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Seismic, Hydroacoustic and Infrasound Monitoring for Seismic Stations Applying 3G/4G Technologies

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INTRODUCTION

In order to monitor the state of health (SoH) of the stations, a low-cost remote monitoring system was implemented.

METHODS/DATA

An electronic board was designed with various types of sensors, the values obtained from the station environment are collected and sent to the NDC through a VPN connection with the help of the local 3G/4G internet.

START

RESULTS

The data received at the NDC are stored in a database, then plotted for the station operator to analyze the data and consider action if necessary.

CONCLUSION

The implementation of this monitoring system in a remote station helps the operator to supervise, anticipate failures and make corrective maintenance visits efficient.

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INTRODUCTION

Fundación Privada de Fieles
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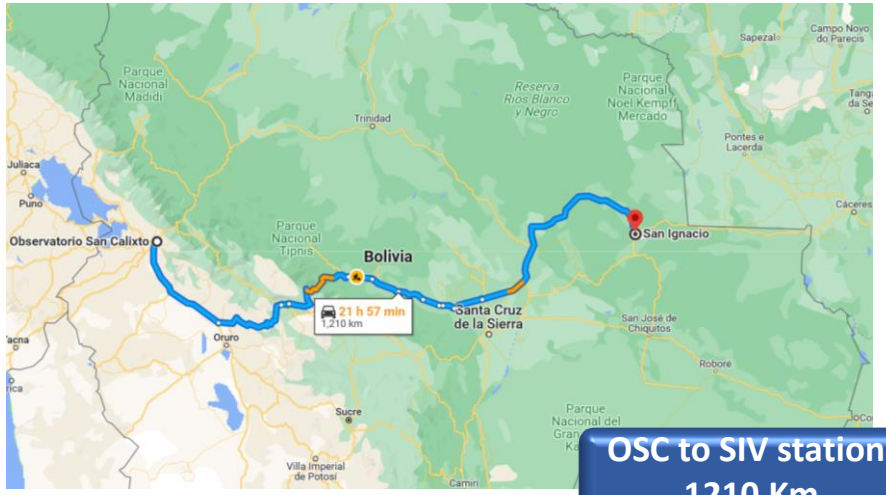
The San Calixto Observatory (OSC) is the National Data Center of the Plurinational State of Bolivia that operates the certified seismic stations PS06-LPAZ, AS08-SIV and the infrasound network IS08-BO.

The distances between our national data center and the farthest seismic station is more than 1000 km (AS08-SIV) at 2 days of travel by car, the other two are located in the Altiplano region where the working environment is often complicated.

Observatorio San Calixto



OSC to SIV station: 1210 Km

In order to ensure efficient preventive and corrective maintenance at the station, a tool was implemented to monitor the health status of the stations.

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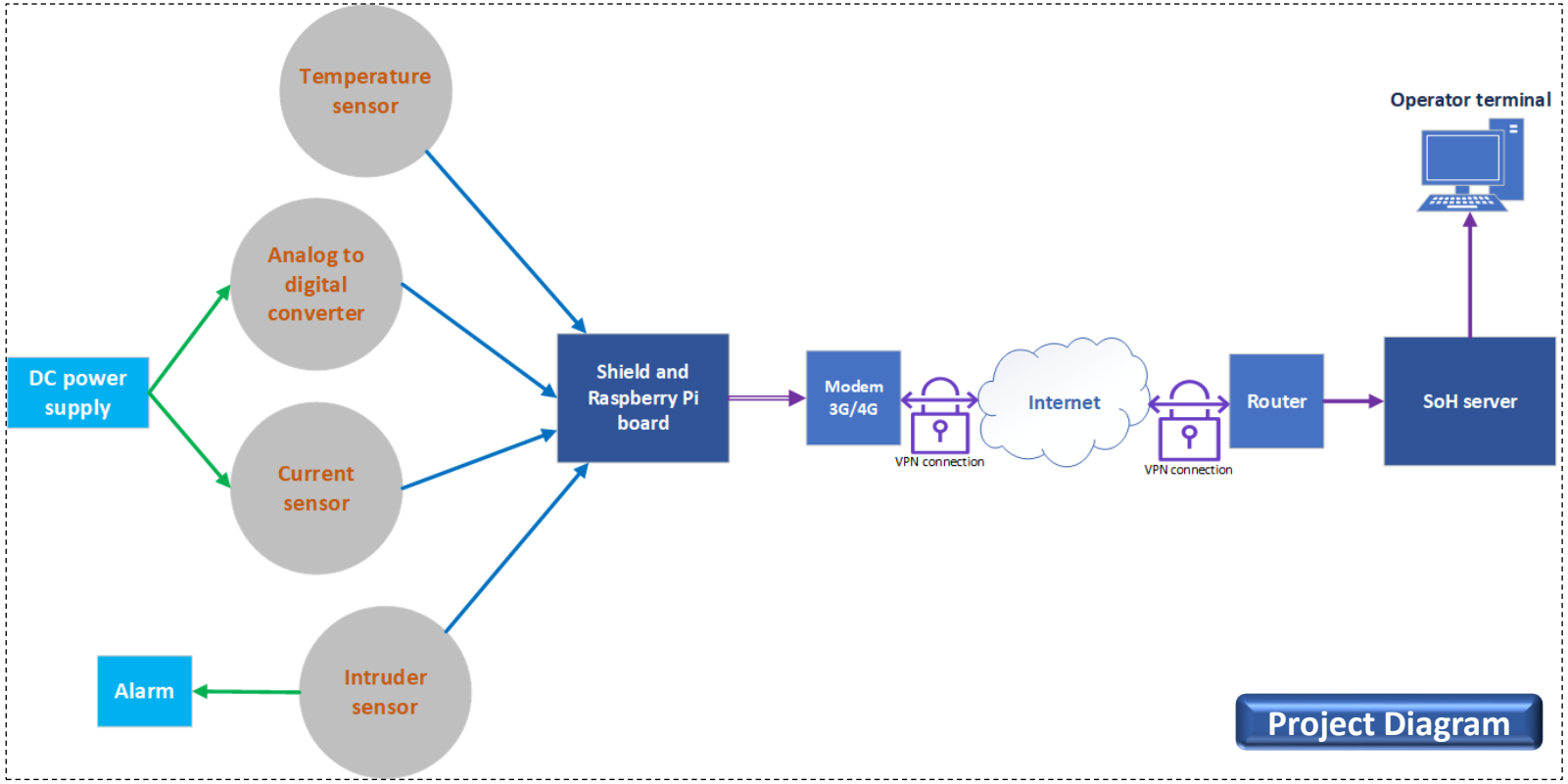
OBJECTIVES

