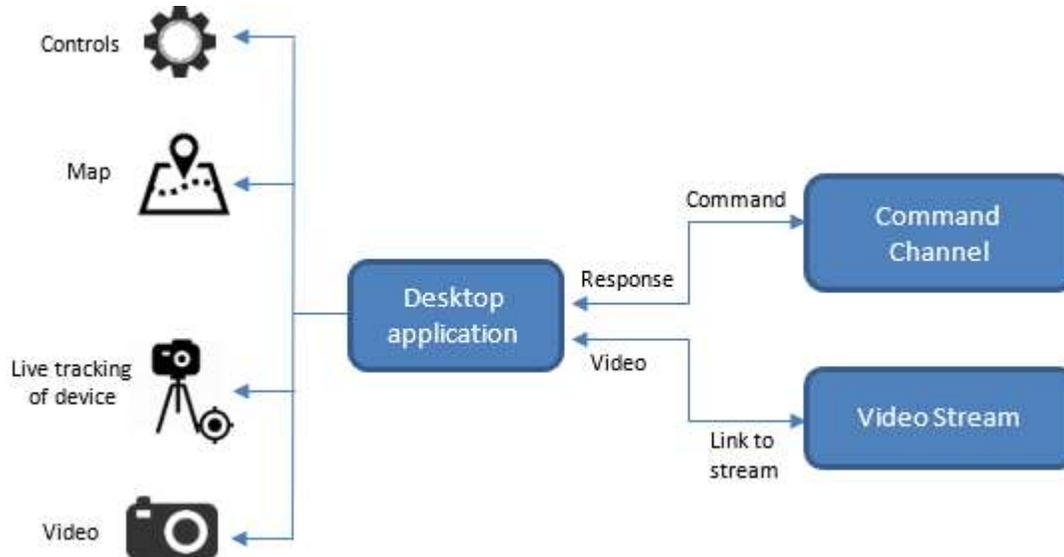
Fig: 2 – Software Architecture

The VLC API allows for streaming of the video feed from the device. It also gives the user the option to record the feed that is being streamed. The Real Time Streaming Protocol (RTSP) is the protocol used to stream video to the application.

The commands sent to the device are formatted in Hexadecimal sequences. The response from the device is used to confirm the successful implementation of the command.

The completely offline design ensures security of the data viewed via the application.

Hardware Architecture:

The application does not require any specific hardware requirements to run as it is a Runtime Application. However, a higher end of processing capabilities is recommended for faster performance.

The surveillance device consists of a camera unit and a mount. The mode of the camera can be changed between thermal, day/night or polarized. It also consists of sensors to detect location and orientation. The following units can be found in the camera:

1. Thermal imaging sensor
2. Day channel cameras
3. Eye-safe laser range finder
4. GPS

5. Compass
6. Communication interfaces

The mount is the structure that enables movement of the camera along the horizontal and vertical axes. The speed control is maintained within the mount, which can also be regulated from the application.

Fig: 3 – Camera and Mount Setup

The camera and the mount are connected to an interface system. This in turn is connected to a desktop, from which they can be controlled.

Fig: 4 – Interface box to integrate the hardware with software

Purpose of Application

The application was built with primary focus on taking advantage of the GIS functionalities while controlling the remote surveillance device. Within military applications, the maps to be viewed are sensitive and do not conform to the known Projection Systems. This Runtime application does not restrict the user from loading maps from such sources and projection systems.

Keeping track the location and orientation of the device allows the user to monitor and take decisions on the fly. The details of surrounding area can be overseen from the map, while keeping in check the live feed of the same.

For controlling the device, the user need not be near the site. The camera can be switched between modes if the visibility falls. The view angle can be changed to focus of the area of interest detected from map using the mount controls. This can be verified from the changes of view angle on the map as well.

**Fig: 5 – Changes in orientation on map when mount is rotated from application**

Modules

The application integrates the mapping and GIS module with modules to interact with the surveillance device. The modules in the application can be split as follows:

   (i)   Mapping Module
   (ii) Camera Control
   (iii) Mount Control
   (iv) Video Streaming Module
   (v)   Video Recording Module

Mapping Module:
The utility of this application is to track the location and view angle of the surveillance device on the map. The runtime application does not load any basemap on startup. This allows the user to load any map to the application, which in turn will be considered the basemap for further actions. The user is given the option to load raster map to the application. On loading, the application adapts to the projection system of the map.
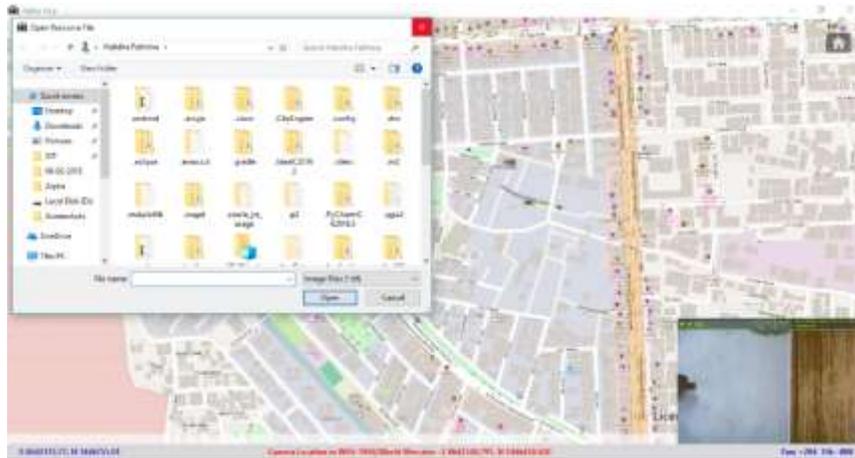
Fig: 6 – Option to choose basemap

The location of the surveillance device is received as a series of hexadecimal strings in the WGS-84 projection system. This is projected to the system of the basemap that has been loaded and displayed. The orientation of the device is also tracked in a similar way and updated on the map continuously.

