



HUMIDITY GUARDIAN

Smart Environment Monitoring System

GitHub: https://github.com/YuShiCheryl/514_Project_YuShi

Yu Shi



PROBLEM STATEMENT

In many buildings, with heating turned on, the room becomes extremely dry and irritating to the respiratory system. Currently most residences use their subjective feelings estimate humidity.

There's a lack of indicator that show visualized real-time humidity, and proactive alerts.

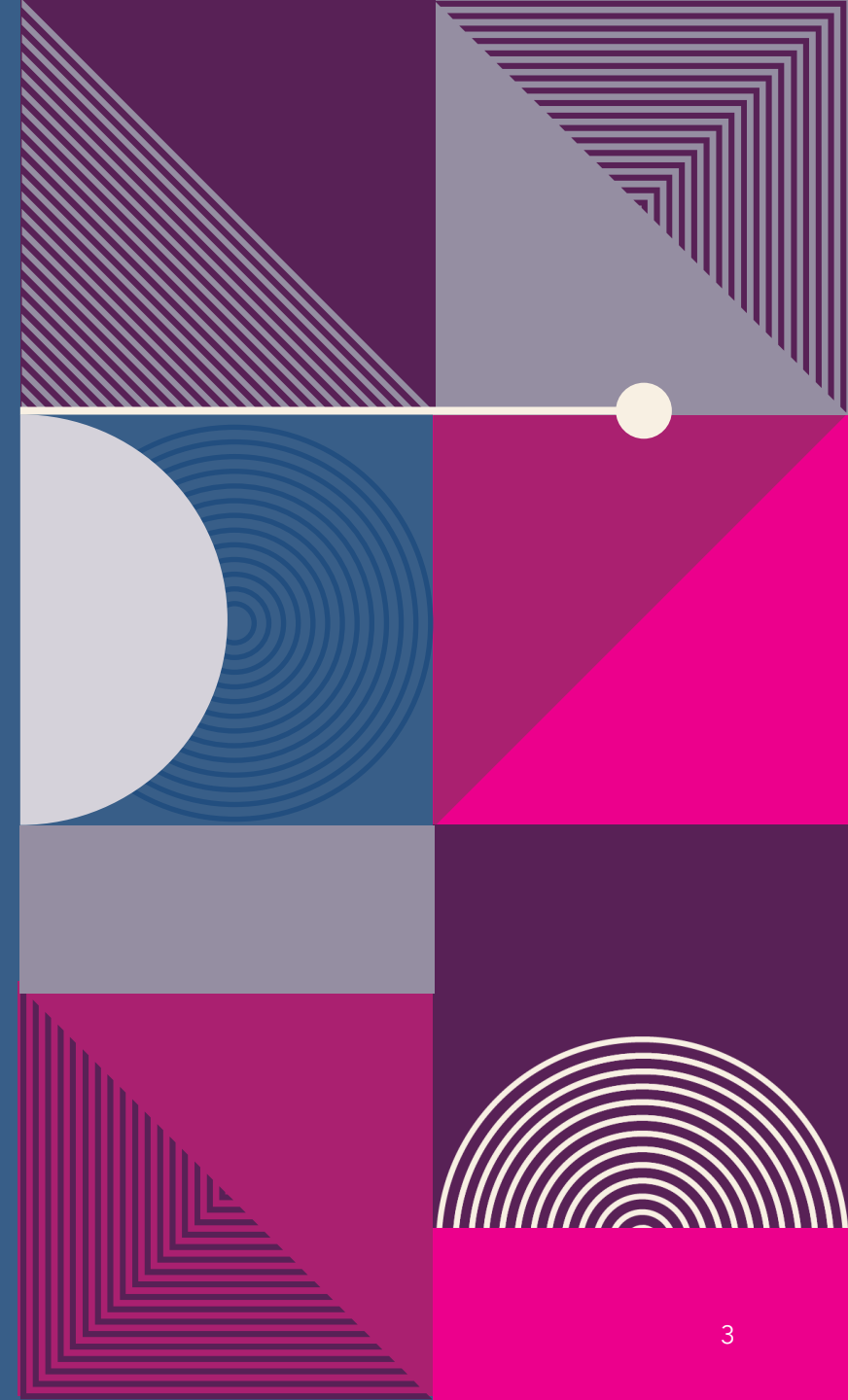
PROPOSED SOLUTION

Two-Device Smart System

- Sensing Unit: BME280 sensor + LED + ESP32S3
- Display Unit: Stepper gauge + OLED + LED + ESP32S3

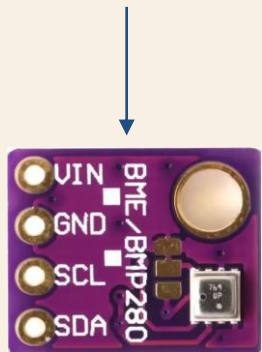
Key Features:

- Real-time RH precision monitoring
- Low-power BLE communication
- Visual + textual feedback system (OLED display & Stepper motor & LED)
- Proactive alerts



