Mini Project Report

Optimizing crop sowing and assessing uncultivable regions using humidity and temperature sensors

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1. Introduction

This project explores the use of Wireless Sensor Networks (WSNs) in agricultural fields to optimize crop cultivation and assess arid or uncultivable areas. By deploying humidity and temperature sensors, data is collected and transmitted via the 6LoWPAN protocol, enabling real-time communication and remote monitoring. This system notifies farmers through a web server, reducing labor costs and providing accurate measurements of field conditions compared to traditional methods.

2.Background

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- **Contiki OS:** Contiki OS is an open-source operating system for the Internet of Things (IoT), designed for low-power wireless devices. It supports the 6LoWPAN protocol, making it suitable for WSN applications in agriculture.
- **Cooja Simulator:** Cooja is a network simulator for Contiki OS that allows for the emulation of motes in a WSN. It provides a virtual environment to test and debug WSN applications before deployment in the field.
- **BonnMotion:**BonnMotion is a tool used for the simulation of mobility scenarios. It is primarily utilized in the context of mobile ad hoc networks (MANETs), vehicular ad hoc networks (VANETs), and other mobile network simulations.
- **PowerTrace:**Powertrace is a tool integrated within the Cooja network simulator, which is part of the Contiki OS ecosystem. It is used to monitor and measure the power consumption of nodes in simulated wireless sensor networks.

Project Description

Problem Statement:

The project addresses the challenge of identifying optimal conditions for sowing crops and evaluating arid or uncultivable regions in a field using sensor technology.

Objectives:

- Deploy temperature and humidity sensors to monitor field conditions.
- Transmit collected data using the 6LoWPAN protocol.
- Notify farmers through a web server for remote monitoring.
- Reduce labor costs and improve the accuracy of field condition measurements.

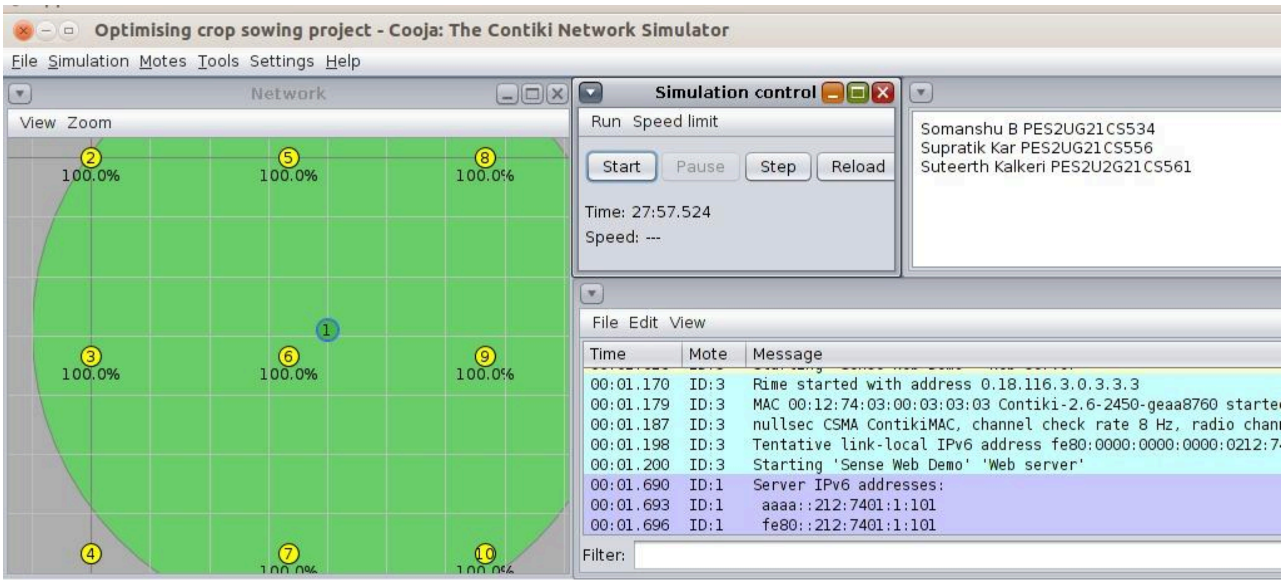
Implementation

Development Environment: The development environment includes Contiki OS and the Cooja simulator for emulating the WSN. The project uses Wireshark for network monitoring and analysis.