Adding map of any projection gives the flexibility to work with various data sources without any interference in the workflow. The movement of the cursor on the map is tracked on the status bar, in the coordinate system of the basemap that is loaded. The Projection system of the loaded map is also displayed in the status bar
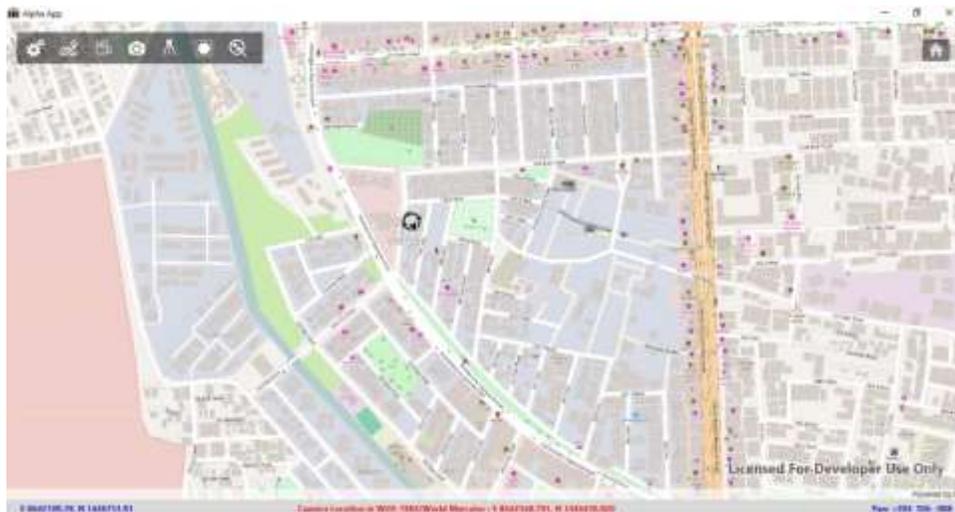

Fig: 7 – Application with basemap loaded and projection system displayed

The Home option on the map keeps track of location of the surveillance device. This makes it easy for the user to return to the location of device when the extent is moved beyond that of the device.

Camera Control:

The control of camera involves actions like zooming in and out, changing polarity, changing the channel etc. The stabilization of the camera can be tested in this menu as well. The Menu control of the camera can also be accessed by using the options given.
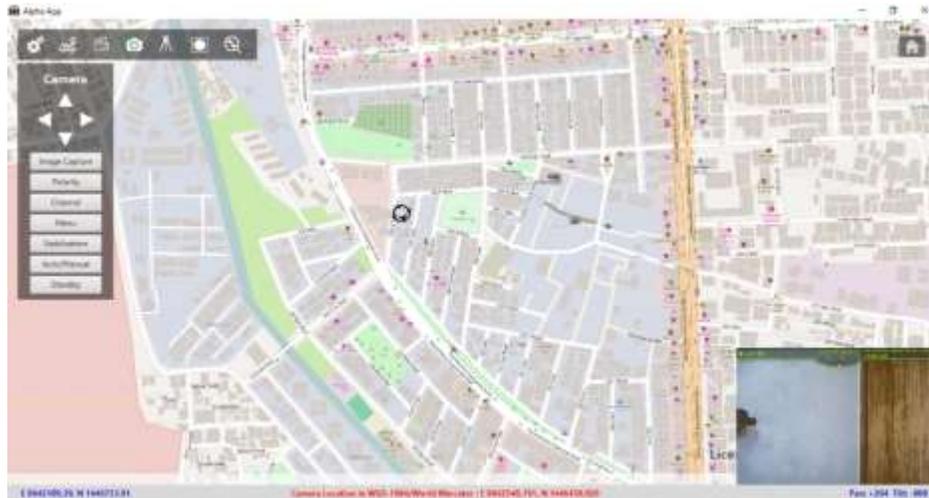
Fig: 8 – Camera control

Fig: 9 – Controlling menu within camera using camera control

Mount Module:

The controls for the mount are essential for orienting the camera. The correct working of the movement can be tested before using it with the 'Bite Test'. The movement of the mount can be controlled in both vertical and horizontal axes. For continuous scans, the mount can be set to scan mode. The speed of scan and the angles between which the scan should take place can be controlled. Value of angles are validated based on type of scan.

Fig: 10 –Mount Control

Video Streaming Module:

Video feed from the camera device is streamed to the application. Using the Real Time Streaming Protocol (RTSP), the video is displayed as viewed through the camera. The location of the camera is also visible on the feed, along with the orientation with respect to North.

Fig: 11 –Mount Control

Video Recording Module:

The video feed can be recorded to be reviewed later. The recording is enabled via VLC APIs, and is stored in defined location. The videos are stored with a time-stamp within folders with the date as name.

Fig: 12 –Recording mode

Conclusion

The ArcGIS Runtime application developed provided the user with flexibility to create a secure, standalone application that can work completely offline. The ArcGIS Runtime enabled the user to connect with the external hardware like the camera and the mount and thus provided Realtime data into the application as well as real time control of the hardware through the application. The users were able to load raster data of any projection system, and the coordinate from the camera and the direction from the mount were converted to the projection system of the map seamlessly, tightly integrating the three systems: the camera, mount and the application. This enabled the users to control the systems located remotely from the application and provided real time surveillance data with spatial insights.

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