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ALBERTA WILDFIRE DETECTION CHALLENGE

Operational Demonstration of Six Wildfire Detection Systems

PROJECT NUMBER: 301015004

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Detection is critical for successful wildfire management. The Alberta Wildfire Detection Challenge was a collaborative program between Alberta Wildfire, Alberta Innovates, and FPInnovations. The program selected six commercially available fixed detection systems for a challenge. These systems were installed and operated on the Marten Mountain Lookout tower near Slave Lake, Alberta, Canada during the 2022 wildfire season. This report presented analyzed performance data of these systems from the demonstration in an operational environment. Results will facilitate a better understanding of these systems.

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BACKGROUND

Wildfire detection is a critical part of wildfire management. Early detection allows wildfire agencies to manage a fire before it grows beyond control. Successful initial attack on a wildfire also relies on early detection to be effective. Once a wildfire is beyond control, operational costs and the potential loss of values and livelihood can increase dramatically.

Alberta's Spring 2019 Wildfire Review

Wildfire detection started in Alberta with ground patrols on horseback in the early 19th century because of increasing government involvement in resource management (Klein, 2005). Currently, Alberta Wildfire's detection program uses multiple detection methods to form its detection network. These include fire lookouts, aerial and ground patrols, satellite data and imagery, and public reporting via 310-FIRE. Alberta's Spring 2019 Wildfire Review (MNP LLP, 2020) identified an opportunity for improvement in the detection section to "continue to evaluate the application and use of emerging wildfire detection technology on Alberta's landscapes" (p. 75). Another opportunity for improvement identified in the report was to "investigate detection options that reduce program dependency on the lookout system. Look to alternative detection methods that require less capital expenditure than that of the lookout system and that mitigate the labour regulation and safety concerns associated with the operation of the towers." (p. 73). This detection challenge addressed these statements by evaluating commercially available wildfire detection technology.

Operational detection evaluation literature

Wildfire detection has evolved around technology development over the last 100 years. The availability of aircraft, electricity, lookout towers, fire finders, radio and telecommunications have increased the detection distance and enabled more efficient and effective initial attack (Klein, 2005). Over the past 20 years, more technological advances have occurred in wildfire detection from image processing, special sensors (such as infrared, near-infrared, and multi spectrum), machine learning, artificial intelligence, and wireless communications. Multiple systems based on these technologies were showcased at the International Wildland Fire Detection Workshop in 2003 (Schroeder), 2006 (Karmacharya), 2010 (de Bruijn), and 2015 (Ault). Operational evaluations were seldom conducted for each new systems due to the complexities of integration with an existing emergency system and the high cost of infrastructure support. During this time, only a few systems were tested in an operational wildfire environment.

Three video-based wildfire smoke detection systems were evaluated in Alberta and Saskatchewan during the summer of 2003 (Schroeder, 2004). That project looked at ForestWatch, FireWatch, and a manual remote controlled camera system. ForestWatch and FireWatch were both semi-automatic detection systems at the time. All three systems were deemed to be capable of detecting wildfire smokes, but the two semi-automatic detection systems were more reliable than the manually operated remote controlled camera system.

The ForestWatch system was tested operationally in Alberta in 2004 (Schroeder, 2005). In that study, the system was found capable of operating in the Alberta environment. The author also believed the system had the potential to be cost effective relative to a fire lookout and suggested a long-term evaluation with an expanded camera network.

An operational study assessed three detection systems in Australia between March 3 and May 15 of 2010 (Matthews, et al., 2010). These systems were EYEfi, FireWatch, and ForestWatch. All systems were based on image analysis from cameras and sensors installed on fixed towers. The study found all the systems tested were able to observe and locate fires during both day and night. However, detection by the camera systems was slower and less reliable than by a trained human observer.

The Hummingbird Network Smoke Detection Service was evaluated in 2017 and 2018 (Hsieh & Roy). The system used crowdsourcing to detect visible smoke with existing cameras. Results indicated that the system could detect and report smokes; however, further refinements were encouraged to increase detection success and address operational issues.

A short detection exercise was conducted between August 23 to 29, 2021, in Alberta to understand how well current detection technology uses imagery from existing cameras on towers to detect smoke (Hsieh & Baxter, 2022). Seven systems that used artificial intelligence (AI)/machine learning technology were involved in this exercise. One system detected seven of the 11 artificial smokes while the rest detected two smokes or less. The detection distance of all successful detections was less than or equal to 18 km. The question coming out of that exercise was “will these detection systems improve their performance if they use their own proprietary equipment”?

Alberta Innovates and the small business challenge

Based on the recommendations of the 2019 Wildfire Review, Alberta Wildfire collaborated with Alberta Innovates and FPInnovations to investigate new methods and technologies for wildfire detection in 2022. This project utilized the small business challenge program of Alberta Innovates which provides a framework to govern an entire product demonstration to solve an operational issue. The framework includes generating a program guide, inviting for submission, submitting applications, selecting solutions, contracting, and demonstration. The program guide contains specific criteria and that was used in the selection process. The rigorous process ensures the selection for demonstration has a high success rate.

The program invited 17 detection service providers to submit applications. A selection committee selected six successful applicants for the challenge. The selected applicants all had established commercial wildfire detection products and fit the selection criteria. These applicants were provided a contract with funding to demonstrate their systems during the 2022 wildfire season.

OBJECTIVES

1. Install and demonstrate the capabilities of six established and commercially available wildfire detection systems in Alberta's operational environment during the 2022 wildfire season.

2. Facilitate a better understanding of the performance of these systems in relation to Alberta's current practices.

METHODS

Selected applicants and their systems

The selection committee reviewed and selected six applicants for this detection challenge (Table 1). The six successful applicants have existing customers and credible references.

Table 1. List of six selected applicants and their systems.

Company	System	Country
EnviroVision Solutions Inc.	ForestWatch	USA
exci pty ltd	exci	Australia
Fireball Information Technologies, LLC	FIREBALL	USA
IQ Technologies for Earth and Space GmbH	IQ FireWatch	Germany
SmokeD Sp. z o.o.	SmokeD	Poland
Working on Fire Latin America Limited Agency in Chile	Firehawk	Chile

ForestWatch and Firehawk both originated from South Africa, but their regional offices (USA and Chile, respectively) had submitted their applications.

Throughout this report, we used the name of the system to refer to both the company and its detection system.

All systems in this detection challenge are fixed detection systems that have a set coverage area. Alberta Wildfire supplied the tower infrastructure and communication to the Internet. Each company supplied its own detection equipment and services. The major components of these systems include proprietary cameras and sensors on towers, image capture and processing units at the tower site, and detection services away from the tower site. These detection services include artificial intelligence and machine learning algorithms to analyze and capture the smoke signatures of wildfires, and a tool to geo-reference the location of a wildfire. Only exci and FIREBALL did not utilize human operators.

All cameras and sensors were installed between 120 and 190 feet above the ground (36 to 58 m). They were positioned above the lookout cupola, which is 100 feet (33 m) above the ground.

For the technological details of each system, readers can visit each company's website (Appendix 2).

Study locations

All systems were installed on the Marten Mountain Lookout tower in Alberta, Canada (Figure 1). The tower is 20 km north of the Town of Slave Lake. The 40 km radius of the lookout coverage area has the following views: to the west is the waterbody of Slave Lake; to the east is a hill that limits visibility; to the south is the town of Slave Lake and the Mitsue industrial area; to the north is forest. Boreal forest species are the primary vegetation cover. Many industrial activities such as forestry, oil, and gas are also spread across the landscape.