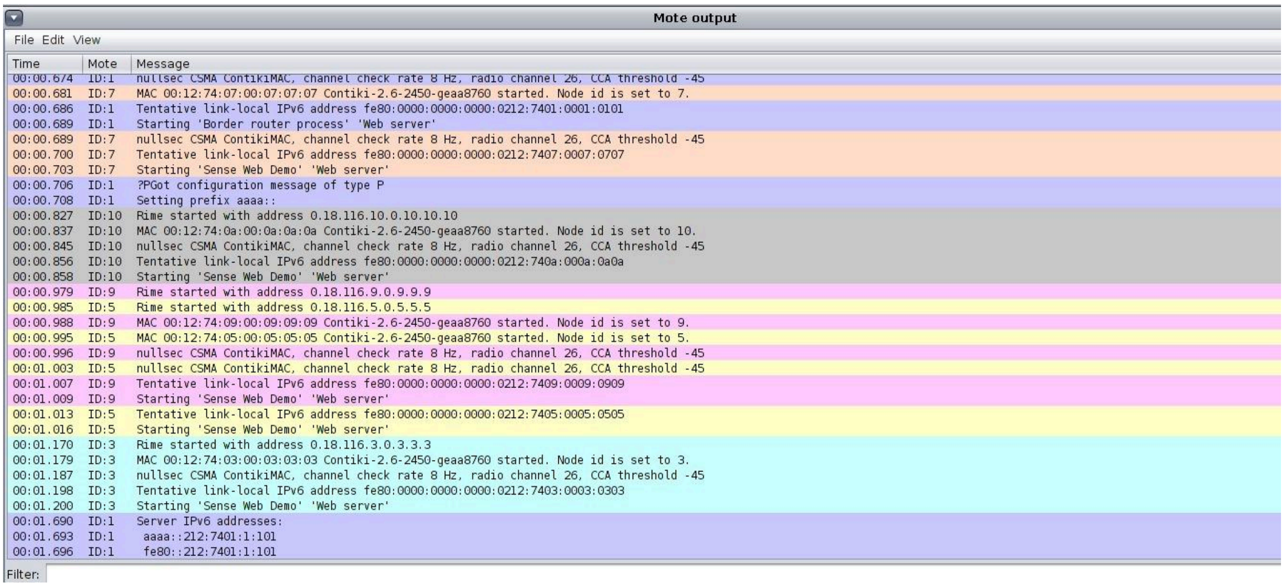
Mobility in Cooja: Mobility is simulated in Cooja by configuring node positions and movement patterns to represent real-world scenarios.This is done with the help of an external application named BonnMotion who's output can then be converted into a .dat file using WiseML and then imported into Cooja for mobility simulation

Wireshark Integration: Wireshark is used to capture and analyze network traffic, providing insights into data transmission and protocol performance.