The main objective of this project is to implement a low-cost remote monitoring system based on embedded technology (Raspberry Pi) with data transmission through a VPN connection using local 3G/4G internet.

By means of the SOH monitoring system it will be possible to observe vital parameters of a seismic station, such as solar panel voltage, utilization voltage, load current, utilization current, temperature of the seismic vault, and the same system will also monitor the integrity of the station in case of vandalism attempts.



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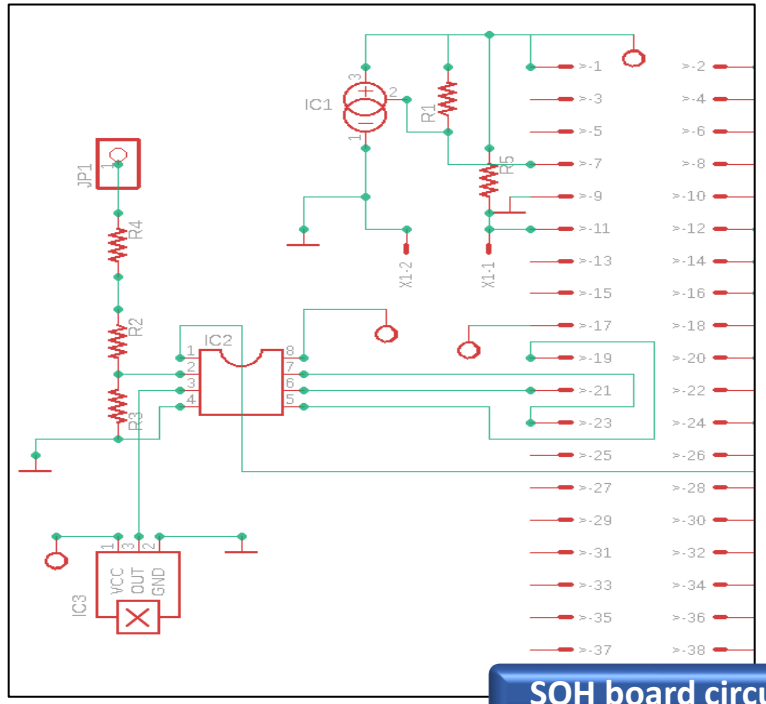
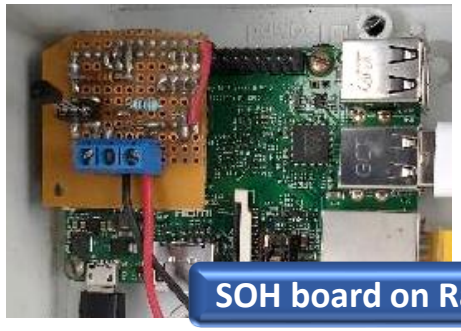
METHODOLOGY

Development of the SOH board:
To implement the monitoring system, an electronic board was designed and built, this board has an analog to digital converter (IC2) for reading voltages, a 9-bit digital temperature sensor (IC1), current sensors (IC3) plus a switch (X1-1,2) for intrusion monitoring.The electronics board will be connected to the GPIO of the Raspberry Pi board as shown in the picture.