This boreal forest area experiences a high number of wildfires due to a high number of lightning strikes and human activities. In 2011, a wildfire entered the Town of Slave Lake and burned around 500 structures (Alberta Agriculture and Forestry, 2012).

Figure 1. Location of Marten Mountain Lookout. Image source: Google Earth.

The visibility map of Marten Mountain Lookout is presented in Figure 2. Figure 3 describes the visibility classes as per the Lookout Observer Manual (Hinton Training Centre, 2015).

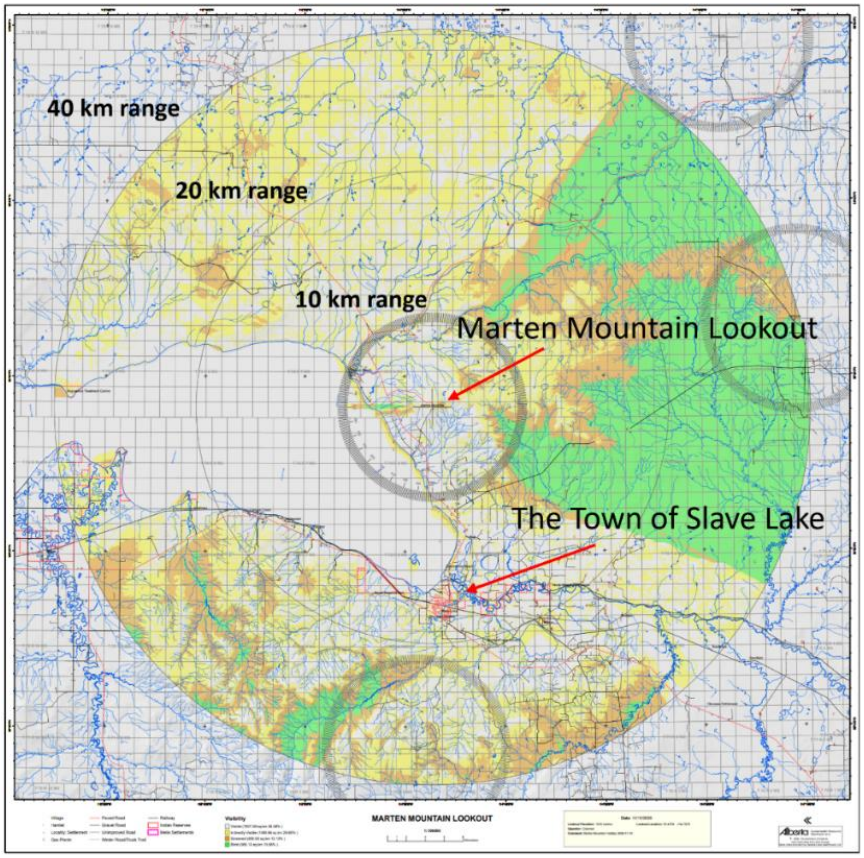

Figure 2. Marten Mountain Lookout visibility map. Source: Alberta Wildfire.

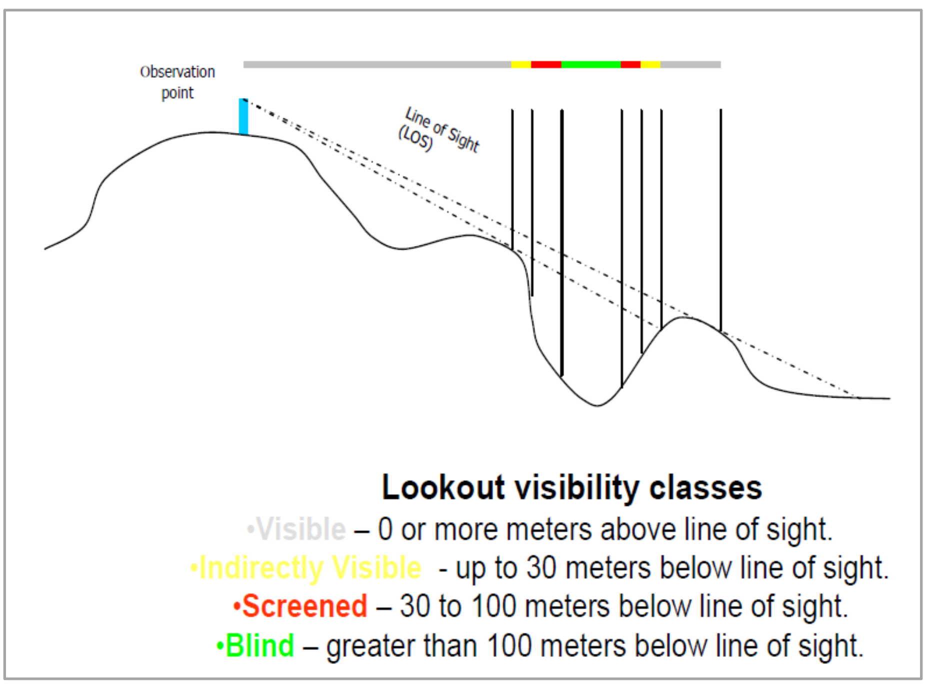

Figure 3. Lookout visibility classes. Source: Alberta Wildfire.

Execution of the detection challenge

After the applicant selection process, the project was divided into three phases: installation, calibration, and demonstration. The installation phase started in May 2022. After each system was installed, the calibration phase was started. The calibration phase ran until June 30. The demonstration phase started on July 1 and was completed by September 15.

The calibration phase allowed each system to establish its own detection workflow, familiarize themselves with the operational procedures in Alberta, and gather data to calibrate their detection algorithm and geo-referencing tool. A total of eight artificial smokes were generated during this phase for calibration purposes.

Data for performance analysis of the detection systems was collected only during the demonstration phase. Results are presented in this report.

Operational procedures

All systems have their own end-user applications to deliver detection alarms. However, the Slave Lake Wildfire Management Area duty room was too small to accommodate all six systems. In addition, the dispatchers needed to be trained to use these applications. To overcome these challenges, a unified operational procedure was established. The procedure simplified the delivery process of detection alarms to minimize distractions in the duty room and focus on the performance of the systems.

When a system had a positive detection, it sent a detection message via email to the duty room and to the researcher. The detection message was required to contain the following information:

- Time of discovery
- Location information of the fire or smoke (such a latitude and longitude, or bearing and distances)
- An image of the detection with a marker
- A hyperlink to a web user interface (optional)

When the duty room received a detection message, the arrival time was stamped on the email and was used as the reporting time for analysis purposes.

After receiving a detection message from a system, the duty room would investigate the source by having a confirmation from another detection system or dispatching initial attack resources. After investigation, the duty room then returned a detection result to the system and a copy to the researcher.

The Marten Mountain Lookout observer used the Osborne Fire Finder to identify fire locations and reported to the duty room via radio. When possible, the observer used cross shots with other lookouts later to increase location accuracy. All selected systems have the ability of getting a cross shot from different towers to increase the location accuracy of fires. However, cross shots were not possible during this challenge because only one tower was used. For fair comparison, only the initial detection messages that were without cross shots from the lookout observer were used for analysis in this report.

Operational period

The daily operational period for all systems was between 8:00 am and 8:00 pm Mountain Daylight Saving Time. Two systems (ForestWatch and SmokeD) opted to provide 24/7 detection services, which included nighttime detections. Firehawk only started 24/7 detection service on August 3. The results section of this report presents performance during the daily operational period only. System performance outside the daily operational period is examined in the Discussion section of this report.

