Multifunctional System Project
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Introduction:

This project combines a clock, air quality display, and hand sanitation device into a multifunctional system designed to enhance public health and safety while raising environmental awareness. The device is also designed as an alert system to warn people nearby when air quality is poor. By combining these functionalities into a compact, user-friendly design, the project aims to address modern concerns about health and environmental well-being.

Context:

After the recent covid-19 pandemic, it has become clear to society how important sanitation is for our health. According to the Cooperative Institute for Research in Environmental Sciences at the University of Colorado Boulder, “tracking carbon dioxide levels indoors is an inexpensive and powerful way to monitor the risk of people getting covid-19”. In an indoor environment, the chance of getting covid-19 is proportional to the amount of CO2 in the air. When humans exhale, they are emitting CO2 into the atmosphere which may also contain infectious pathogens. Thus, the higher the CO2 in indoor spaces, the more potential infectious pathogens may be in the air[1]. This doesn’t just go for covid-19 as many bacterial pathogens have been found to have increased virulence and growth potential in elevated CO2 levels[2]. A simple way to prevent the spread of pathogens in these areas is to practice hand hygiene. A hand sanitizer with at least 60% alcohol is effective at killing germs[3]. Thus, my project targets to alert others of potential pathogens in indoor spaces when CO2 levels are high, encouraging them to sanitise their hands to avoid the spreading of germs. For example, implementing this project in busy indoor spaces such as gyms, shopping centres and university hallways will allow others to see and raise awareness of the surrounding air conditions and encourage people to take action in protecting themselves and others from harmful pathogens. More people will feel inclined to use hand sanitizer when they are able to see and are aware of their surrounding air conditions as opposed to a hand sanitizer that does not display air quality.

Technical Requirements:

- Monitor current CO2 levels in ppm
- Display the CO2 levels onto the OLED screen
- Record the current time in hh:mm
- Display the current time on the OLED screen in hh:mm
- Alternate between air monitor display and clock display on the OLED screen
- Activate a warning system when elevated CO2 levels detected
- Dispense hand sanitizer in an automated fashion

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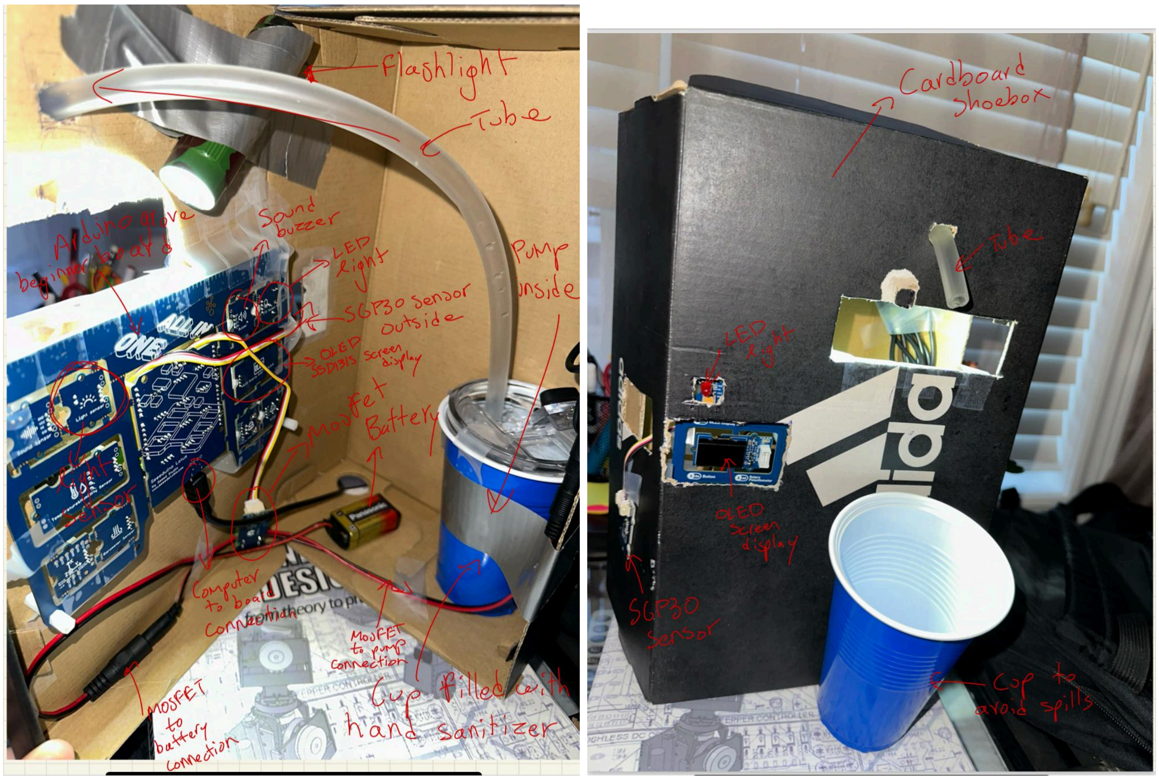
Components List:

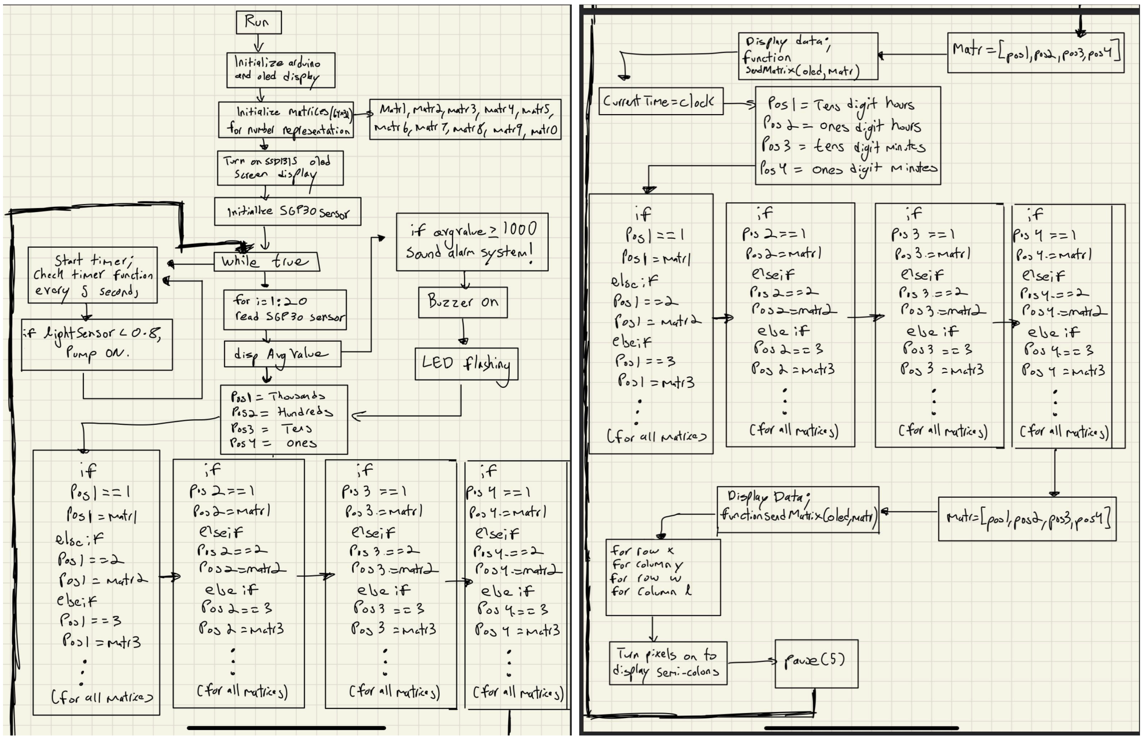
- Cardboard shoebox
- Arduino grove beginner kit, specifically;
- SSD1315 OLED screen display
- Light Sensor
- SGP30 CO2 sensor
- Battery
- Mosfet
- Pump
- Tube
- Flashlight
- Hand sanitizer
- Tape
- LED light
- Sound buzzer



Figures 2 & 3: The Mosfet is plugged into port D2 and is connected to a battery which powers a pump inside a cup filled with hand sanitizer. The tube extends from the pump to the outside of the box to dispense hand sanitizer for the user. The pump is activated once a hand is placed underneath the tube, which blocks the light sensor from receiving light from the flashlight. A hole is cut on the side of the box to expose the SGP30 sensor(connected to I2C port) to air conditions outside the box. The OLED display and LED light are also exposed to the user so they may view the current air quality display or clock display. If air quality becomes poor and reaches a threshold value, a warning system will go off where the buzzer goes off and the LED light flashes to warn users of the poor air conditions and risk of pathogens in the air.

Procedure:

