Wireless Camera Node Network

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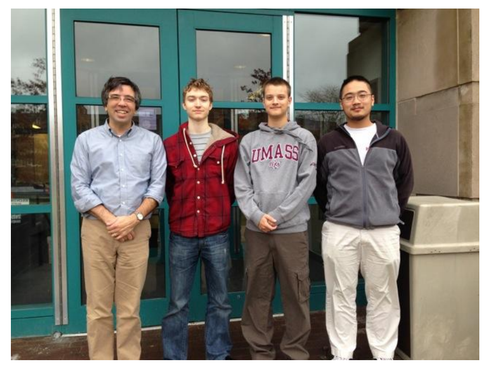
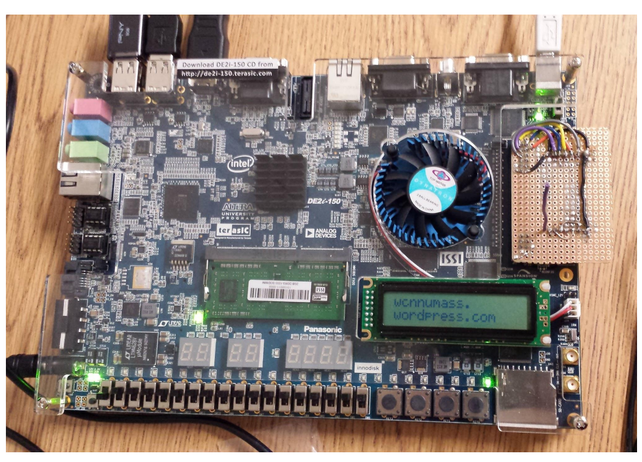


Abstract:

WCNN (Wireless Camera Node Network) is a wireless sensor network composed of environmental sensors and cameras used to remotely monitor wildlife populations. WCNN consists of multiple nodes organized into a tree-like network structure. The nodes will be attached to trees or other structures to capture images of medium and large mammals during the daytime.

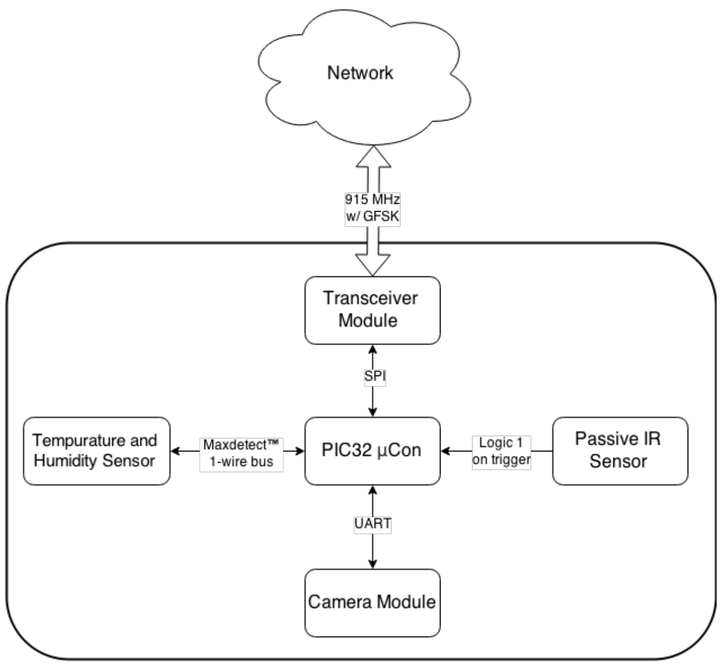
In this system, each individual node contains a camera, a temperature sensor, and a humidity sensor. The nodes capture images when motion is detected using an infrared sensor. Images are then sent to a server. The nodes that are out of reach from the server will send data to other intermediate nodes before reaching the server. The server will send the received images and sensor data to a website for analysis.