Wildfire and test smokes

The coverage area of Marten Mountain Lookout experiences an average of 20 wildfires annually. A large portion of these occur in May and June. Because data collection for the detection challenge started on July 1 (after the spring wildfire season), the researcher used a Curtis Dyna-Fog 1200 smoke generator (Gibos, 2005) to improve the size of the dataset (Figure 4). The smoke from the generator is similar in size to that generated by a wildfire that is approximately 0.1 hectare. A 0.1-hectare wildfire is suitable for a four-person initial attack crew to action in Alberta according to experienced crew leaders.

Figure 4. The Curtis Dyna-Fog 1200 smoke generator.

All test smokes were generated within a 40 km radius of the tower. The smoke generator ran for 30 minutes for each smoke. All test smokes were confirmed by at least one of the fixed detection systems, including the lookout observer from Marten Mountain Lookout. All detection systems, including the lookout observer, were not notified of the location or the time that the test smokes would occur.

The detection results were separated into two datasets: wildfires and test smokes. This was done because of the fundamental differences in their characteristics—wildfire smoke typically gets larger over the observation period, whereas test smokes are more consistent in size and lasted for only 30 minutes.

Data analysis

Detection messages were grouped into four categories to assist Alberta Wildfire to understand each system's capabilities for successful detections by eliminating or reducing false alarms and avoiding reporting on known smokes and valid fire permits:

1. **Successful detection**: Included wildfires, test smokes, and others such as attended fires and machinery exhaust that were not on the known smoke and fire permit lists.
2. **Nothing found**: The cause of the detection message could not be found by the dispatched initial attack resources or by other detection methods. This also included false alarms.
3. **Known smoke**: Permitted industry smokes with known locations. Examples included pulp mills and gravel crush sites.
4. **Fire permit**: Burns that had valid burn permits. Industry and private landowners are required to have valid fire permit to conduct burning during the wildfire season.

Alberta has a system where landowners can apply for fire permits during the wildfire season. These fire permits allow applicants to conduct burning in a prescribed method. Known smokes are smokes generated by industrial activities and known to the local wildfire management area. It is important for detection systems not to report these known smokes, burns with valid fire permits, and false alarms because dispatching initial attack resources to these locations is costly and time-wasting.

Four metrics were used to evaluate the performance of the detection systems: detection distance, reporting efficiency, location accuracy, and system availability.

Detection distance was difficult to pinpoint for each system in the wildland environment because of the limited number of samples and uncontrollable smoke appearing in the operational environment. Therefore, detection successes were grouped into 10 km-segments.

Reporting efficiency represents how fast a fire can be reported. Only successful detection records are used for reporting efficiency. Each test smoke had a definite start time, but the specific ignition time of wildfire were unknown. Therefore, the latency analysis on test smokes and wildfires are separated into two datasets.

Location accuracy was represented by the difference between reported and actual fire locations. Location information was required in each detection message. The longer the distance, the lower the accuracy of system's geo-referencing tool. Lower location accuracy can lead to longer response times for initial attack resources, especially for ground crews because their visibility is limited by trees.

System availability is an important criterion. Higher availability indicates a system is spending more time on detection duty and less on maintenance. System availability was calculated based on the down-time portion out of total duty time and represented as a percentage.

Four criteria were used to determine which fires were to be used for analysis:

1. Only wildfires and test smokes were used for analysis calculations.
2. When a wildfire or test smoke was detected by a fixed detection system, including the Marten Mountain Lookout observer, it was deemed to be a valid target and other systems were expected to detect it.
3. When multiple fires were caused by the same lighting storm and were located within 1 km of each other, they were grouped and assigned as a single wildfire for the fixed detection performance analysis.
4. The Marten Mountain Lookout observer operated on a different detection schedule than the selected systems. The performance analysis for the lookout observer did not include any fires occurring outside the lookout's operational period.

RESULTS

A total of 54 events were recorded and of these 14 were wildfires and 33 were test smokes. Seven events were excluded:

- Five wildfires could not be confirmed by any of the fixed detection systems.
- One wildfire was detected 46.3 km away from the lookout and was outside the responsible coverage area (40 km).
- One wildfire occurred after 8:00 pm and was outside the designated operational period.

The details of the events are described in Appendix 1.

Categories of detection messages

More than 300 detection messages from different detection agents were received and analyzed. These detection agents included the six selected fixed detection systems, the Marten Mountain Lookout observer, public reporting via 310-FIRE in Alberta, unplanned forestry staff, and aircraft.

Table 2 shows the categories of detection messages from the fixed detection systems. The dataset for the Marten Mountain Lookout observer was used as a control for comparison.

Table 2. Categories of detection messages from the Marten Mountain Lookout observer and six fixed detection systems.

System	Successful detection				Nothing found	Known smoke	Fire permit	Overall total
	Wildfire (n=14)	Test smoke (n=33)	Other	Total				
Lookout observer	12	33	5	**50**	1	0	1	**52**

Firehawk	5	24	3	**32**	11	2	0	**45**
IQ FireWatch	9	17	7	**33**	12	7	0	**52**
ForestWatch	1	10	4	**15**	17	7	0	**39**
SmokeD	1	9	0	**10**	16	13	0	**39**
exci	2	1	2	**5**	2	4	0	**11**
FIREBALL	0	0	0	**0**	0	0	0	**0**

n = number of samples

FIREBALL had been installed but was not operational.

Results show IQ FireWatch and Firehawk were the best performers on detection success among the six installed systems. However, the Marten Mountain Lookout observer had the highest success.

Detection distance

Table 3 shows the number of detection successes on test smokes for the different distance segments for each fixed detection system. Figure 5 shows the rate of detection success in a chart format. Table 4 shows the number of detection successes on wildfires. Because of the low number of samples to provide a meaningful result, the detection successes on wildfires were not compiled into a chart for determining detection distances.

Table 3. Successful detections of test smokes in the different distance segments among the fixed detection systems.

System	5 – 10 km	10 – 20 km	20 – 30 km	30 – 40 km
	Number of test smokes within each distance segment (n)			
	8	8	8	9
Lookout observer	8	8	8	9
Firehawk	7	7	6	4
IQ FireWatch	6	4	5	2
ForestWatch	4	3	3	0
SmokeD	7	1	1	0
exci	0	0	1	0
FIREBALL	0	0	0	0

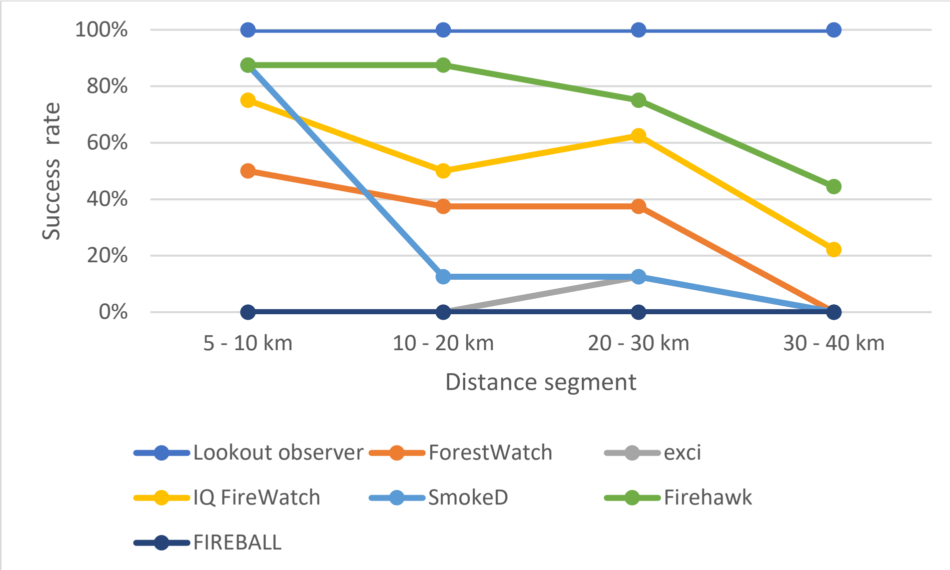

Figure 5. The success rate of detecting test smokes in the different distance segments among the fixed detection systems.

