WEATHER STATION SECURITY SYSTEM FEASIBILITY ANALYSIS

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Abstract: This paper discusses the challenges experienced by weather station implementers in regards to security. It proposes and gives the cost effect analysis of a weather station security system. This is very important due to the high cost of maintenance that is as a result of theft and vandalism of weather station equipment.

Keywords: weather station security, image processing, Surveillance System

1 Introduction

Securing of Automatic Weather Station (AWS) components is becoming a big concern to meteorological services in developing countries. Unlike other components, which are kept under close supervision, AWSs are deployed in outside or remote environments[1]. These remote environments especially in Africa are located in off-the-grid locations, leaving the power-dependent AWSs to rely on renewable power supplies[2]. The AWS requires sufficient power for sensors to collect, process and to enable radios transmit the collected weather data. Such power demanding activities may in some instances require big sized solar panels and batteries, which form the main components of AWS power supplies. The solar panels and batteries have found various uses such as lighting and phone charging in many homesteads[3]. The AWS vulnerability coupled with their power supply domestic values, many AWSs have been vandalised, making them unable to perform the functions they were intended to perform.

AWS Vandalism is the act of deliberately destroying or damaging weather station equipment Vandalism reduces the number of operational AWSs, hence a reduced amount of weather data collected. Besides weather data loss, the cost of replacing an AWS is prohibitively high.

As such, vandalised stations often remain non-operational for quite a long time and sometimes are completely abandoned. The growing number of non-functional AWSs, causes a sparse network of stations, leading to limited weather data collected. Limited weather data affects the accuracy of weather forecasts. Inaccurate weather forecasting negatively affects many sectors including agriculture, construction, entertainment and transport. It is thus important to secure the available AWSs to minimize vandalism.

The meteorological services have been employing a series of mechanisms to enhance AWS security. While many AWSs are installed in remote locations[1], preference has always been given to sites close to communities and especially near police posts, as a way of using communities to monitor the stations. Such a mechanism is only efficient during the day, leaving stations vulnerable at night. In regards to remotely deployed stations, physical security mechanisms such as caging the entire station, using padlocks as well as caging the solar panels have been used. Despite the effort, AWSs are still vandalized, rendering the traditional security mechanisms inefficient.

A few AWS manufacturers have been able to supplement their AWSs with security systems. An example of such stations is the delta weather stations[4], which is equipped with motion detections sensors. These motion sensors, on sensing motion near the AWS sound an alarm, which signals persons in charge to check the station. This security mechanism may raise false alarms especially if any of object comes in close proximity with the AWS. As false alarms grow in number, important alarms may be ignored. We are proposing a reliable and cost-efficient security system, which shall be based on cameras. The cameras shall be placed at locations, which enable them capture images from the AWS surrounding, process them and raise an alarm. We believe that improved security of the AWSs shall reduce vandalism cases and enable meteorological services maintain the available AWSs, hence enough data for forecasting purposes.

2 Security Mechanisms

Several security mechanisms have been used to enhance the security of various AWS. Integrated Security Corporation located in Michigan, USA near Detroit manufactured the Infinity 2020 which is the premier fence mounted intrusion detection system[5]

The set back to using such a solution is its cost of installation and mantainace. Costs are even higher compared to replacing a given weather station equipment. We determined this from

its long list of specifications[5]. This makes the whole project unjustifiable as well as making the idea non-viable.

Another product on the market is the HD 1080P Weather Station Security Wi-Fi Camera that has a wide range of features. Such as usage as a normal weather station, remote access on both android and OS, as well as motion detection [6].

Using such a solution has several setbacks one being its cost which is at $170.69 amazon price which is relatively high. Another setback is its lack of support for windows phones.

The Smart Motion Detection System that uses the Raspberry Pi is also another security measure that is related to the project we proposed.

