

WRO

ZIMBABWE

REPORT

Team Rockstar - Forest Guard

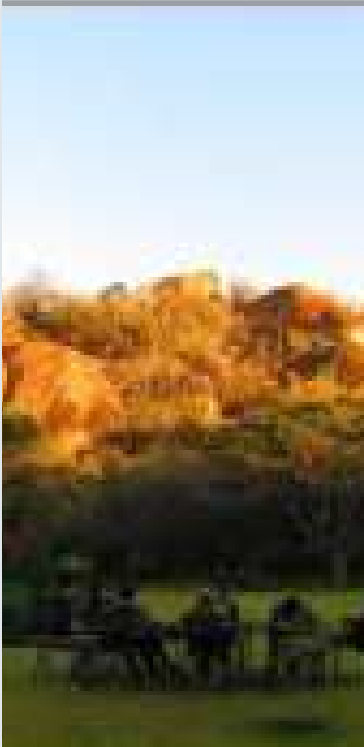


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INTRODUCTION

Team Rockstars, a group of three high school students from Petra College Senior. The team consists of:

- Munashe Kawadza
- Samuel Familusi
- Caitlin King



Samuel



Munashe



Caitlin

We are from Zimbabwe living and studying in the city of Kings and Queens - Bulawayo.

Samuel is the coder and program developer.

Munashe is the electrical specialist and designer.

Caitlin is the second coder and manager

WHAT IS THE PROBLEM?

Problem:

Illegal gold panning, exploitative tree cutting methods and veld fires pose significant threats to Zimbabwe's forests, contributing to deforestation, climate change, and harm to farmers and their livestock.

Solution:

A monitoring and alert system designed to detect and prevent unauthorized human presence in forests, alerting authorities and sounding alarms when necessary. Additionally, it detects veld fires, enabling early intervention.

Value:

This solution offers a proactive solution to reduce deforestation, addressing climate change and supporting sustainable forest management. Its implementation can have a significant impact globally, protecting forests, farmers, and their livestock.

Benefits:

- Reduces deforestation and climate change
- Prevents illegal gold panning and associated harm to farmers and livestock
- Enables early detection and response to veld fires
- Supports sustainable forest management
- Can be implemented internationally, offering a scalable solution to global forest conservation challenges

Importance:

This solution plays a critical role in protecting Zimbabwe's forests, addressing climate change, illegal mining, land degradation and promoting sustainable development. Its success can have far-reaching impacts, inspiring similar initiatives worldwide.

OUR SOLUTION

INTRODUCING FOREST GUARD...

Our solution aims to tackle the issue of droughts in Zimbabwe and Sub-Saharan Africa by fixing the problem at its root causes, namely, reduced bodies of water for evaporation and reduced foliage for transpiration, since these are the 2 processes within the water cycle that make up over 90% of all water on the atmosphere through the cycle.

The Forest Guard utilities multiple sensors, such as the PIR and MQ2 gas sensors, to monitor the movement within protected areas and areas that are at risk of being exploited by human interfere e.g gold panning areas, reserves, etc. Using the GSM module and SIM800, it is not only a monitoring system, but also an alert system for important organizations such as EMA and other conservation groups. It has the ability to detect when CO, CO2 and smoke levels are at unacceptable rates and directly contact the appropriate authorities through an SMS. It can also receive SMS instructions and alter its settings accordingly.

This system takes multiple pre-existing products and combines them into one multi-functional unit that is more effective and efficient than any other premade product available on the market today.

OTHER IDEAS WE THOUGHT OF

- Cloud based weather/climate monitoring system for farmers.
- We did not choose this idea because we felt that it was not feasible with the sensors available to us.
- Methane measuring system within cattle farms
- We did not choose this idea because we felt that it did not sufficiently tackle any major problems i.e methane from cattle is not a major cause of climate problems, especially in Zimbabwe
- Robot that monitor and analyze air quality, helping cities develop strategies to reduce pollution and improve public health. These robots capture CO₂ from the atmosphere and convert it into useful products like fuels and chemicals.
- We did not choose this idea because the secondary function (converting CO₂ into useful products) was not feasible with the components or the time available. Also, we wanted to make a system that specifically tackles an area which directly affects large parts of Zimbabwe and Sub-Saharan Africa (the majority of Zimbabwe consists of rural areas)

He said some of his workers who died from the veld fires had served for almost 30 years at the farm.