Results show the Marten Mountain Lookout observer was effective at the 40 km distance for both test smokes and wildfires. In addition, the lookout observer also detected a wildfire smoke at 46 km.

Of the six fixed detection systems, Firehawk had the best performance with an 88% detection success rate between 10 and 20 km on test smokes, this then drops to 78% between 20 and 30 km.

Table 4. Successful detections of wildfire smoke in the different distance segments among the fixed detection systems.

System	5 – 10 km	10 – 20 km	20 – 30 km	30 – 40 km
	Number of wildfires within the distance segments (n)			
	4	3	4	3
Lookout observer	4	3	3	2
IQ FireWatch	2	1	3	3
Firehawk	1	1	1	2
exci	0	1	0	1
SmokeD	0	0	0	1
ForestWatch	0	0	0	1
FIREBALL	0	0	0	0

The numbers in Table 4 were low and inconsistent and thus could not be used as a reference to determine the detection distances of the systems.

Reporting efficiency

Table 5 documents the time it took for each system to report test smokes. Table 6 shows the comparative delay of reporting time for wildfires. The first report for each wildfire is used as the baseline and its report time is set to zero.

Table 5. Time taken to report test smokes.

System	5 – 10 km		10 – 20 km		20 – 30 km		30 – 40 km		Overall	
	Average (mins)	n	Average (mins)	n	Average (mins)	n	Average (mins)	n	Average (mins)	n
Lookout observer	2	8	3	8	2	8	7	9	4	33
Firehawk	3	7	6	7	10	6	7	4	6	24
IQ FireWatch	12	6	16	4	16	5	12	2	14	17
SmokeD	6	7	15	1	31	1	n/a	0	10	9
ForestWatch	18	4	25	3	30	3	n/a	0	24	10
exci	n/a	0	n/a	0	11	1	n/a	0	11	1
FIREBALL	n/a	0	n/a	0	n/a	0	n/a	0	n/a	0

n = number of samples

Firehawk had the fastest average time reporting test smokes among the six systems. The rest of the systems exceeded 10 minutes. exci and FIREBALL did not have sufficient data to determine an average time.

Table 6. Comparative delay for reporting wildfires.

System	5 – 10 km		10 – 20 km		20 – 30 km		30 – 40 km		Overall	
	Average (mins)	n	Average (mins)	n	Average (mins)	n	Average (mins)	n	Average (mins)	n
Lookout observer	6	4	0	3	0	3	1	2	2	12
Firehawk	1	1	5	1	16	1	1	2	5	5
IQ FireWatch	5	2	9	1	25	3	17	3	12	9
exci	n/a	0	0	1	n/a	0	62	1	31	2
SmokeD	n/a	0	n/a	0	n/a	0	55	1	55	1
ForestWatch	n/a	0	n/a	0	n/a	0	79	1	79	1
FIREBALL	n/a	0	n/a	0	n/a	0	n/a	0	n/a	0

n = number of samples

For reporting wildfires, Firehawk had the lowest latency. However, the results were not significant because of the small number of the samples.

There was insufficient data from exci, SmokeD, ForestWatch, and FIREBALL to determine their latency on reporting wildfires.

Location accuracy

Table 7 shows the average distances between the reported and actual locations. The number of samples in the table includes wildfires and test smokes.

Table 7. Distances between reported and actual locations.

System	5 – 10 km		10 – 20 km		20 – 30 km		30 – 40 km		Overall	
	Average (kms)	n	Average (kms)	n	Average (kms)	n	Average (kms)	n	Average (kms)	n
Lookout observer	1.3	12	1.2	11	1.3	12	2.1	11	1.5	45
IQ FireWatch	0.4	8	0.8	5	1.1	8	3.13	5	0.9	26
Firehawk	4.7	8	4.3	8	5.2	7	3.3	6	4.4	29
SmokeD	1.6	7	1.2	1	1.6	1	9.5	1	2.4	10
ForestWatch	0.4	4	1.1	3	12.7	3	1.3	1	4.0	11
exci	n/a	0	14	1	11.5	1	13.5	1	13	3
FIREBALL	n/a	0	n/a	0	n/a	0	n/a	0	n/a	0

n = number of samples

IQ FireWatch had the best accuracy on reporting locations and was better than the lookout's performance. SmokeD was second overall but the numbers of samples are too low beyond 10 kms to determine the reliability of the result.

System availability

The total number of operational hours between July 1 and September 15, with the daily operational period between 8:00 am to 8:00 pm, was 924 hours. There were 67 hours of downtime that impacted all systems due to a network issue; these hours are not included in Table 8.

The Marten Mountain Lookout observer did not have any downtime. The lookout observer operated on a different detection schedule than the selected systems. The schedule was changed daily by the duty officer base on the weather condition and fire hazard.

Table 8. Availability of all systems in hours and percentages.

System	Total downtime (hrs)	Availability
Lookout observer	0	100%
IQ FireWatch	0	100%
Firehawk	0	100%
exci	0	100%
ForestWatch	95	90%

System	Total downtime (hrs)	Availability
SmokeD	189	80%
FIREBALL	Not operational	

FIREBALL did not operate during the entire challenge. The rest of the five systems were able to detect, monitor, and report any technical instabilities.

ForestWatch had a malfunctioning onsite processing unit that caused their downtime.

SmokeD has five fixed detectors and two PTZ cameras. Malfunctioning detectors accounted for all its downtime. SmokeD maintained a 360° detection coverage because of its unique deployment. The PTZ cameras remained operational when its fixed detectors malfunctioned.

Both ForestWatch and SmokeD reported the issues quickly and took the necessary steps to address them. Most of the downtime of both systems were caused by shipping and replacement time.

DISCUSSION

System performance

Results show Firehawk and IQ FireWatch as the top performers among the six detection systems in this detection challenge. The performance of these systems has improved when compared to results from previous evaluations with similar systems (Matthews, et al., 2010). However, the Marten Mountain Lookout observer still outperformed these systems.

Detection distance and success rates

One of Alberta's wildfire management objectives is to find wildfires that can be safely managed by a four-person initial attack crew. A fire size of 0.1 hectare is used as the quantifiable measurement to describe this objective. As stated in the methods section of this report, test smokes are similar in size to the smoke generated by a 0.1-hectare wildfire. Test smokes are also more consistent (in size and duration) than wildfires, and are therefore used for determining detection distances for systems in Alberta. Figure 5 provides a reference for detection distance and success rate of the systems based on this detection goal.

In this detection challenge, the top performers had detection success rates near 60% on test smokes within a 40 km coverage area. However, the success rate fell to 44% (Figure 5) when test smokes were between 30 and 40 kms away. The success rate increased to 88% between 10 and 20 kms. This shows detection success increased as the distances decreased and reflects that the strength of the systems is in short to medium distances at this time.

The reader should note that if the detection goal was different, the detection success rates of these systems will change (e.g., the detection success rate will increase if a detection goal is to find fires that have 0.5 ha in sizes instead of 0.1 ha).

Not reporting valid fire permits, known smokes, and false alarms

The results in Table 2 show that no system reported any burn with a valid fire permit, except one detection message from the lookout observer. This is evidence that all systems can receive and process a list of fire permits daily. These systems also verified any detection alarms from the list of fire permits effectively.