This system is suitable for small personal area surveillance. I.e. personal office cabin, bank locker room, parking entrance. Whenever the motion is detected through PIR sensor inside the room the image is captured through camera and temporarily stored in the raspberry pi module[7]. Internet of things based application can be used remotely to view the activity and get notifications when motion is detected. This solution's downside is the need for the PIR sensors which will need more costs making the project not viable.

The optris PI LightWeight is another solution to equipment security as it uses infrared recordings. Its disadvantage is the camera size which is too big implying that intruder can easily avoid being captured[8].

3 Methodology

UNMA is the entity that has the mandate to promote, monitor weather and climate as well as provide weather prediction and advisories to government and advisories to government and other stakeholders for use in sustainable development[9]. Through its mandate, UNMA installs weather stations across the country and maintain them to ensure continuous operation. In order to establish requirements for an AWS security system, reviewed literature on status of weather stations in Uganda, visited two weather stations and carried out an interview with three UNMA station network managers. The network station managers are in charge of overseeing the installation and maintenance of weather stations throughout the country. The team keeps records on the status of stations. Among the

records provided by the team was a report on vandalism of the weather stations taken between 2005 to 2008 and 2005 to 2013.

We used interviews to establish challenges facing available security mechanisms and their challenges. What opportunities are available for introducing a new security system? While automated systems may be more reliable, their continuous operations is highly dependent on resource allocation and readiness of users. The study set out to establish the readiness of UNMA to embrace the new technology. Below are the feasibility categories that the study was based on

i. Technology.
ii. Budget.
iii. Location.

4 Findings

In the survey we carried out, we found out that whereas the AWSs are a good alternative to monitoring weather conditions at 24 hours daily with minimum human supervision, it has been noted that over the years, they have a weakness of being vandalized. Prior to installation of a station UNMA takes various security precautions. Among them include the following.

A Weather site is identified within the premises of the hosting Organization. The site should be in clear observation of the stakeholders. This is followed by construction of a chain link rectangular perimeter fence where the station is installed to keep off intruders. The fence has a lockable gate with strong padlocks. The bottom of the chain lick is fortified with concrete to avoid intruders getting into the fence from the bottom.

The main challenge with this sort of security approach (Using locks) is that with time they get compromised due to rusting brought about by the rain water, due and frost

Table 1: Map of installed VS vandalised

SNO	Model	Qty	Vandalised	Percent	Component
1	Skye Instruments	10	3	30	Solar Panels
2	Davis	33	8	24	Solar Panel
3	Adcon	43	3	7	Solar Panel
	Total	86	14	16	

5 System Design.

5.1 System Architecture

The weather station security system will be an embedded system comprising a camera and a raspberry pi. It will be a follow-on member of a family product intended for use in providing security services at given weather stations.

The camera with the integration of the pi motion detection module will be able to detect motion change in the environment. This dynamic behaviour will be coordinated on the raspberry pi which acts as the control centre.

When motion change is detected the camera module will be activated immediately. Next the images of the intruder will be captured and uploaded to the weather station caretaker through an email notification as attachments.

The station caretaker will review the images to determine the next course of action. That is either triggering the alarm to scare away the intruder or to stream view the images from the weather station directly for more critical analysis. This live streaming shall be enabled through the use of raspivid [10]. This procedure will reduce the number of false alarms.

The communication of the camera and the raspberry pi shall occur over cable or wire connection whereas the email notification message with intrusion images as attachments and pi is expected to occur over a wireless network (internet).

The system shall contain the log files for future references. This is important for big data analysis.

The system caretaker shall use the interface designed to address the course of action depending on the information received from the weather station (The images attached to email notification).