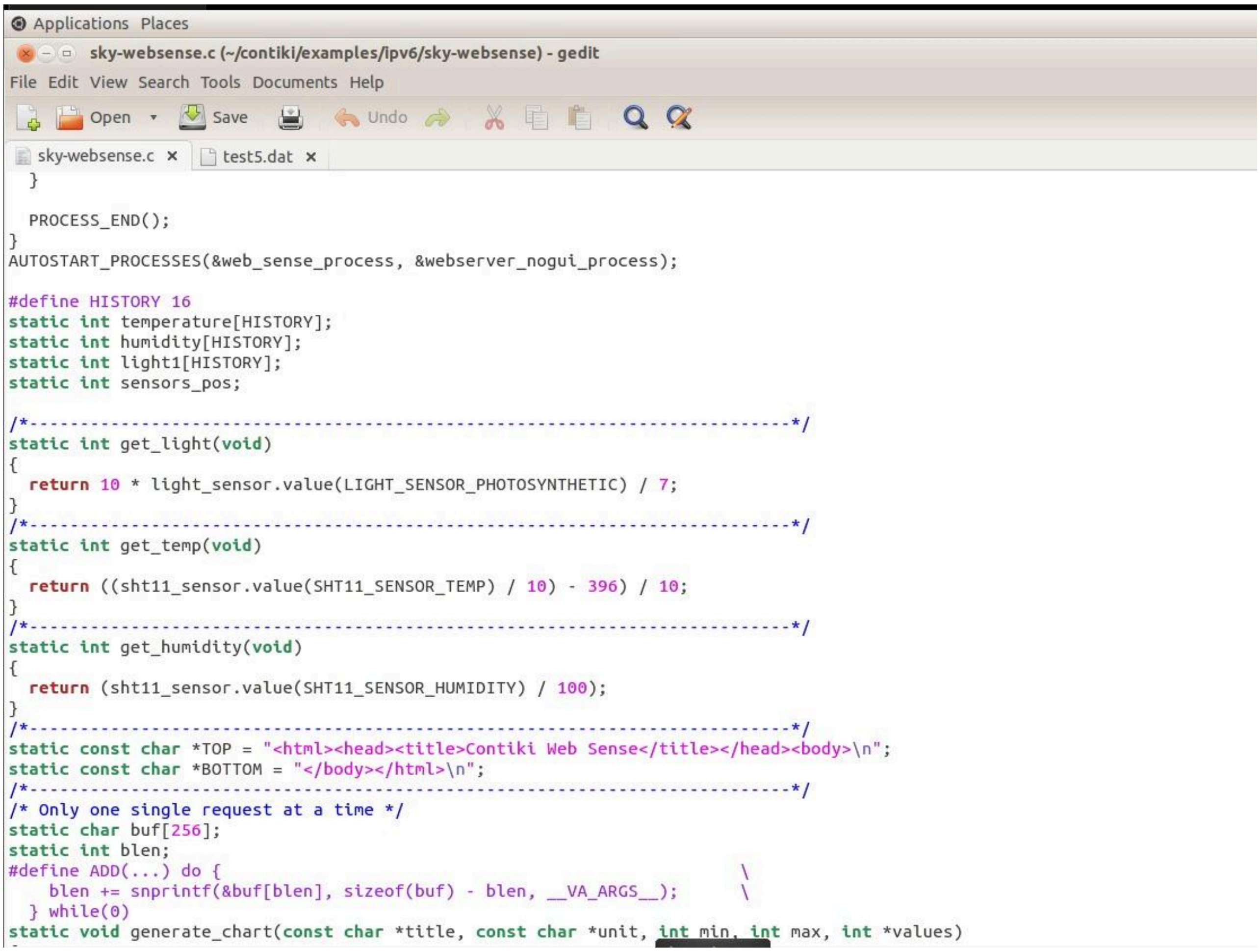
Relevant Screenshots:



a.Topology



b.Mote Output



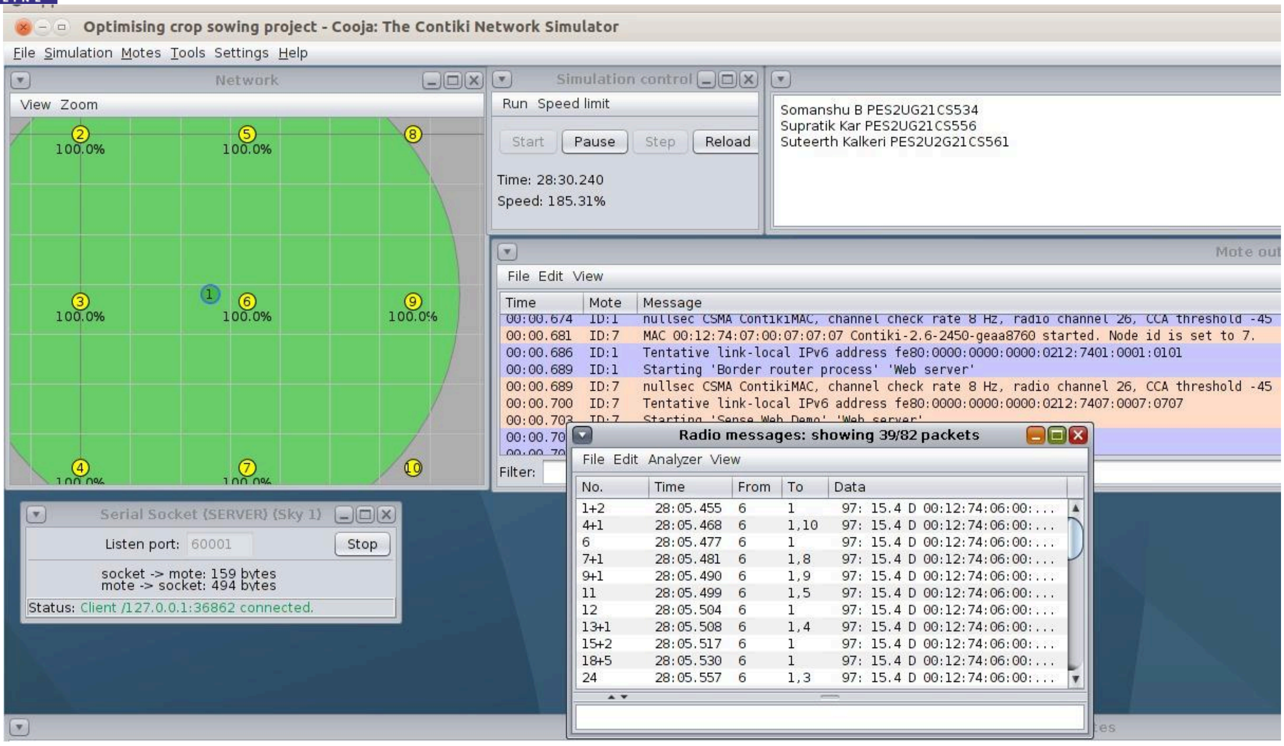
c.Skywebsense mote code file modification sky-websense.c (~/contiki/examples/ipv6/sky-websense) - gedit

```c
  SEND_STRING(&s->sout, TOP);

  if(strncmp(s->filename, "/index", 6) == 0 ||
     s->filename[1] == '\0') {
    /* Default page: show latest sensor values as text (does not
       require Internet connection to Google for charts). */
    blen = 0;
    int temp = get_temp();
    int hum = get_humidity();
    const char *condition = (temp >= 20 && temp <= 35 && hum > 40) ? "Region is Cultivable" : "Region is Not Cultivable";

    ADD("<h1>Current readings</h1>\n"
        "Light: %u<br>"
        "Temperature: %u&deg; C<br>"
        "Humidity: %u%%<br>"
        "Condition: %s",
        get_light(), temp, hum, condition);
    SEND_STRING(&s->sout, buf);
```

