Automated Vent Controller

Group 15 Sponsored By Chris Neiger

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Background - The Warehouse



- Owned by our sponsor Chris Neiger
- 6000 sq ft warehouse in Niceville FL
- Majority of use is from 2-8pm
- Plasma cutter, TIG welder, CNC, and other machinery creates pockets of heat

Background - The Warehouse

- 4 Vents
 - Can be fully open, closed, or paused between stages
 - Already installed and powered
- Full time from open to close ~ 25 seconds
- Operated manually through switches





Background - The Warehouse



Current Control System

- Each vent controlled by one switch
- Switch up open
- Switch down closed
- Switch mid paused

Motivations

- Automate Vents to cool warehouse
- Warehouse is large and expensive to air condition
- Space used during limited hours
- Smart Home/ IoT tech becoming increasingly more desired
- Natural cooling is better environmentally



Goals & Objectives

- Five indoor sensors to aggregate warehouse temperature and humidity
 - Sensors placed to find heat pockets
- Compare with outdoor temperature and humidity
- Control Unit interprets data and tells each vent which position to be in
- Touch screen installed in warehouse to see vent states and take manual control
- Website to check and adjust vents remotely



Requirement Specifications

<u>Component</u>	<u>Parameter</u>	Design Specification
*Sensor Unit Battery	Lifespan	1+ year
Sensor Unit	Maximum Range	100 feet
*Main Unit (Display)	Update Time	2 seconds
Main Unit (Automation)	Override Expiration	1 hour
Main Unit (Controls)	Response Time	1 second
Temperature Sensing	Accuracy	± .5 C
Humidity Sensing	Accuracy	2%
*Web Controller	Response Time	60 seconds
Web Scraping	Update Time	1x /second

Requirement Specifications

<u>Component</u>	<u>Parameter</u>	Design Specification
Sensor Unit	Maximum Range	100 feet
Main Unit (Display)	Update Time	40 seconds
Main Unit (Automation)	Override Expiration	3 hours
Main Unit (Controls)	Response Time	1 second
Temperature Sensing	Accuracy	± .5 C
Humidity Sensing	Accuracy	2%
Web Controller	Response Time	60 seconds
Web Scraping	Update Time	1x /second

Overall Block Diagram - Hardware



Main Control Unit

Power Supply- LM2576

Bluetooth Module- HM-10

Wifi Module- ESP 8266

Touch Display- Adafruit 3.5" TFT Display w/ resistive touch sensing.

Relay Module - ELEGOO 4-Channel Relay Module

Microcontroller- Atmel ATMEGA2560



Part Selection-Wifi Module



	ESP 8266	Adafruit Huzzah
Input Voltage	3.3V input	3-6V input
Logic Level	3.3V logic level	3.3V logic level
Core	ESP 8266	ESP 8266
Programming	Arduino IDE	Arduino IDE (Requires FTDI Cable)





Closing Relays

Indoor Sensor Units

- 5 Sensors
 - Wall Mounted
- Detect temperature and humidity within warehouse
- Send Data to Main Control Unit
- Data aggregate for best accuracy
- Data collected 1x/minute



Proposed Sensor Placement

"Control Room" 14 feet Already Climate Controlled/ No Effect from Vents 25 feet 60 feet Key: Main Warehouse Area Vents Vents Effect this Area Sensors Doors Controller

100 feet

Parts Selection - Temperature/Humidity Sensor

Comparison of DHT11 and DHT22 Sensors



Adafruit

Parameter	DHT11	DHT22
Temp Range	0-50(C)	-40-80(C)
Temp Accuracy	+/-2(C)	+/-0.5(C)
Humidity Range	20%-90%	0%-100%
Humidity Accuracy	+/-5%	+/-2%
Sampling Time	1s	2s
Price	~\$5/each	~\$10/each

Parts Selection - BLE





Microcenter

Parts Selection - Arduino Nano Every



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On Order:	2,500	Expected 6/9/2022
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Out of Stock

🔁 Order now, can ship on 05-Sep-2022 🚺

Parts Selection - Battery



Battery	CR2	Lithium 9V
Voltage (V)	3	9
Number needed to meet Voltage requirement	3	1
Practical life (mAh)	800	1200
System Cost	\$13.50	\$6.89

Overall Block Diagram - Software



Software - Code Outline



- Sketches are uploaded using Arduino IDE to configure each module
- Hosting service provides our own server domain and database support
- All PHP files are placed into "File Manager" of the hosting service
 - PHP script to receive data and insert it into a MySQL database
 - PHP script that displays the database content on a web page
- Visualize the readings from anywhere by accessing our domain name.