The whole system rotates around the pi architecture[11]

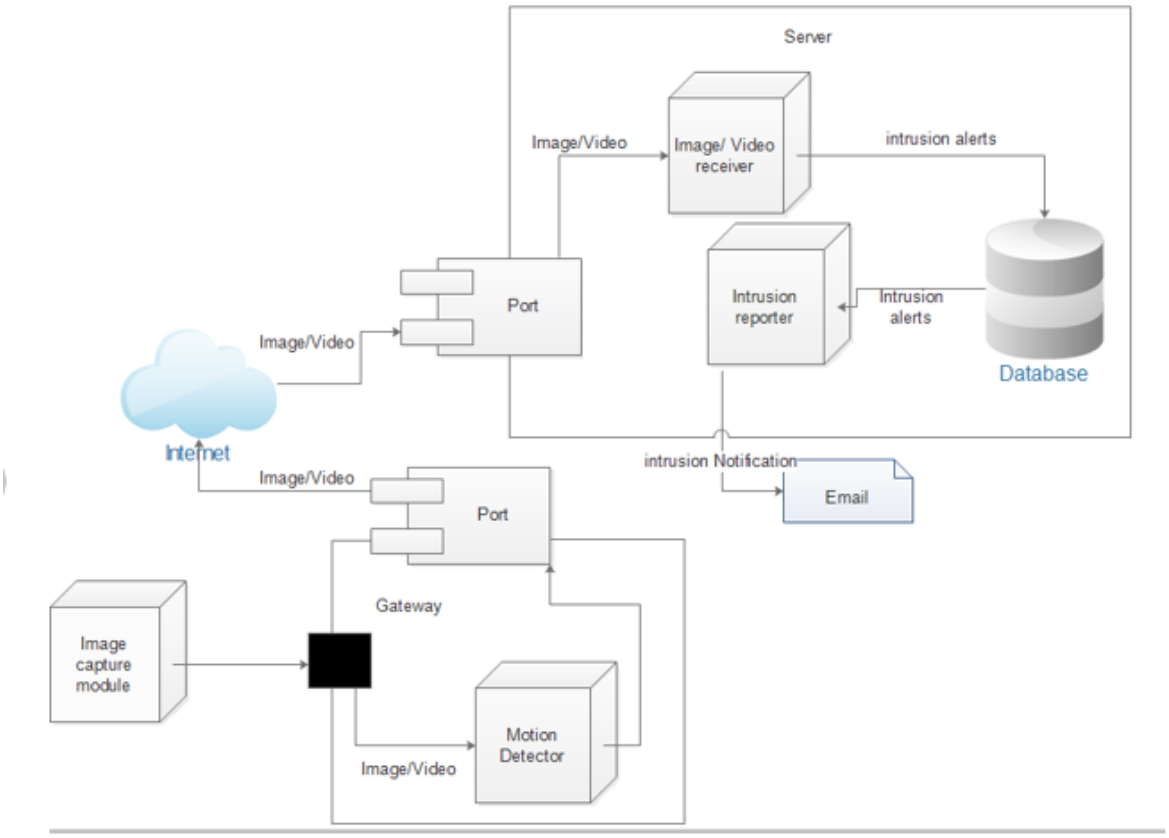

Figure 1: System Architectural Diagram.

5.2 Deployment requirements

5.2.1 Environmental Considerations.

Most weather stations are located in remote areas [12]. In comparison with those located in urban areas, the cage enclosures is a security mechanism they use in common. These cages are secured with padlocks. The setback to using padlocks is that after a period of time, they get compromised due exposure to rain, frost and dew. They can easily be picked on and easily copied. Possession of a mechanical key can be copied if there is extended physical access[13].

Figure 2: Makerere University Weather Station

Given this setting, which is almost the same as the different weather stations, the ideal place for camera placement would be the diagonal corners so that they capture activities happening in the entire station. Setting them up in this way would require using two cameras for every weather station.