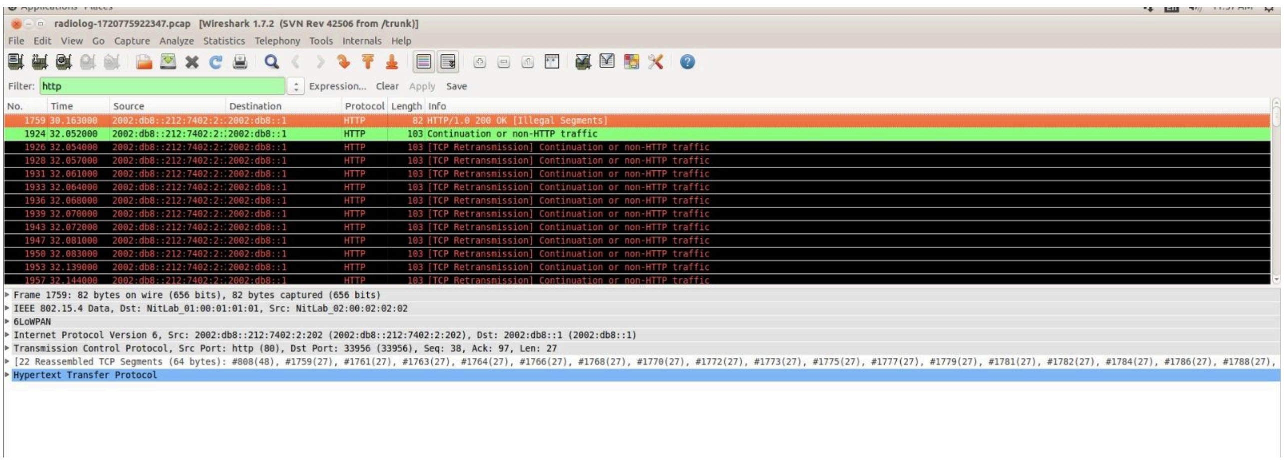
d.Condition to check if soil is cultivable

```
user@instant-contiki:~/contiki/examples/ipv6/rpl-border-router$ make connect-rou
ter-cooja
TARGET not defined, using target 'native'
sudo ../../../tools/tunslip6 -a 127.0.0.1 aaaa::1/64
slip connected to ``127.0.0.1:60001''
opened tun device ``/dev/tun0''
ifconfig tun0 inet `hostname` up
ifconfig tun0 add aaaa::1/64
ifconfig tun0 add fe80::0:0:0:1/64
ifconfig tun0

tun0      Link encap:UNSPEC  HWaddr 00-00-00-00-00-00-00-00-00-00-00-00-00-00-00
-00
          inet addr:127.0.1.1  P-t-P:127.0.1.1  Mask:255.255.255.255
          inet6 addr: fe80::1/64 Scope:Link
          inet6 addr: aaaa::1/64 Scope:Global
          UP POINTOPOINT RUNNING NOARP MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:500
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

Rime started with address 0.18.116.1.0.1.1.1
MAC 00:12:74:01:00:01:01:01 Contiki-2.6-2450-geaa8760 started. Node id is set to
 1.
nullsec CSMA ContikiMAC, channel check rate 8 Hz, radio channel 26, CCA threshol
d -45
Tentative link-local IPv6 address fe80:0000:0000:0000:0212:7401:0001:0101
Starting 'Border router process' 'Web server'
*** Address:aaaa::1 => aaaa:0000:0000:0000
Got configuration message of type P
Setting prefix aaaa::
```