“Every month I’m losing an animal after having fallen into these holes dug by illegal miners. More often than not we find them dead and rotting,” said Mr Stone.

Mr Mike Stone

Bongani Ndlovu, Chronicle Reporter

THE recent death of the tenacious 10 men as they battled a raging veld fire at Lot 43 of Red Rose Farm in Esigodini, Umzingwane District in Matabeleland South, is a culmination of years of fierce running battles with gold panners.

Illegal Mineral Panning & illegal alluvial Mining

In 2021, EMA conducted a survey that showed that a total of 11 163ha of land and a stretch of 1 555 km of riverine ecosystems have been degraded countrywide. This is all due to illegal mineral panning. Panned rivers are polluted and full of silt instead of water which reduces the quality of water. In the process, ravine diversity is destroyed and human health including aquatic life is affected by the polluted water.

Did you know Once mercury gets into your water, rivers, soils, wells, or air it cannot be removed? There are no methods of cleaning up mercury from the environment. Mercury used by illegal miners is very hazardous affecting both the well-being of the environment and the public.

THE GLOBAL GOALS

TARGET 15.7



ELIMINATE POACHING AND TRAFFICKING OF PROTECTED SPECIES

Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products.


TARGET 15.5



PROTECT BIODIVERSITY AND NATURAL HABITATS

Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species.

TARGET 15.4



ENSURE CONSERVATION OF MOUNTAIN ECOSYSTEMS

By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development.

TARGET 15.2



END DEFORESTATION AND RESTORE DEGRADED FORESTS

By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally.



Esigodini is a mineral-rich area resulting in rampant illegal gold mining activities. Illegal gold miners are the main culprits when it comes to veld fires. They set fire to clear land for them to be able to detect gold using metal detectors.

TECHNICAL ASPECTS

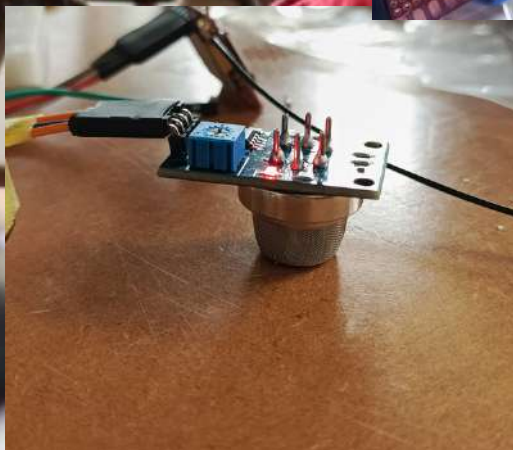
MECHANICAL CONSTRUCTION



PIR to
detect motion



Opening door
for servicing



Gas sensor to
detect CO₂



Easy repair/replacement
of parts

CODE

```
def process_sms(sms_data: list[str]):  
    messages = []  
    for line_index in range(len(sms_data)):  
        if "+CMGL:" in sms_data[line_index]:  
            cmgl = sms_data[line_index].split(",")  
            message_body = sms_data[line_index + 1]  
            sender_number = cmgl[2].replace("'", "")  
            messages.append((sender_number, message_body))  
    return messages
```

```
# Conservation Area Intelligence Technology  
# Monitoring Undisturbed Natural Areas  
# Forest Advanced Monitoring Instrument
```

```
from machine import Pin, ADC, UART  
from utime import sleep, time
```

```
led = Pin("LED", Pin.OUT)
```

```
green_led = Pin("GP17", Pin.OUT)  
orange_led = Pin("GP18", Pin.OUT)  
blue_led = Pin("GP16", Pin.OUT)
```

```
sensor_button = Pin("GP0", Pin.IN)  
buzzer = Pin("GP1", Pin.OUT)
```

```
pir = Pin("GP2", Pin.IN)  
buzzer = Pin("GP19", Pin.OUT)  
mq2 = ADC(26)
```