Software - UI Design



- Same user interface on the touch display and the website
- The main screen displays indoor and outdoor climate data, as well as buttons to control each vent
- The information screen displays additional device details/controls

Touch Display (concept illustration)

- Current status of each vent is underlined
- Outdoor data gathered by the API
- Overriding will stop automation for 1 hour



Touch Display (prototype)



- Control each vent individually
- Easily compare indoor and outdoor temperature & humidity
- Access the information screen for additional details and options

Website (Wireframes)

- The functionality is the same as the touch display.
- The outdoor temperature can get updated by clicking on the refresh button in the top right corner

Vent 1	Vent 2	Outdoor Humidity	Indoor Humidity
Open Midway Closed	Open Midway Closed	78 54%	78 50%
Vent 3 Open Midway Closed	Vent 4 Open Midway Closed	Battery Life	Override Automation
imate		/8%	On <u>Off</u>

Outdoor Weather Data



- With the time constraints we have, we are planning to use this free weather API.
- Allows for 60 calls per minute, has Niceville as one of the cities.

Website (Prototype)

- The navigation bar at the top, is where links to the other available pages are in.
- The side navigation bar links to parts of the page, to make it easier for the user to get to the information they want.



Prototype - Main Control Unit



Prototype - Sensor Unit



Prototype Testing



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PCB Design- Main Control Unit

- Two Layer Design
- Center- ATMEGA2560
- Bottom- Relay and Communication Connections
- Right- Screen Power, Data, and Control
- Top- Power Supply and Auxiliary Components
- Left- Interrupts Connections and Bootloading Communication.



PCB Design - Sensor Unit

- Two-layer PCB for each sensor unit
- Arduino Nano Every, HM 10, DHT22, and 9V Battery on each board
- Approximately 5cm x 5cm



Finance and Budget

Running Total : \$558.47

Order	Cost	Order	Cost	Order	Cost
HXD8357D (LCD Screen), DHT22 (Temp Sensor), ESP8266 (Wifi)	\$75.60	Bluefruits, voltage regulators, and step converter	\$61.46	SMD Components	\$45.28
Arduino Nano Every	\$24.72	Relay x4	\$33.69	Wifi Module	\$11.76
Arduino Mega	\$54.12	Ship Sensor to Orlando	\$8.45	Lithium 9V Battery	\$7.34
DHT22 (Temp Sensor) x4	\$54.52	Controller and sensor PCBs	\$25.33	Switches	\$16.02
HM 10 (BLE), Lithium 9V Battery, Battery Case 3 pack	\$26.61	4x Arduino Nano Every	\$43.17	Working HM 10s x5	\$70.40

Current Progress & Future Plans

Completed

- Component Testing
 - HM-10 (6), 3.5" TFT Display,
 ESP8266, Relay (4), DHT22 (5), and
 power supply
- One-to-many BT communication loop
 - 1 master and 5 slaves (with DHTs)
- Database setup
 - Created tables for users, vent status, and climate data
- Basic website template
 - Register, login, view account, logout
- Designed and ordered PCBs

Going Forward

- Test wireless communication distance requirements
- Measure open/close time duration for each vent at warehouse
- Map the ventilation buttons to trigger the relays
- Code the automation logic
- Add details to information screen
- Send gathered information to database
- Install and evaluate at warehouse

Progress



Work Distributions

	High Level Hardware	<u>Sensors</u>	High Level Software	User Interface
Primary	David	Gisela	Wendy	Angelica
<u>Secondary</u>	Gisela	David	Angelica	Wendy