Reports on known smokes were low but not eliminated. Many of these known smokes were rock crushers and gravel operations in different locations. The smokes from these industrial activities were difficult to differentiate from wildfires and test smokes for the systems. Firehawk only reported two known smokes over two and half months (Table 2). IQ FireWatch and ForestWatch both reported known smokes several times. But these numbers were manageable for the duty room.

Except FIREBALL, all other systems performed well on not reporting false alarms. Firehawk had the lowest number at 11 over the two and half months. Other systems also had low numbers which were manageable by the duty room.

System availability and success rate

Firehawk and IQ FireWatch experienced no downtime during the detection challenge. At the same time, both systems had the highest numbers of detection successes among the systems.

Low system availability can lead to lower performance because of missed opportunities to detect fires and test smokes during downtime (Table 9) and recalibrations (often required after replacing malfunctioning components).

Table 9. Detections missed during the downtime of ForestWatch and SmokeD.

System	Wildfire	Test smoke
ForestWatch	3	3
SmokeD	9	13

Downtime has an impact on costs because equipment replacement or maintenance on a tower requires certified technicians. If a tower is in a remote area and is fly-in only, transportation costs can be high.

Except FIREBALL, all systems modularized their components toward plug and play for ease of installation and replacement. Other steps that can be utilized to increase system availability include having redundancy or spare parts on site and dual channels for data communications.

Users of these systems need to discuss this with vendors and their internal telecommunications specialist to determine their cost and risk tolerance.

Use of own proprietary equipment

All systems used their own proprietary equipment in this detection challenge. During the detection exercise in 2021, detection systems used existing cameras on the towers (Hsieh & Baxter, 2022). All detection successes in 2021 were within 18 kms when using these existing cameras. In 2022, the detection distance increased to between 20 and 30 kms with a near 80% success rate when the systems used their own equipment. This increase in performance can be credited to better system integration, more efficient image processing for transfer, and priority of camera control to fit the needs.

The number of data points in 2021 were limited and not enough to produce a meaningful comparison on the efficiency of reporting, location accuracy, and not reporting false alarms or known smokes. However, these performance indicators are related to the operational workflows of the systems and should not be impacted by equipment differences directly.

Detection messages from other detection methods

Alberta Wildfire uses various detection methods within their forest protection area. Other than fire lookouts, the rest of the methods are considered as non-fixed detection methods. Detection messages from the other methods within the same coverage area were included in the dataset that were forwarded to the researcher. These methods included public reporting via 310-FIRE, unplanned forestry aircraft, and unplanned forestry staff detections.

Ground and helitack patrols did not submit any detection message within the coverage area of Marten Mountain Lookout. No planned fixed wing aerial patrols were conducted during the demonstration phase (July 1 to September 15).

Table 10 shows the results from the other detection methods. It includes wildfires that were in the blind area of Marten Mountain Lookout and could not be detected by any of the fixed detection systems. Therefore, the results were not used to compare with the fixed detection systems.

Public reporting occurs 24 hours a day. A single fire event may result in multiple detection messages from public reporting over time. Several detection messages from public reporting were grouped together as one successful detection if they were reporting on the same wildfire or test smoke.

On August 20, seven detection messages from public reporting were not investigated by the duty room because multiple wildfires already occurred within the coverage area. These detection messages did not contain specific location information and were difficult to verify. These seven detection messages were not included in the dataset.

Table 10. Results of other detection methods.

System	Successful detection				Nothing found	Known smoke	Fire permit	Overall total
	Wildfire	Test smoke (n=33)	Other	Total				
Public reporting	9	4	0	**11**	8	0	0	**19**
Unplanned forestry aircraft	2	0	0	**2**	5	0	0	**7**
Unplanned forestry staff	4	0	0	**4**	0	0	0	**4**

Public reporting detected two wildfires (SWF089 and SWF102) that were not reported by any fixed detection system. All wildfires found by unplanned forestry aircraft and unplanned forestry staff were not detected by the fixed detection systems.

Comparison with current Alberta detection practices

Alberta Wildfire uses multiple methods for wildfire detection. The primary planned detection method is the fire lookout utilizing a lookout observer. The selected systems in this detection challenge were installed on the same tower of Marten Mountain Lookout. Results showed that the lookout observer had the highest performance on detection success, detection distance, not reporting false alarm and known smokes, and reporting efficiency. Location accuracy for the lookout observer ranked second behind IQ FireWatch and was 0.6 km.

Public reporting also contributed a significant amount of detection success. As expected, most detection successes were near highways, busy resource roads, and the area surrounding the Town of Slave Lake. These reporting locations also overlap with cellular coverage. The results show the public was aware and willing to report wildfires via 310-FIRE. However, public reporting is also associated with higher false alarms and lower accuracy of locations when compared with other fixed detection systems.

An opportunity for enhancing public reporting is identified by expanding cellular coverage.

Night detection

Night detection is the detection service provided during low or no sunlight. ForestWatch, SmokeD, and Firehawk chose to provide detection coverage outside of the operational period which included night detection. Only eight detection messages from public reporting and Firehawk were considered as night detection (Table 11).

Table 11. Night detection messages.

System	Successful detection			Nothing found	Known smoke	Fire permit	Overall total
	Wildfire	Other	Total				
Firehawk	0	2	**2**	4	0	0	**6**
Public reporting	0	0	**0**	2	0	0	**2**

These results show that Firehawk has the ability to detect fires during nighttime. Two successful night detections were the results of an attended fire and a car fire. These two detection successes suggest that this type of detection system could be used as a monitoring tool at night. However, the number of records could not provide conclusive evidence of the value from night detection by the systems.

A new methodology is needed if verifying the efficacy of night detection is deemed to be important. There are two initial reasons for this: the smokes from the smoke generator cannot be seen in dark and second, there are not many wildfire ignitions at night.

Detection success between test smokes and wildfires

One vendor claimed that its system can detect wildfires better than smoke from a smoke generator. It is acknowledged that smoke from wildfires and a smoke generator differ chemically. However, results from this project could not verify the difference based on the detection success. The number of wildfires was too low for this comparison.

Increasing accuracy of locating fire

These systems showed they could provide relatively accurate geo-referenced locations for detected fires in latitude and longitude. They also included bearing (degrees) information within the detection messages. All systems were equipped with cross shot capabilities but were not utilized because only one tower was used during this detection challenge. Location accuracy will increase with cross shots if multiple units of a system are deployed on different towers.

However, cross-shot function cannot replace geo-reference capability of a stand-alone system in Alberta environment because of the high cost to establish a network for cross shots only.

Human operators

Firehawk, IQ FireWatch, ForestWatch, and SmokeD systems used human operators. The data showed that these systems performed better than systems that did not have human operators. The researcher assumed these systems were using human operators to increase performance. No specific information was gathered on the tasks of these human operators carried out since they were included as part of the system. Each system may have a different list of tasks for their human operators. When purchasing these systems, discussions should occur on what these tasks are and whose responsibility it is to provide the operators.

Other considerations

A comparative cost analysis on these systems was not within the scope of this detection challenge. The funding provided to the companies was to recover base costs only and cannot be used for commercial pricing. In addition, infrastructure and communication costs are highly variable depending on location. The total cost of a system therefore is variable and would need to be considered on a case-by-case basis.

All systems have their own proprietary user interface applications. These applications contain geo-mapping, image/video feeds, and alarm management as basic elements. This detection challenge did not utilize these applications. Instead, we asked companies to send detection messages by emails with specific requirements. All companies had modified their systems to meet this new requirement. Except for FIREBALL, the other companies demonstrated they can cater to the needs of operational integration on functional and data levels.