First, the arduino grove board must be plugged into a computer running MATLAB software. A connection must be initialised using the I2C library. Next, the oled screen display must be initialised using I2C library address 0x3C. An initialization sequence to turn on the screen display is found on seeed studio in the SSD1315 OLED screen display specifications file[4]. The numbers 0-9 and empty matrix were initialised by creating a zeros matrix and setting specific row and column values to 255(maximum intensity) to create number segments. The matrices are 64x32 pixels since the entire OLED screen display is 64 x 128 pixels and we wish to display a maximum of 4 digits across the screen. Next, the SGP30 sensor is connected to port I2C and initialised using Mr. Eric Prandovszky's driver and support file and Professor Smith's initialization code from lab J[5]. The Mosfet is connected to port D2 and connected to a battery and a pump that is placed in a cup containing hand sanitizer. A cardboard shoebox is taken and the arduino grove board is taped to the middle of the box from the inside, with the OLED display and LED light facing towards the nearest side of the box. A flashlight is taped to the wall above the light sensor. Next a rectangular hole in the cardboard is cut in the gap between the flashlight and the light sensor, big enough so one can place their hand through it. More rectangular holes are cut in the cardboard exposing the OLED screen display, LED light, and SGP30 sensor to the outside of the box. A hole for the pump tube to go through is cut above the hole that is under the flashlight(the tube was cut in half in order to fit). The cup containing hand sanitizer is placed inside the box and wires are taped to the inside of the box for cleanliness. Next, a while true loop is written to loop through the following code indefinitely. Inside the loop, a timer is started that will check a function that reads the voltage of the light sensor every 5 seconds. The function contains a simple conditional statement, where if the light sensor is blocked from receiving light from the flashlight, meeting a threshold value of<0.8(when someone places their hand there to dispense sanitizer) the pump will turn on for 1.4 seconds dispensing hand sanitizer. A for loop is written for the SGP30 sensor to iterate 20 times. The average values are extracted into a matrix containing 4 digits; the thousands, hundreds, tens and ones columns. A conditional statement is written to assign a matrix number to a position. For example, if the thousands column is position 1 and is equal to one, then position 1== matr1 which is the matrix representing the number 1. This is done for all 4 possible positions(for each digit of the average SGP30 sensor value). Next, a position matrix(with 4 positions) is written where each position has been assigned to a matrix number depending on the sensor readings. Since each number matrix is 64x32, 4 number matrices will span the entire 64x128 screen. A function call is implemented to write this position matrix to the OLED screen display. A conditional statement checks if the number displayed indicates a high CO2 concentration which may then trigger a warning system that consists of the buzzer going off and the LED light flashing on and off. The display stays on for about 15 seconds before switching to a clock display. The clock display uses Matlab’s internal clock function to get the live time. The logic here is similar above but instead the hours and minutes are extracted into a 4 element row matrix. Through conditional statements, the elements are assigned a position number representation depending on their value. This is then put into a position matrix. The semicolon pixels between the hours and minutes are turned on by writing data to specific rows and columns with intensity 255(to be turned on). The function to write the position matrix data to the OLED screen display is called. The display stays on for about 10 seconds before the loop is repeated.


Run
Initialize arduino and oled display
Initialize matrices(64x32) for number representation
Matr1, matr2, matr3, matr4, matr5, matr6, matr7, matr8, matr9, matr0
Turn on SSD1315 oled Screen display
Initiallze SGP30 Sensor
While true
Start timer; Check timer function every 5 seconds
if lightSensor < 0.8, Pump ON.
for i=1:20 read SGP30 sensor
disp Avg Value
if avgvalue ≥ 1000 Sound alarm system!
Buzzer on
LED flashing
Pos1 = Thousands
Pos2 = Hundreds
Pos3 = Tens
Pos4 = ones
if Pos1==1 Pos1=matr1 elseif Pos1==2 Pos1 = matr2 elseif Pos1==3 Pos1=matr3 (for all matrices)
if Pos2==1 Pos2=matr1 elseif Pos2==2 Pos2=matr2 else if Pos2==3 Pos2=matr3 (for all matrices)
if Pos3==1 Pos3=matr1 elseif Pos3==2 Pos3=matr2 else if Pos3==3 Pos3=matr3 (for all matrices)
if Pos4==1 Pos4=matr1 elseif Pos4==2 Pos4=matr2 else if Pos4==3 Pos4=matr3 (for all matrices)
Matr=[pos1,pos2,pos3,pos4]
Display data; function SendMatrix(oled, Matr)
Current Time=clock
Pos1 = Tens digit hours
Pos2 = ones digit hours
Pos3 = tens digit minutes
Pos4 = ones digit mintes
if Pos1==1 Pos1=matr1 elseif Pos1==2 Pos1 = matr2 elseif Pos1==3 Pos1=matr3 (for all matrices)
if Pos2==1 Pos2=matr1 elseif Pos2==2 Pos2=matr2 else if Pos2==3 Pos2=matr3 (for all matrices)
if Pos3==1 Pos3=matr1 elseif Pos3==2 Pos3=matr2 else if Pos3==3 Pos3=matr3 (for all matrices)
if Pos4==1 Pos4=matr1 elseif Pos4==2 Pos4=matr2 else if Pos4==3 Pos4=matr3 (for all matrices)
matr=[pos1,pos2,pos3,pos4]
Display Data; function SendMatrix(oled,matr)
for row x
for column y
for row w
for Column z
Turn pixels on to display Semi-colons
Pause(5)

Figures 5 & 6: An example flowchart of how the system works in MATLAB

Contingency:

Unforeseen challenges may arise that require proactive planning. For example, keeping a few backup sensors in case of failure is recommended for future engineering projects. As well, there should be considerable time spent on testing and debugging to ensure all components of the system are working correctly. Specifically, for this project ensure that the hand sanitizer used is not too viscous as it may get stuck and not pump through the tube.

References

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3. Canada, Public Health Agency of. “Government of Canada.” *Canada.Ca*, / Gouvernement du Canada, 14 June 2024, www.canada.ca/en/public-health/services/healthy-living/hand-hygiene.html.
4. “Grove - OLED Display 0.96" (SSD1315): Seeed Studio Wiki.” *Seeed Studio Wiki RSS*, wiki.seeedstudio.com/Grove-OLED-Display-0.96-SSD1315/. Accessed 1 Dec. 2024.
5. Smith, James Andrew. *LabJ File for EECS1011*. York University, 2024. www.yorku.ca/eclass/