5.2.1.1 Raspberry Pi

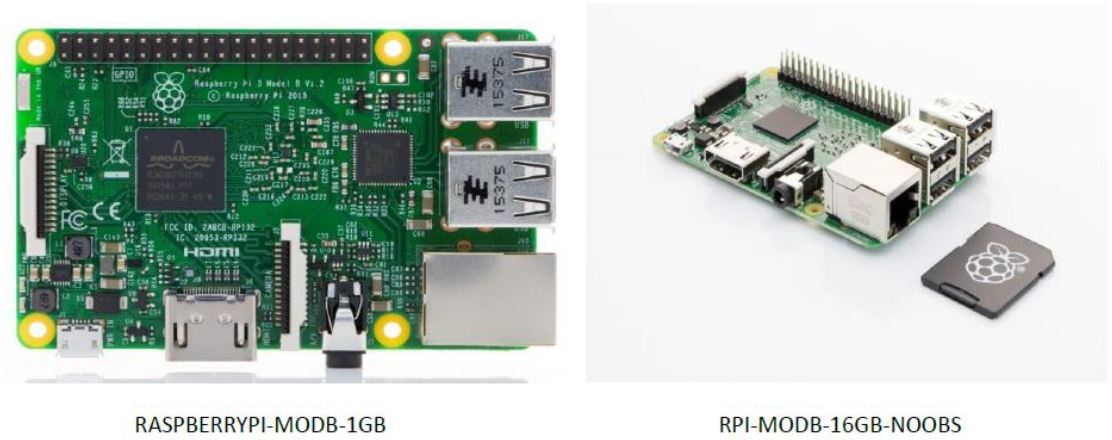

Figure 3: Raspberry Model B

The Raspberry pi model uses an upgraded switched Micro USB power source (now supports up to 2.4 Amps) [14][15]. The raspberry is powered by the solar panels installed at the weather station like how the GroveWeatherPi Sensor Suite[16].

5.2.1.2 Camera specifications.

We shall use Waveshare Raspberry Pi Camera Module OV5647 ($30.99) [17]

Figure 4: Camera(F)OV5467

Table 2: Camera(F))OV5467 specification table

CCD size	¼ inch
Aperture	(F):1.8
Vision	Night vision
Sensor best Resolution	1080p
Compatibility	All models of Raspberry PI
Screw Holes	4
Infrared support	2
Power Output	3.3V
Megapixels	5
Focal Length	3.6MM(Adjustable)

6 Cost Benefit analysis

Table 3: Financial cost estimates

Item		**Quantity**	**Price**	**Total**
Camera Module		2	$30.99	$61.98
Mounting Screws		8	$0.10	$0.80
Wires		50ft	$0.25/ft	$17.50
Camera casing		2	$10	$20
Camera shipping costs		2	$10	$20
			Total	$199.48

Benefits

Weather equipment security mechanism of using layered technologies makes it harder to reach the centre. (And makes burglars more likely to cry as each layer unfolds!) . This makes it an excellent and essential level to weather station equipment security. It reduces the rate of weather security equipment vandalism. provides efficient and convenient motion detection surveillance, enables real time monitoring of the weather stations, cameras will help to capture events in detail even under extreme conditions and security cameras with night vision work effectively during day or night as they can adjust to varying levels of light. Camera technology also has the ability to allow you to dial in remotely from an offsite location.

7 Conclusions

While it was generally agreed that using advanced technology to ensure security at the various weather stations would provide a better solution, the survey results also indicated that issues concerned with feasibility, manageability, effectiveness and cost should be top of the list before suggesting the kind of solution to implement.

7.1 Recommendations

Due to the large amount of power that is consumed by the cameras, the system will be implemented first on stations with grid power connectivity.

Instead of email alerts, sms alerts would be more convenient since they don't require any internet connection.[18]

7.2 Future Work

Due to the remoteness of most stations, tracking motion might not be sufficient to ensure the security of the station, implementing a GPS tracker would help in the recovery of the equipment as implemented in the bonrix software or the Adafruit Ultimate GPS on the Raspberry Pi [19][20]. It works in such a way that the Gps tracking unit uses the Global Positioning System to determine the precise location of a vehicle, person, or other asset to which it is attached and records the position of the asset at regular Intervals.

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