Other operational integration components that were not within the scope of this report but will be important for consideration when deployed on government properties are:

- compliance with IM/IT security policies
- compliance with privacy policies

CONCLUSION

Alberta Wildfire, Alberta Innovates, and FPInnovations collaborated on the Alberta Detection Challenge. The challenge provided the funding and an opportunity for six companies to demonstrate their fixed detection systems in an operational environment during the 2022 wildfire season in Alberta. Six commercial wildfire detection systems were selected and installed on the Marten Mountain Fire Lookout tower near the Town of Slave Lake. The companies and their systems are:

- exci by exci pty ltd
- FIREBALL by Fireball Information Technologies, LLC
- Firehawk by Working on Fire Latin America Limited Agency in Chile
- ForestWatch by EnviroVision Solutions Inc
- IQ FireWatch by IQ Technologies for Earth and Space GmbH
- SmokeD by SmokeD Sp. z o.o.

The aim of this detection challenge was to gain a better understanding of the performance of these systems and to compare their performance to Alberta’s current detection methods.

All systems, except FIREBALL, completed the installations and calibrations by June 30, 2022. The demonstration began on July 1 and ended on September 15, 2022. FIREBALL was not operational during the entire challenge. Data on 14 wildfires and 33 test smokes were collected and analyzed. The findings are:

- The performance of these fixed detection systems has improved over last 10 years with AI/machine learning.
- Systems using their own equipment, including proprietary camera and sensors, had better performance than using imagery from existing cameras.
- Firehawk and IQ FireWatch had best performance among the selected systems.
- The best performing system had a detection distance on the test smokes between 20 to 30 kms with a near 80% detection success rate (Figure 5). The size of test smokes was similar to that generated by a 0.1-hectare wildfire, the size which a four-person initial attack crew is dispatched to action.
- The Marten Mountain Lookout observer had a detection distance range of 40 kms with 100% detection success on the test smokes.
- These systems have the capability to manage fire permits and known smokes without reporting them.
- The false alarms from these systems were low and manageable by the duty room.
- The Marten Mountain Lookout observer had the best reporting efficiency (Table 5 and Table 6). Firehawk had the best efficiency among the selected systems. The rest of the systems took close to 10 minutes or longer to report fires.
- IQ FireWatch had the best accuracy of reporting fire locations, followed closely by the lookout. The accuracy can increase by enabling cross shots if multiple units of a system are deployed on different towers.
- IQ FireWatch and Firehawk achieved 100% system availability.
- Successful systems are using human operators to improve the performance.
- Comparison with current detection practices:
    - The Marten Mountain Lookout observer had the best performance among fixed detection systems on detection success, detection distance, reporting efficiency, and not report on false alarm and known smokes.
    - Public reporting using 310-FIRE was effective within the cellular coverage area.
    - Other unplanned detection methods found fires in the blind area of the lookout.
- Efficacy of night detection was not conclusive because of the small size of the dataset. A new methodology would be required to evaluate night detection capability of these systems.

The comments from each company are provided in Appendix 3. exci did not provide comment before the publishing of this report.

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APPENDIX 1: FIRE EVENT RECORDS

Cause	Start time	First report	Distance (km)	Visibility category	Notes
smoke generator	7/11/22 12:10	7/11/22 12:10	20.2	direct	first by lookout
smoke generator	7/11/22 13:31	7/11/22 13:31	10.8	direct	first by lookout
smoke generator	7/11/22 15:05	7/11/22 15:07	25.8	direct	first by lookout
smoke generator	7/12/22 11:59	7/12/22 12:03	21.8	direct	first by lookout
smoke generator	7/12/22 13:41	7/12/22 13:43	31.4	direct	first by lookout
smoke generator	7/12/22 15:15	7/12/22 15:17	10.3	indirectly visible	first by lookout
wildfire - SWF056		7/12/22 10:47	39.5	screened	first by Firehawk
wildfire - SWF057		7/12/22 20:44	19.3	screened	outside the operational period; first detected by exci and confirmed by the lookout
wildfire - SWF058		7/15/22 18:37	8	direct	first by lookout; caused by lighting
Wildfire - SWF059		7/15/22 19:03	18.8	screened	reported by LFS; not found by any fixed system; caused by lighting
wildfire - SWF060		7/15/22 19:44	30.9	blind	first by lookout
wildfire - SWF061/62/63		7/15/22 20:06	25.1	indirectly visible	first by unplanned forestry aircraft; not found by any fixed system; caused by lighting
wildfire - SWF084		7/19/22 18:44	23.4	direct	only by lookout
wildfire - SWF088		7/24/22 14:45	23.4	direct	first by lookout
wildfire - SWF089		7/25/22 5:57	37.2	indirectly visible	first by 310-fire; outside operational period; not found by any fixed system; human caused
smoke generator	7/26/22 13:12	7/26/22 13:18	39.4	direct	first by lookout
smoke generator	7/26/22 15:09	7/26/22 15:09	5.8	direct	first by lookout
smoke generator	7/27/22 11:12	7/27/22 11:14	16.2	direct	first by lookout

Cause	Start time	First report	Distance (km)	Visibility category	Notes
wildfire - SWF100		7/30/22 19:31	18.6	direct	only by lookout; human caused
wildfire - SWF101		8/1/22 16:42	35.7	direct	first by IQ; confirmed by the Lookout; caused by lighting
wildfire - SWF102		8/1/22 17:12	36.6	indirectly visible	only by 310-fire; not found by any fixed system; caused by lighting
smoke generator	8/10/22 12:23	8/10/22 12:34	21.7	direct	first by lookout
smoke generator	8/10/22 14:14	8/10/22 14:15	5.4	direct	first by lookout
smoke generator	8/10/22 15:44	8/10/22 15:46	9.4	direct	first by Firehawk
smoke generator	8/11/22 10:39	8/11/22 10:42	16.1	direct	first by lookout
smoke generator	8/11/22 12:39	8/11/22 12:40	25.8	indirectly visible	first by lookout
smoke generator	8/11/22 14:16	8/11/22 14:22	18.7	direct	first by lookout
smoke generator	8/11/22 15:51	8/11/22 15:54	6.3	direct	first by Firehawk
wildfire - SWF108		8/13/22 17:37	46.3	indirectly visible	only by lookout; caused by lighting
wildfire - SWF120/122		8/20/22 18:06	14.8	screened	only by unplanned forestry aircraft; not found by any fixed system; caused by lighting
wildfire - SWF116		8/20/22 18:20	14.4	screened	first by lookout; caused by lighting
wildfire - SWF117		8/20/22 18:45	16	screened	only by lookout; caused by lighting
wildfire - SWF125		8/22/22 15:43	9.8	indirectly visible	first by IQ and lookout; caused by lighting
wildfire - SWF131		8/23/22 18:46	6.4	indirectly visible	first by lookout; caused by lighting
wildfire - SWF129/130		8/23/22 18:46	8.1	screened	first by lookout; caused by lighting
wildfire - SWF133		8/26/22 15:14	21.4	direct	first by lookout
smoke generator	8/31/22 11:15	8/31/22 11:16	22.2	direct	first by lookout
smoke generator	8/31/22 14:00	8/31/22 14:01	17.3	direct	first by lookout