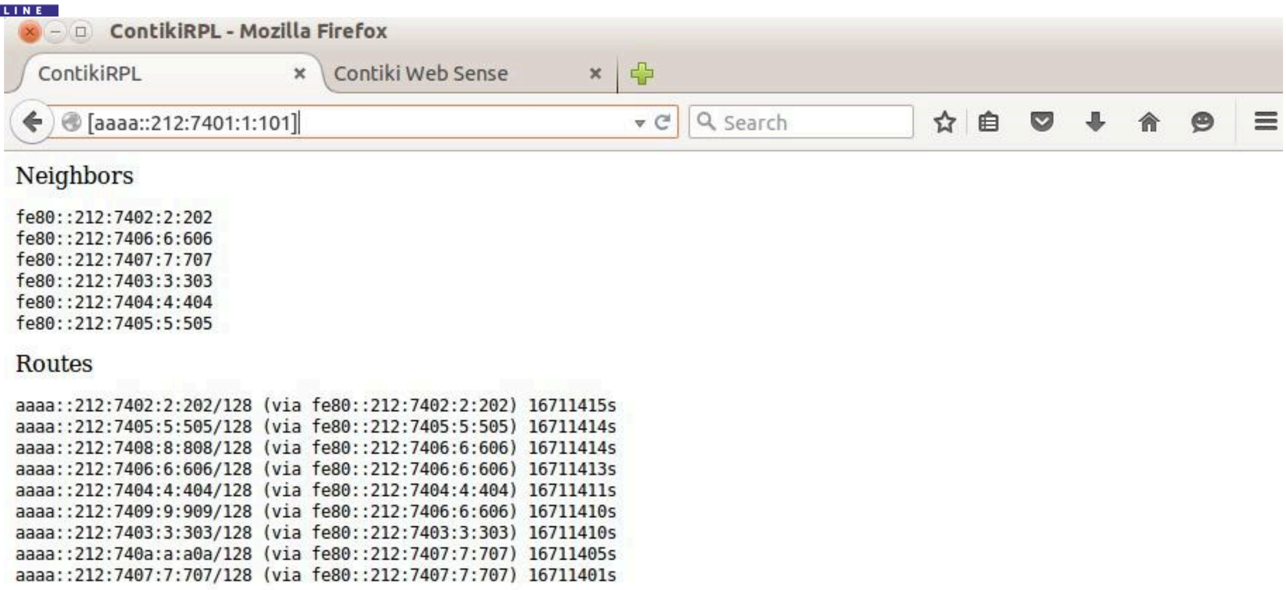
e.Setting up router for viewing sensor information on the internet