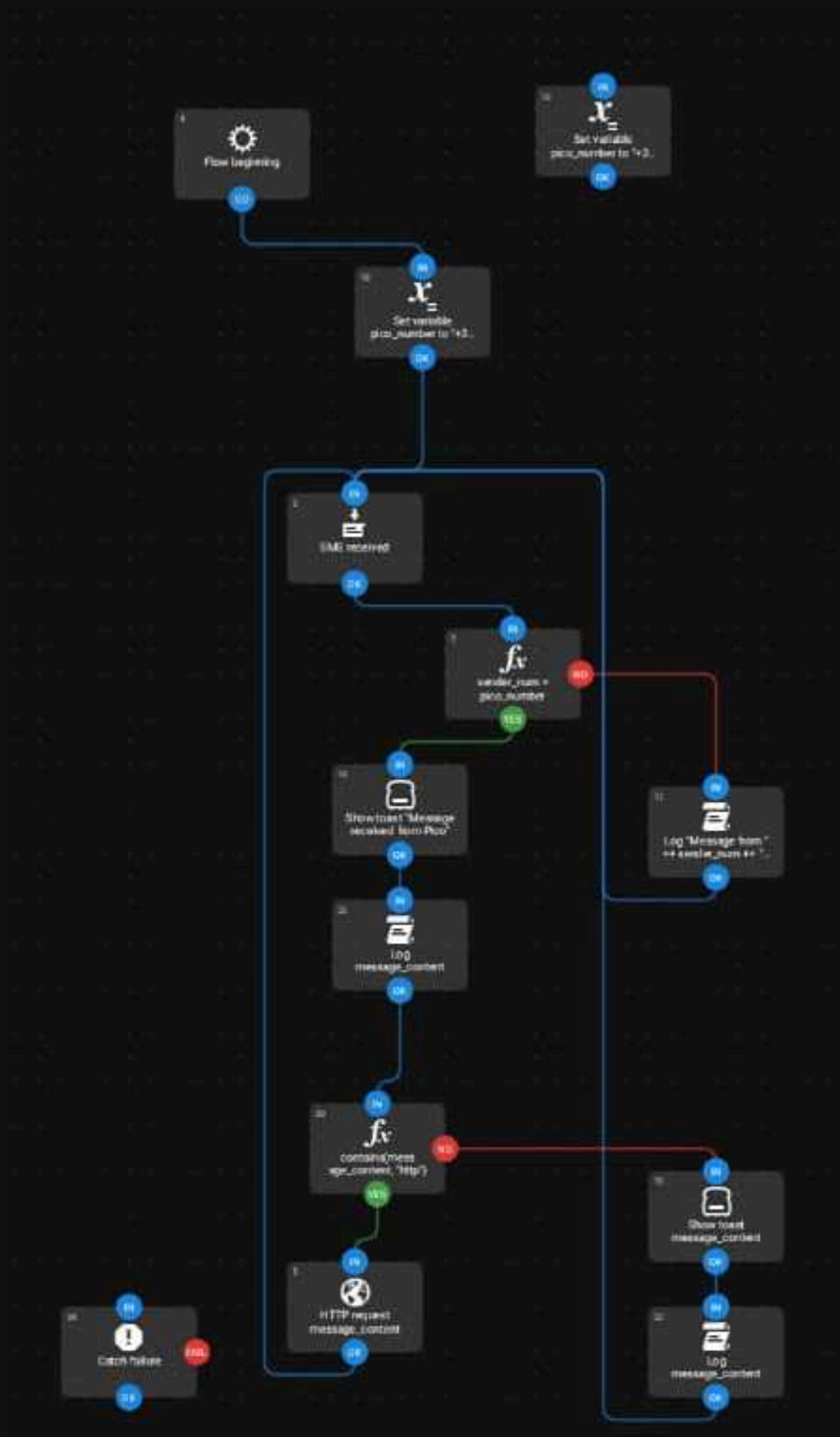
```
sim800l = UART(1, baudrate=9600, tx=Pin("GP4"), rx=Pin("GP5"))
```

```
write_api_key = "XXXXXXXXXXXX"  
samy_phone_num = "XXXXXXXXXX"  
cait_phone_num = "XXXXXXXXXX"
```

```
def receive_sms():  
    send_at_command("AT+CMGF=1")  
  
    sms_read = send_at_command('AT+CMGL="REC UNREAD"', wait=10)  
    # sms_read = send_at_command('AT+CMGL="ALL"', wait=10)  
    if not sms_read:  
        return  
  
    # fix this code to handle more than one sms being sent  
    message_content = list(map(str.strip, sms_read.split("\n")))  
  
    return message_content
```

```
def sms_to_thingspeak(field, value):  
    global last_sms_time  
    last_sms_time = time()  
    print("sending to thingspeak")  
    send_sms(  
        samy_phone_num,  
        f"https://api.thingspeak.com/update?api_key={write_api_key}&field{field}={value}",  
    )
```

Utilisation of Automate to combat problems faced with the GSM module



CHALLENGES

Getting the GPRS to function within the SIM module

Possibly due to failure to setting up the correct access point name which gives it an IP address to connect to the internet.