Cause	Start time	First report	Distance (km)	Visibility category	Notes
smoke generator	8/31/22 15:47	8/31/22 15:48	6.8	direct	first by lookout
smoke generator	9/1/22 11:15	9/1/22 11:17	38.5	direct	first by lookout
smoke generator	9/1/22 12:32	9/1/22 12:35	35.4	direct	only by lookout
smoke generator	9/1/22 14:15	9/1/22 14:19	10.1	direct	first by lookout
smoke generator	9/1/22 16:15	9/1/22 16:18	25.2	direct	first by lookout
smoke generator	9/1/22 17:40	9/1/22 17:41	26.5	direct	only by lookout
smoke generator	9/2/22 11:10	9/2/22 11:11	30.4	direct	first by lookout
smoke generator	9/6/22 13:33	9/6/22 13:35	10.1	direct	first by lookout
smoke generator	9/6/22 15:06	9/6/22 15:09	6.9	direct	first by Firehawk and lookout
smoke generator	9/13/22 12:13	9/13/22 12:15	7.4	direct	first by lookout
smoke generator	9/13/22 14:13	9/13/22 14:19	34	direct	only by lookout
smoke generator	9/14/22 12:29	9/14/22 12:44	38.5	direct	only by lookout
smoke generator	9/14/22 13:53	9/14/22 13:55	8.2	direct	first by lookout
smoke generator	9/14/22 15:37	9/14/22 15:38	30.8	direct	first by lookout
smoke generator	9/14/22 16:42	9/14/22 17:09	36.9	screened	only by lookout
wildfire - SWF156		9/15/22 15:28	21.3	direct	first by 310-fire

APPENDIX 2: COMPANY WEBSITES

Company	System	Website
EnviroVision Solutions Inc.	ForestWatch	http://evsusa.biz/
exci pty ltd	exci	https://www.exci.ai/
Fireball Information Technologies, LLC	FIREBALL	https://fireballit.com/
IQ Technologies for Earth and Space GmbH	IQ FireWatch	https://www.iq-firewatch.com/
SmokeD Sp. z o.o.	SmokeD	https://smokedsystem.com/
Working on Fire Latin America Limited Agency in Chile	Firehawk	https://www.firehawkdetection.com/

APPENDIX 3: COMPANY COMMENTS

The following comments have been provided by the small business challenge participants and have not been edited by FPInnovations. FPInnovations does not accept any responsibility or liability regarding products and services mentioned in these comments as they have been provided by a third party.

FIREBALL

Fireball has years of experience detecting smoke from image streams from many hundreds of Company A's Q60xx-E and Q60xx-E series rotating surveillance cameras. These cameras properly handle the ONVIF standard. Indeed, Company A developed ONVIF which is now an open industry standard.

At present Fireball collects and screens over 4 million images per day and precisely locates new smokes nearly always in the first image where smoke is present. Anticipating participation in the Alberta Detection Challenge, Fireball contacted the US western regional distributor of Company A Cameras and asked them to hold three cameras for purchase in March and delivery before the end of April. The distributor indicated that they would have the cameras.

AB Innovates funding was received on April 13, 2022 and Fireball immediately contacted the Company distributor. The distributor informed Fireball because the cameras had not been paid for in March they had been sold. The distributor said that they understood that a supply chain problem was seriously limiting production of the Q60xx series cameras. Consequently, there were no Q60xx series of any type available in North America.

Fireball was forced to source a different camera type on a very short timeframe given that camera installation on the Marten Mountain tower was to begin early in May. Fireball contacted six video surveillance camera manufactures asking it they could deliver 3 cameras to Edmonton by the second week of May. Ultimately the Company L Model x was chosen for four reasons:

1. A review of the technical specifications of the cameras provided by the manufacturer met or exceeded Fireball's specifications including a high-quality sensor array from a trusted manufacturer, full compatibility with the ONVIF surveillance camera operation/communication protocol. Company L claimed to meet the specifications, claimed ability to communicate with the camera both through on-camera software or through software applications designed to consolidate the management of camera networks. Also, Company L offered a 4K camera which theoretically could speed smoke detection because 4K represents twice the resolution of many other high-end surveillance cameras.
2. Company L promised rapid and deep access to technical support for companies who joined their Commercial Partner
3. Until very recently, Company L had been a subsidiary of Company F Systems, a company with whom Fireball has had a long and trusted relationship. Company F had made a significant invest in Company L before Company F sold to a Chinese firm, Company D.

4. Company L is a Canadian company providing potential to deliver to Canada in a short time frame. They, in fact, represented that the cameras could be in Edmonton at the end of the first week of May.

Unfortunately, several of the key representations of Company L proved to be untrue and/or at least seriously misguided.

Among the problems experienced with the Company L Model x where:

1. The cameras are neither made nor warehoused in Canada. The model x is made by Company D in China. The cameras are warehoused in Indiana USA. And although Fireball was told that the cameras could be expressed to Edmonton they were trucked as part of a UPS full truck load. The cameras were delivered more than two weeks later than promised and paid for.
2. These Company D cameras were not compatible with any of the Company L software. The documentation provided with the cameras did not reveal Internet Protocol Port on which the ONVIF server was located. (This may have been the reason for the incompatibility.)
3. Eventually it was found that among all of the Company L hardware and software the Model x cameras only communicate with the Company L Nxx Network Video Recorder. Further, that network video recorder cannot be access remotely for camera control or transfer to remote computers.
4. Fireball did join the Company L Commercial Partners program to obtain better technical support. After many calls to the support center Fireball at last chanced upon a technician who would provide clear information. The helpful technician stated that Company L itself did not have the information to answer our questions. He stated that Company L is now owned by Company D and advised calling Company D technical support.
5. Fireball contacted Company D technical support. The technician from Company D refused to answer any questions. In the end the person from Company D began to yell at us, saying that they were not allowed to provide information on the Model x camera. He then hung up.
6. Subsequently, Fireball began to look for the ONVIF port and interface on the Model x. After much searching the ONVIF server was found on a non-standard ethernet port.
7. The ONVIF server on the Model X camera was not completely implemented. Fireball wrote code that could capture the images from the incomplete interface. These image streams were parsed on a computer installed in the building at the bottom of the Marten Mountain tower. The images could then be pushed to the Fuego platform running on Amazon Web Services.
8. After the images were successfully delivered to our AWS pipeline, Fireball began detecting smokes from the Marten Mountain tower.
9. However, the Model X cameras azimuth data were strangely inconsistent. Much time and energy was spent trying to understand how we might calibrate the azimuth data. In the end Fireball found that the azimuth reference point (Zero degrees) drifted in the direction that the camera was being rotated and that the drift was related to the speed of rotation. It was not clear if this was a hardware or software problem or possibly a

combination. Without a stable azimuth and pitch calibration it is impossible to geo-locate fires in the standard fashion. In spite attempting to find some kind of fix even after the Alberta Challenge was over, Fireball has not been able to establish a reliable geographic reference for the Company L Model x cameras.

10. Fireball has written to Company L to express our profound disappointment.
11. Fireball apologizes to AB Innovates and to Alberta Wildfire for the difficulties that we encountered. Company A Q60xx cameras have only become available again in the last 45 days.

Firehawk

We have only one comment and it pertains to the positioning of the detections: location accuracy on Table 7. Distances between reported and actual locations.

During post trial analysis an anomaly in the calibration process brought on by an inaccurate height operand (of the installed cameras) was encountered. This accounted for an average factor of 93.7% of the reported error margin over all detection distances.

ForestWatch

EVS has several hundred installations globally, and over 100 individual sites in North America which are almost evenly split between the US and Canada. Additionally, there are currently 104 sites scheduled for installation through 2024.

Thank you for the opportunity to participate in the Alberta Detection Challenge.