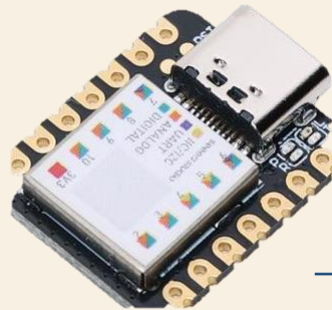
SYSTEM ARCHITECTURE

Room humidity



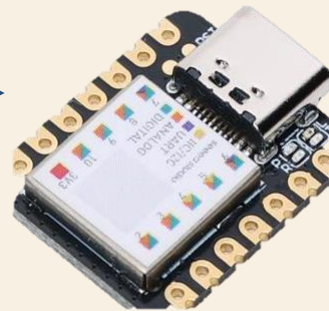
Raw data

Process data



BLE
Transfer data

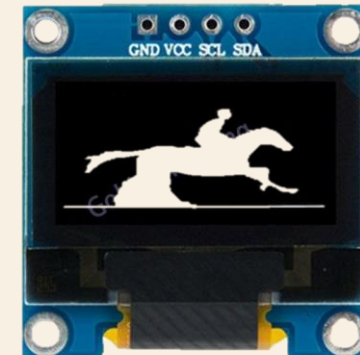
Receive data



Needle rotation



Display information



CRITICAL COMPONENTS



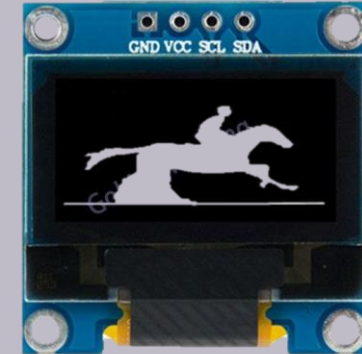
Seeed XIAO
ESP32S3



BME280
sensor



X27 stepper
motor



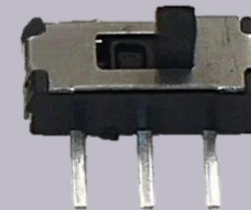
SSD1306
OLED display



2000mA
battery



LED



Switch



Custom PCB



SIGNAL PROCESSING

- **Data Optimization Pipeline**

Noise Filtering: Moving average (5-sample window)

BLE Compression: 32-bit → 16-bit encoding

Sensor Unit Power Management

- 2000mAh LiPo battery (25-day runtime)
- Idle modes between measurements
- Low-power BLE advertising

Sensor device							
System Parameters (defined by hardware)	form the datasheets		Profiles (usage of each component mode - defined by software and usage)				
			"off"	"sensing"	"interactive"		
Processor							
Active	200 mW		0%	2%	0%		
Active+BLE	250 mW		0%	2%	0%		
Idle	10 mW		0%	96%	0%		
Sleep	1 mW		100%	0%	0%		
LED							
On	10 mW		0%	100%	0%		
Sensor							
On	2 mW		0%	2%	0%		
Idle	0.1 mW		0%	98%	0%		
Off	0 mW		100%	0%	0%		
Battery			16	7	1 hours/day typical usage		
Capacity	2000 mAh						
Nominal Voltage	3.7 V						
Regulator Efficiency	90%						

Display Unit Power Management

- Low-power BLE

Display device							
System Parameters (defined by hardware) form the datasheets				Profiles (usage of each component mode - defined by software and usage)			
				"off"	"Update Display"	"interactive"	
Processor							
Active	200 mW			0%	2%	0%	
Active+BLE	250 mW			0%	2%	0%	
Idle	10 mW			0%	96%	0%	
Sleep	1 mW			100%	0%	0%	
LED							
On	10 mW			0%	100%	0%	
Motor							
On	192 mW			0%	2%	0%	
Idle	0 mW			0%	98%	0%	
Off	0 mW			100%	0%	0%	
Display							
On	33 mW			0%	100%	0%	
Off (leakage)	1 mW			100%	0%	0%	
				16	7	1 hours/day typical usage	
Battery							
Capacity	2000 mAh						
Nominal Voltage	3.7 V						
Regulator Efficiency	90%						

BUDGET SUMMARY

ITEM NAME	QUANTITY	UNIT PRICE	TOTAL PRICE
Seed Studio XIAO ESP32S3	2	\$7.49	\$14.98
Lithium Polymer Battery 3.7V 2000mAh	2	\$11.99	\$23.98
BATTERY LITH-ION 3.7V 1.2AH	1	\$9.95	\$9.95
BME280	1	\$4.17	\$4.17
PLA Filament 1.75mm, White	1	\$13.99	\$13.99
			\$67.07



FUTURE ENHANCEMENTS

- Connection with smart humidifier to auto turn on
- Multi-sensor support
- Cloud connectivity for historical data
- AI-driven humidity prediction
- Commercial enclosure design



THANK YOU

Link to video showing functional devices:

https://drive.google.com/drive/folders/1QfyZYgxHViFXgOcEMUnJ5V_oN5PGQldo?usp=sharing