Node



Server

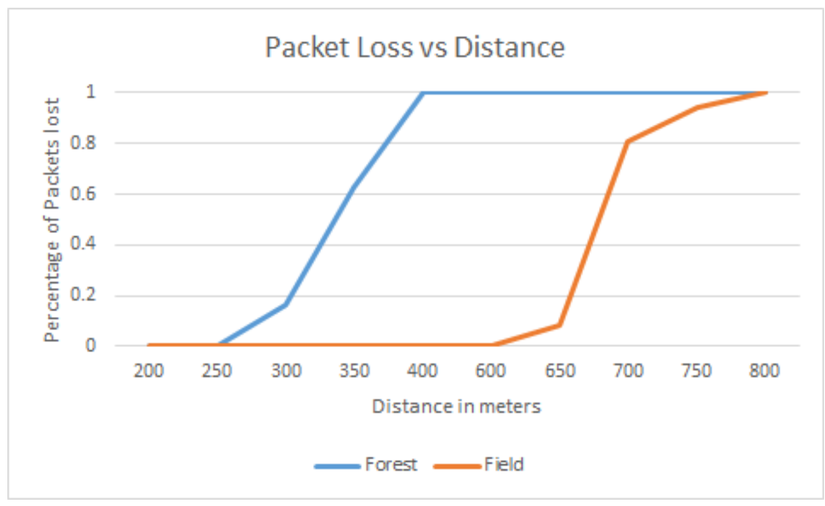
Node Block Diagram



Node Details:

- When the PIR sensor detects motion, the camera will capture an image and the node will read temperature and humidity data from sensors.
- Each node has an 8-bit address. (address 0 is reserved for the server.)
- Each node has a parent node and a list of children nodes.
- When prompted for data by its parent node, the node will send data to its parent node.
- The node will also ask its children for data and forward that data to the server.

Results:



A range test shows that the nodes have a reliable range of up to 600 meters in a field or 300 meters in a forest.

Battery life is highly dependant on the network configuration and image capture frequency. A typical node is transmitting 2% of the time and receiving 2% of the time. Based on the measured power consumption, the node will consume an average of 17.3mW and will have a battery life of 83.2 days.

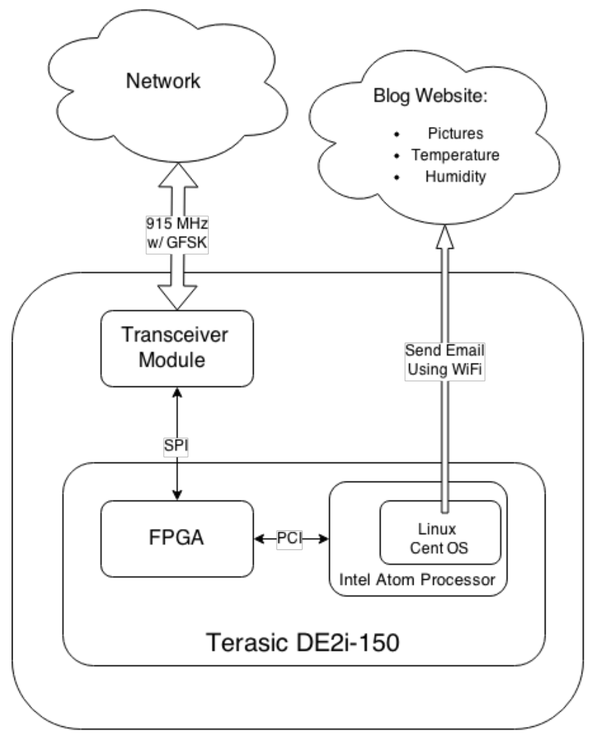
Power Consumption

Modes:	Sleep	RX	TX
Current	160uA	38mA	330mA
Power	720µW	171mW	1.485W

Server Details:

- The Terasic DE2i-150 development board consists of an Intel Atom processor and an Altera Cyclone IV FPGA.
- The FPGA contains a NIOS II soft processor, which runs a program to control the network.
- A transceiver module is connected to the FPGA to enable communication with nodes.
- The Atom runs a program to receive data from the FPGA and post it to a website.

Server Block Diagram



Acknowledgment:

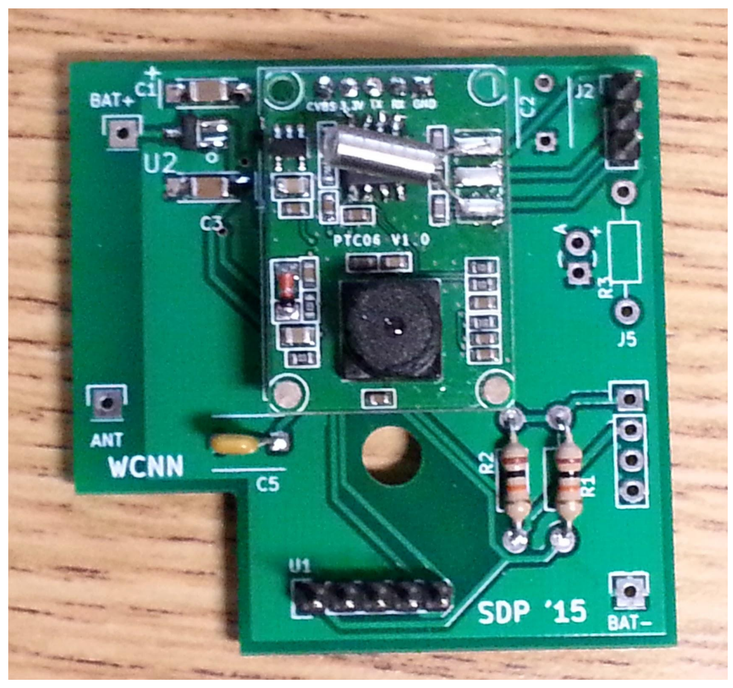
We owe our great success to Professor Paul Siqueira; it would've been very different without his advice and guidance. We would also like to thank our reviewers, Professor Krishna and Professor Pishro-Nik, for spending their time to evaluate our project.

Node Operation:

The nodes spend most of their time in sleep mode where the components are all placed in a low power mode. If motion is detected by the PIR sensor, the microcontroller will turn the camera on, take a picture, read sensor data, and go back to sleep mode.

The node will also wake up every 60 seconds to sync with the network. During this time, the server will ask nodes if they have any pictures. This will allow nodes that do not need to stay awake to return to sleep mode. Nodes will also reset their sleep timers when they receive this packet in order to remain in sync with the rest of the network.

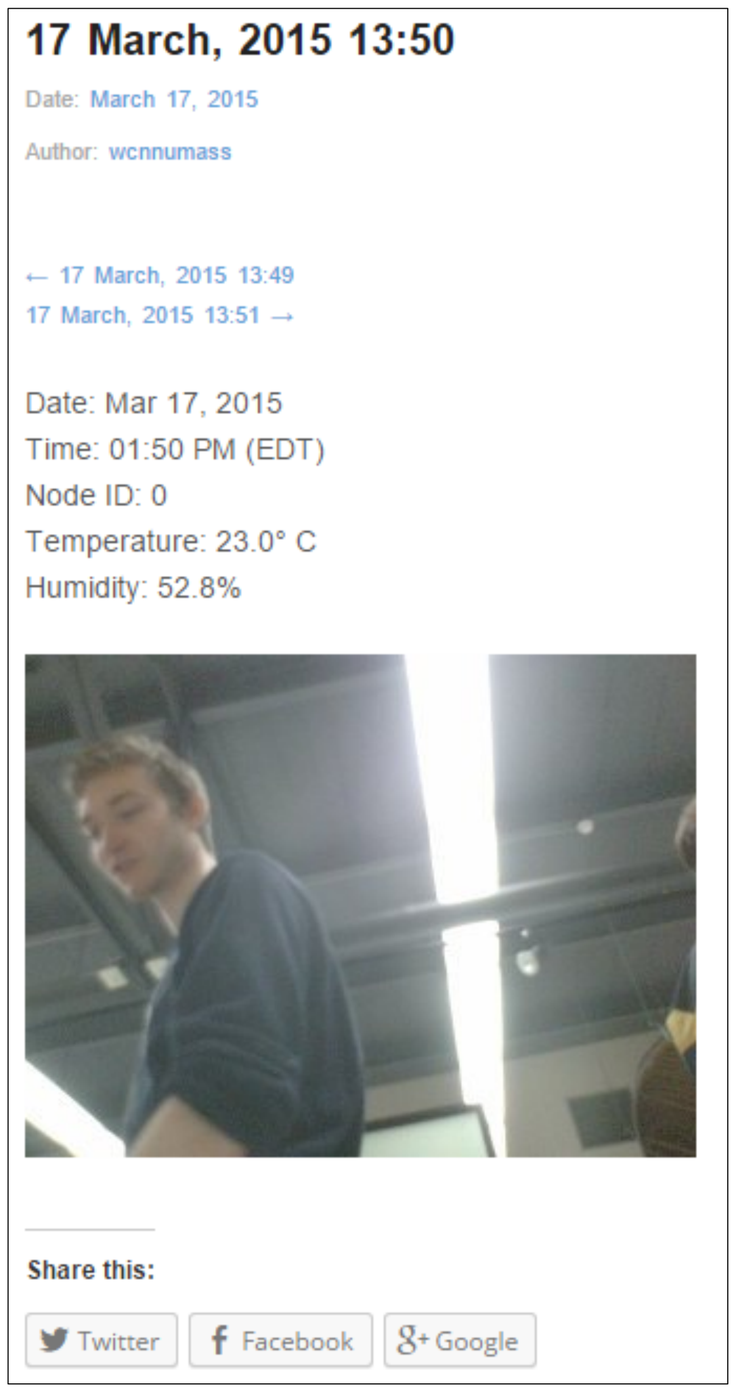
The server will then ask the nodes with pictures to transmit them one at a time in order to avoid collisions. When a node has finished transmitting its pictures and the pictures of all of its child nodes, it will return to sleep mode.