The Alberta Detection Challenge brought some unique challenges for EVS. In the North American Market, all of our current installations are owned by the end user, all of which are also responsible for conducting detection operations. The Alberta Challenge required each company to provide the human interface of detection and provide a smoke report in order to participate. Because of this, we optioned to send data and images to one of the detection centers that we own in South Africa. This detection center is well suited and is responsible for hundreds of detection events every month within the region. However, it should be noted that the issues we experienced during the test period resulted in EVS making improvements to our system coding and infrastructure which resulted in much faster reporting turn times. Additionally, in review of our performance, we have concluded the following:

1. The calibration process that existed at the time of testing was not sufficient for intercontinental transmission.
2. The time difference between the two zones contributed greatly to the overall outcome.
3. EVS team which was tasked with detection needed improved direction which would have resulted in improved study results.

We thank the teams at FP Innovations and the Alberta Detection Challenge for allowing EVS the opportunity to participate and for all the support to complete the challenge.

IQ FireWatch

As one of six companies offering automated solutions for early wildfire detection, we were invited to participate in the Alberta wildfire challenge 2022 and were able to contribute our many years of expertise and experience. This challenge is intended to allow a comparison between systems in largely identical, but challenging conditions.

Set-up and calibration phase

The setup and commissioning by an IQ engineer and our on-site partner went professionally and smoothly together with the FPInnovations and Alberta Wildfire Telecommunications staff.

Unfortunately, due to bad weather conditions, the calibration phase was much shorter than planned and only a few test smoke runs were possible before the actual challenge.

Operating

Contrary to our recommendation and the usual approach to have the operating carried out on site in Alberta by people who already have the necessary domain knowledge of the local and regional conditions, the operating had to be outsourced to a third-party provider. In order to achieve optimal operating results, a longer training period is required to develop knowledge about local conditions and characteristics, as well as a feeling for the environment among the acting persons. Only with the same level of knowledge about regional characteristics and conditions a comparability with local lookout observers is possible.

Night detection

IQ FireWatch has been successfully offering night detection including 24/7 operating for more than 10 years. However, an implementation within this challenge was not required, which is why it was not used.

Methodology and approach

Compared to many other tests, we can confirm that we considered the approach in the Alberta wildfire challenge 2022 as very positive, professional and goal oriented. The comparable results between the systems used are ensured, firstly, by the duration of the tests over an entire fire season and, secondly, by a largely standardised approach to message recording, which was carried out by e-mail to the duty room.

The comparability between the automatic systems and the lookout observer is limited due to the different methodology (data transmission, recording procedure, etc.). The expertise of the people at the lookout tower is nevertheless very creditable and is reflected in the good results.

Regarding the use of a fog machine to simulate test smoke, there are concerns on our part as outlined below. The author of the study has taken this into account by presenting artificial and natural smoke separately.

Fundamental differences between test smoke by fog machines and real wildfires

It should be noted, as already stated in the report, that artificial smoke-like events generated by fog machines differ from real wildfires in fundamental characteristics. For example, the shape of the smoke, which is constantly increasing (see page 8), is crucial for its identification. Furthermore, the chemical composition (see page 18) of the real smoke from a wildfire and the fog from the test smokes are different. This leads to a difference in color and shows features in different spectral ranges. The movement of the two tested types is also different, for example, smoke from a wildfire has a vertically directed movement with minimal horizontal offset, and a heavy fog moves close to the ground, unsteadily, and, after an initial gradient, mostly creeping horizontally.

All three of these features (shape, color, movement) are essential to our detection algorithms in terms of detection accuracy as well as exclusion of smoke other than forest fire smoke to reduce the false positive alarm rate. This is also shown by the results that our detection rates for real fires are significantly higher compared to the other systems than for test smoke via fog machine.

These fundamental differences show that test smoke via fog machines is not suitable to represent wildfires in a representative way. Unfortunately, there is no other possibility at present, except for real test fires, which can only be used to a limited extent due to their hazardous nature.

Report efficiency

The discovery time is different from the reporting time. The former is the time at which the system detects the fire, the latter is the time at which the operator triggers the alarm. The time between these points is variable by waiting for an additional detection process (4-6 minutes), but can be shortened immensely by better domain knowledge of the area around the scene.

Location accuracy and system availability

Even when using only one system without the use of cross bearings, the results show that the automatic system works better than human lookout observer with expertise.

The system availability and longevity of the components is a very high demand, which we also met in this test as expected.

Conclusion

We are grateful for the opportunity to participate in the Alberta wildfire challenge 2022, which was an attempt to establish comparability between manufacturers of different systems of automated early detection of forest fires on the basis of a well thought-out methodology and a largely standardized approach. As a result, it has been shown that many years of experience are absolutely necessary for good results. Two very well established systems have prevailed. This finding is also in line with our experience and that of our customers, as similar systems based on optical smoke detection have been trying to establish themselves on the market in recent years. This statement is especially true for complementary technologies such as detection with microsensors or detection from space via satellites. Terrestrial, optical smoke detection will continue to be the backbone of automated early forest fire detection.

As it has been shown in many projects, the fusion of modern technology with human knowledge is often very helpful. Experience has proven that the best results are achieved when lookout observers are employed as operators in the operating centers of the IQ FireWatch system.

SmokeD

Ladies and Gentlemen, at the very beginning, we would like to express our gratefulness for the opportunity to take part in the conducted tests, which were undoubtedly the best organized of all in which we have participated so far. We remain highly impressed by the commitment and openness of the entire **FPInnovations** and **Alberta Innovates** teams.

SmokeD is primarily dedicated to detecting smoke at a distance of up to 10 miles. The solutions offered by our company consist of a whole family of products that support smoke detection, such as: software dedicated to drones, mobile devices, crisis management centers, etc.

Over the last few years, ***SmokeD*** has been implemented on five continents, in over 150 different locations and group of satisfied customers is constantly expanding. Although the quality of the solutions we provide is our top priority, the tests carried out by **FPInnovations** fell far below our expectations. Emphasizing once again the professionalism and objectivity of the **FPInnovations** team, we would like to draw attention to several elements that ultimately influenced and eventually affected the result of ***SmokeD*** in the tests carried out.

1) Due to supply chain disruptions caused by COVID and the geopolitical situation, we had no stock of equipment stored at our US headquarters. This forced us to deliver all components from Europe, using one of the courier companies. As it turned out, the extremely irresponsible behaviour of the company's employees resulted in a huge delay in the delivery of the entire system and partial damage to some of its components. Despite the circumstances and taking legal action against the carrier, we were unable (due to lack of time) to conduct a thorough test of all ***SmokeD*** components before assembly. As a consequence, two detectors and one of the two PTZ cameras stopped working shortly after installation.

2) Unfortunately, during the installation of the ***SmokeD*** system components, as a result of improper connection to the network, the dedicated switch was also damaged, which was eventually replaced with a non-configured replacement from another manufacturer, provided by **FPInnovations.** Although it was possible to launch the system based on the delivered components, it did not reach full functionality. The development team lost some of the control functions over the detectors and PTZ cameras - their remote diagnostics were no longer available and possible.

3) The ***SmokeD*** system in the tested configuration, usually dedicated to the owners of large forest complexes, also includes all the elements that are part of the equipment dedicated to crisis management centers. These are monitors, control panels that allow you to take manual control over the cameras, etc. Although the system is fully autonomous, in this case it is also crucial to emphasis the possibility of interaction with a person who, under business as usual conditions, has the ability to react to emerging alarms, can configure selected system parameters oneself etc.

During the tests, however, it was decided that the existing monitoring centre in Slave Lake would only receive alerts reported by individual companies participating in the test. In view of the above, all components of the ***SmokeD*** system, which normally go to monitoring centers, in this case have been locked in a secured and not used on a daily basis server building at the observation mast. This forced ***SmokeD*** to introduce a number of ad hoc changes, which certainly also affected the final test results.

With very kind regard,
SmokeD Team

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