SOH board circuit



SOH board on Raspberry Pi

Data Acquisition and Transmission:
In the station; the Raspberry Pi board is used as a low cost VPN server that also processes and collects the data extracted from the sensors through scripts, this data is packaged and a Sender script sends the data packet every three minutes to the NDC SOH server through a VPN connection. This monitoring system requires local 3G/4G internet access for the VPN connection to be performed through a modem.
At the NDC; a Cisco router was configured as the receiving VPN server, the received data will be stored in a MySQL database on a server, from there the data will be accessible to the station operator.

The sequence of the packaged and sent data:

```
station=BVXX-Site_name;date=2022-10-
01_10:15:00;voltage=12.0;temp=22010;vpn=1
;load_current=1.5;intrusion=0;useddisk=7
```

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RESULTS

The data stored in the database are differentiated by an ID for each frame received, these data can be used in various ways and environments.

stations

Field	Type	Key	Extra
id	mediumint(9)	PRI	auto_increment
code	char(10)		
name	char(20)		
sensorSN	char(30)		
digiSN	char(30)		
digiIP	char(15)		
raspiSN	char(30)		
raspiIP	char(15)		
dongleType	char(30)		
dongleSN	char(30)		
dongleIMEI	char(30)		
dateTime	date		
simSN	char(30)		
simNum	char(30)		
simPUK	char(30)		
simProvider	char(10)		
gpsX	float(6,4)		
gpsY	float(6,4)		
hasCtrlStation	tinyint(1)		

status

Field	Type	Key	Extra
id	int(11)	PRI	auto_increment
station	char(30)		
dateTime	datetime		
voltage	float(4,2)		
temperature	float(3,1)		
connection	int(11)		
intrusion	int(11)		
usedDisk	int(11)		

logs

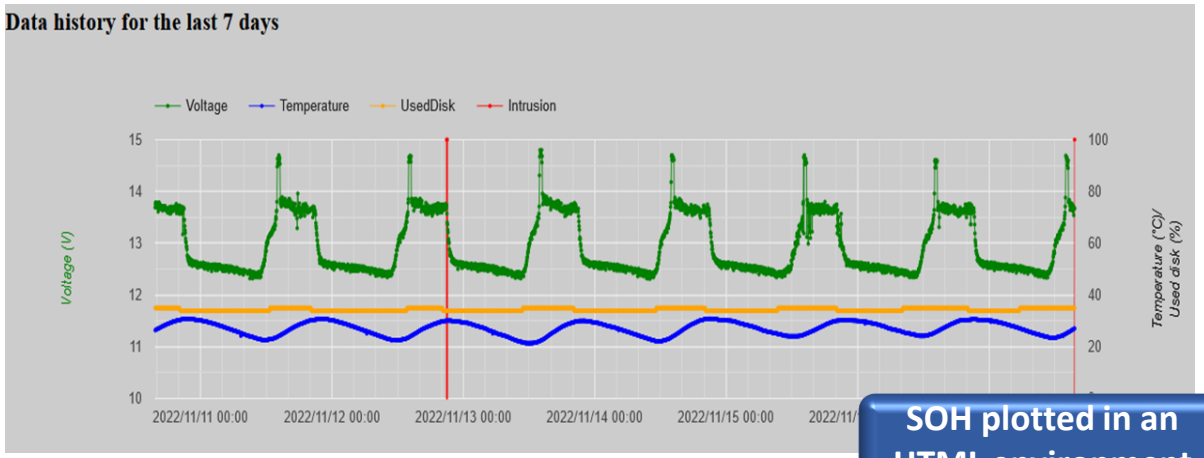
Field	Type	Key	Extra
id	int(11)	PRI	auto_increment
station	char(30)		
dateTime	datetime		
info	text		
type	int(11)		

errors

Field	Type	Key	Extra
id	int(11)	PRI	auto_increment
dateTime	datetime		
station	char(4)		
message	char(255)		

MySQL database structure

In this project the SoH data stored in the database is plotted in an HTML environment with a seven-day display window that is automatically updated every 3 minutes.



SOH plotted in an HTML environment

The terminology and graphed data make it easier for the operator to identify each parameter.

- Voltage (V)
- Temperature (C°)
- Alarm (1 or 0)
- Available memory space (Mb)

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CONCLUSION

- The implementation of this project greatly helps the station operator, the operator can see trends and anticipate problems, as well as more efficiently deal with a corrective maintenance visit to the station.
- It is clear that this system can be improved in many ways, such as the implementation of various sensor modules.
- This monitoring system is inexpensive and easy to install in different types of stations.

Fixed station

Station with monitoring system

Temporary station

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