Node Circuit Board

Specifications

Proposed	Actual
> 2 week battery life under normal conditions	YES
Network should support up to 32 nodes in a reasonable configuration	YES
Server should be able to easily add nodes using a user-friendly interface	NO
Network should account for packet loss	YES
Enclosure should be waterproof	YES
L.O.S. transmission range ≥400m	600m range
Low cost <$100 per node	$41.44 per node



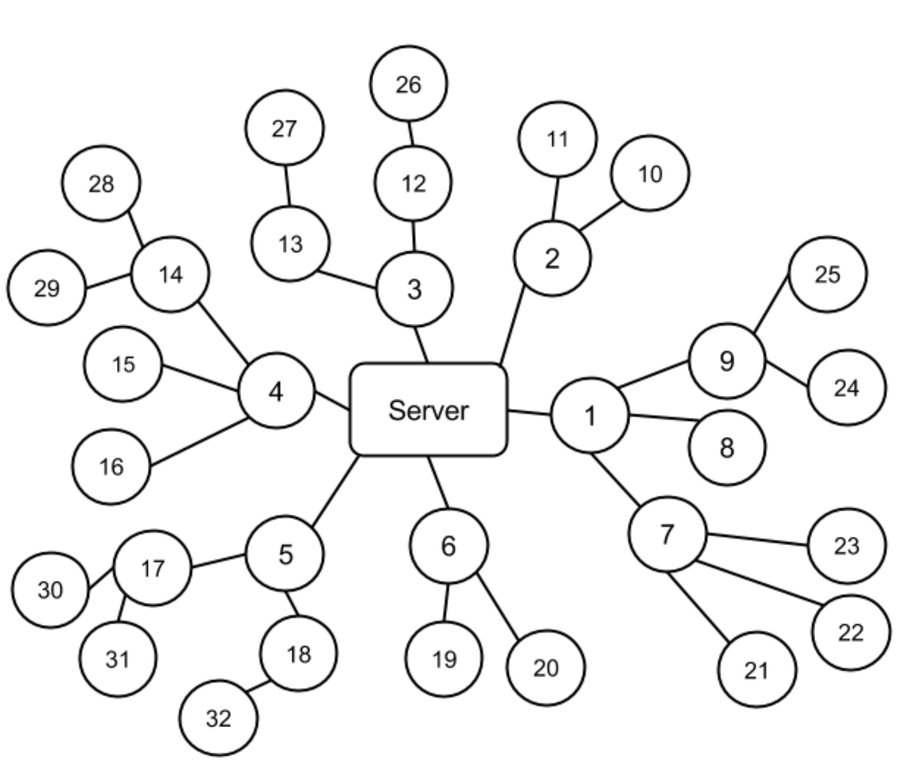
Website Screenshot

Node Cost

Component	Development	Production (1000)
UART JPEG Camera	35.95	11.37
HopeRF RFM23BP (transceiver)	8.50	7.95
DHT22 (sensor)	9.95	2.69
DFrobot PIR sensor	5.65	5.20
PIC32MX170F256B	4.26	2.71
MCP1700T3302E/TT (regulator)	0.37	0.28
RTE002P02TL (MOSFET)	0.32	0.15
Capacitors	0.45	0.24
Resistors	FREE	0.04
Battery Holders	2.22	1.05
Enclosure	12.35	9.25
PCB	0.99	0.51
Total:	**$81.01**	**$41.44**

Server Cost

Component	Development	Production (1000)
Terasic DE2i-150	FREE	555
HopeRF RFM23BP (transceiver)	8.50	7.95
40 Pin Socket	2.51	1.62
Total:	**$11.01**	**$564.57**



Example Network Configuration