Making holes for sensors and actuators. (Lacking tools)

We used a hot glue gun to make them- It would not burn out our plastic case as we wanted a clean finish.

Lack of additional sensors

We made a vibration sensor with copper coils.

1 battery cell not enough

We needed 5-6v from a battery but we did not have enough cells.

SOCIAL IMPACT & INNOVATION

How will it help reduce climate change globally...

It will reduce deforestation

Our system monitors an environment at all times sending real time data to an environmental authority such as EMA.

It will reduce illegal gold panning and land degradation.

It alerts when unauthorized persons enter an environment. When gold panners or soil thieves go into an environment in hopes of doing damage the system alerts authorities who can then sound an alarm.

It will help prevent veld fires.

If the system detects smoke it will alert the management organization who can then contact the fire services to attend to the scene if necessary, greatly increasing the efficiency of responses to both manmade and naturally caused fires in important and protected areas.

It will make the area safer

With our product, there will be a gradual decrease in trespassers, until eventually, the area is essentially free from all unnecessary human interaction with the environment

INNOVATION AND EXPANSION

The Forest Guard could easily be expanded upon to work in a system, with multiple modules being placed within an area, acting as nodes of a larger main network.

This means that it can be placed in various locations within an area of interest in order to expand its range.

It can also be further improved or enhanced with a range of useful customizations. By simply adding a larger range of sensors to the product, its features can be expanded upon e.g. a greater selection of gas sensors, cameras to record trespassers, etc.

System



Forest guard is a solution to a big problem within Zimbabwe and the world.
(Deforestation and veld fires)

MARKET RESEARCH

OUR SOLUTION

FEATURES

- Environment monitoring
- Alerts authorities
- Sounds an alarm
- Blends with forest environment (camouflage)
- Smoke detection
- Fire detection
- Server collecting data
- SMS based
- Forms a node system with other units
- Low cost
(\$55 per unit (prototype)
\$30 per unit (scaled production))

EXISTING PRODUCTS

FEATURES

- Environment monitoring
- Alerts authorities
- Smoke detection
- Fire detection
- Server collecting data
- Expensive
(Ranging from a few hundred dollars going up)

Business canvas model

Customer Segments:

- Government agencies responsible for environmental conservation
- Environmental organizations and NGOs
- Local communities living near forests
- Logging and timber companies
- Tourists and eco-tourism operators

Prototyping costs

Labour(3 days)=\$25
Components=\$20
Workspace=\$10

Value Proposition:

Real-time monitoring and alert system for forest fires and illegal logging
AI-powered surveillance and detection of forest encroachment
Sustainable forest management and conservation planning
Community engagement and education on forest conservation
Certification and labelling of sustainably sourced forest products

Channels:

Web and mobile applications for monitoring and reporting
Partnerships with local communities and environmental organizations
Collaborations with government agencies and authorities

Customer Relationships:

Personalized support and training for system users
Regular updates and reporting on forest health and conservation status
Community outreach and engagement programs
Stakeholder meetings and workshops

Revenue Streams:

Subscription fees for system access and monitoring
Grants and funding from government and environmental organizations
Tourism and eco-tourism revenue

Key Resources:

Advanced technologies (AI, IoT, satellite imaging)
Expert team in forestry, conservation, and IT
Partnerships with local communities and stakeholders
Secure and reliable infrastructure for data storage and transmission

Key Activities:

System development and maintenance
Forest monitoring and data analysis
Community engagement and education
Stakeholder collaboration and reporting

Key Partners:

Government agencies e.g EMA (environmental, forestry, and tourism)
Environmental organizations and NGOs
Local communities and indigenous peoples
Technology and IT service providers

Cost Structure:

System development and maintenance costs
Personnel and expertise costs
Marketing and outreach expenses
Infrastructure and equipment costs

SOURCES AND ACKNOWLEDGEMENTS

Sources

EMA (ema.co.zw)

CHRONICLES (www.chronicle.co.zw)

UN (sdgs.un.org/goals)

Special thanks to the following individuals and organizations for this opportunity:

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Petra College Senior Administration

National University of Science and Technology Administration

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Telco - Sponsors of WRO

+ all other individuals, staff and organizations involved in making WRO Nationals possible