f.Setting up port for sending router information

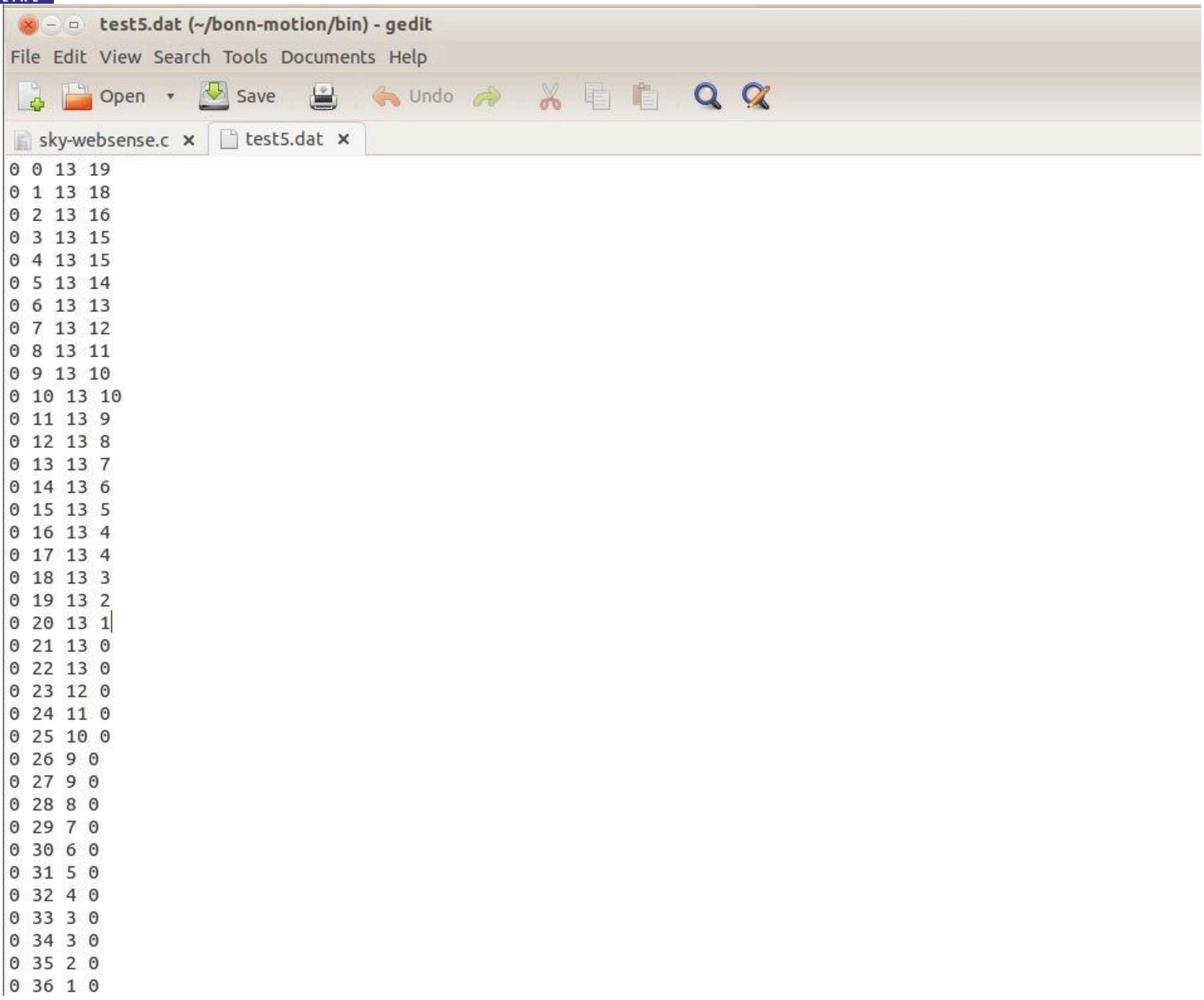


g.Utilising Wireshark to check for lost packets



h.Border Router information about neigbouring motes

i.Current readings of all SkySenseWeb motes



j.dat file representing manhattan data

Modules and Functions:

- **Sensor Data Collection: Code snippets for reading temperature and humidity values.**
- **Data Transmission: Implementing the 6LoWPAN protocol for sending data.**
- **Web Server Notification: Code for sending notifications to the web server.**

Challenges and Solutions: Challenges included ensuring reliable data transmission and accurate sensor readings. Solutions involved optimizing the sensor node placement and enhancing the data processing algorithms.

Results and Discussion

- **Results:**
  The project successfully monitored temperature and humidity across the field, identifying optimal conditions for crop cultivation. Visual aids, such as charts and graphs, illustrate the sensor data collected.
- **Discussion:**

The results demonstrate the effectiveness of WSNs in agricultural monitoring. The system provides timely and precise information, aiding in better decision-making for crop management.

Conclusion

- **Summary:**
  The project achieved its goals of optimizing crop cultivation and evaluating field conditions using WSNs. The system's accuracy and real-time capabilities surpass traditional methods**.**
- **Future Work:**
  Future improvements could include integrating additional sensors for soil moisture and pH levels, enhancing data analytics for predictive modeling, and expanding the network for larger fields.