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ZAS Robotics Sensors

Capstone Projects

ZAS ROBOTICS
BUILD THE FUTURE

Table Of Contents

Project - 1

🌶️ SpiceWorks: The High-Stakes Chili Powder Factory

📍 Background:

In a bustling town in India, there's a famous chili powder manufacturing unit called **SpiceWorks**, known for its premium-grade red chili powder that's exported globally. Each packet is valued at **₹500**, and the factory processes **over 10,000 packets a day**. That's a whopping ₹5,000,000 worth of chili powder daily!

But here's the twist...

The drying and grinding process of the red chilies must be carried out under **precise environmental conditions**:

- **Temperature** must remain below **28°C**.
- **Humidity** must stay under **60%**.
- The machinery should operate on a **stable surface** (movement can cause spillage of ground powder).
- **Ambient light** should be **high** for quality control and detection of impurities.
- If there's **excessive sound**, it might indicate **machine failure or foreign intrusions** (like rats).
- Any disturbance or **magnet presence** near the weighing scale area triggers **weight tampering alarms**.

If these conditions are not maintained, the following issues occur:

- Chili powder gets soggy → **Total wastage.**
- Impurities get missed → **Rejected batches.**
- Spillage or tampering → **Financial losses and legal issues.**
- Machine failure or hazards → **Factory shutdowns.**

🔧Your Mission:

You're now the **Junior IoT Engineer** at SpiceWorks.

The company can't afford these massive losses anymore. You've been hired to design a **Smart Monitoring System** using Arduino and the sensors you already know.

🚨What You Need to Do:

Create a **working prototype** that:

- Continuously **monitors** temperature and humidity using DHT11.
- Triggers a **buzzer** if temp > 28°C or humidity > 60%.
- Uses a **tilt sensor** to detect any movement or shake of the grinding table.
- Uses **LDR** to check light levels (and alert if it drops too low).
- Uses **sound sensor** to detect abnormal noises.
- Uses a **magnetic sensor** to catch any tampering near the scales.
- Uses **OLED screen** to display real-time sensor readings and alerts.

✨Bonus Ideas:

- Add a **NeoPixel** light ring to visually show factory status: green (all good), yellow (warning), red (danger).
- Add a **touch sensor** to reset the buzzer or acknowledge an alert.
- Add a **servo motor** to close a small safety gate when danger is detected.

Project - 2

💉 MediGlow Labs: The Critical Vaccine Storage Facility

📍 Background:

Welcome to **MediGlow Labs**, a world-class biotech company that develops and stores life-saving vaccines — including those for rare diseases like Japanese Encephalitis, Hepatitis, and Rabies. These vaccines are **extremely sensitive to light** during certain stages of formulation and storage.

In the **final bottling and packaging unit**, vaccines are transferred into glass vials inside a **controlled low-light environment**. Even a few seconds of **excessive light exposure** (above a certain intensity) can **degrade the vaccine's active ingredients**, making it ineffective and even dangerous to use.

Each failed batch means:

Financial loss of ₹20 lakhs.
Critical shortage of vaccines in hospitals.
Delayed shipments to developing countries.
Risk to thousands of lives.

⚠️Problem:

Recently, the facility has been experiencing **power fluctuations and occasional exposure to bright light** due to faulty automatic curtains and human error. The lab supervisor wants a **reliable, real-time warning system** to ensure:

- Light never crosses a defined intensity.
- Any exposure is immediately recorded and alarmed.

🔧Your Mission:

You've been hired as the **IoT Safety Engineer** to build a **Light Monitoring & Alert System** using Arduino.

Your smart setup should:

- Use the **LDR sensor** to monitor light intensity **constantly**.
- **When light intensity goes above threshold, immediately trigger:**
    - A **buzzer alarm**.
    - A flashing **red LED**.
    - Display a warning message on the **OLED screen**.
- Keep a **green LED** on when lighting conditions are safe.
- Use a **touch sensor** to acknowledge the warning and mute the buzzer.
- Use a **NeoPixel** ring to show environmental status visually.
- Optional: Log each light breach by toggling an LED counter or recording it (can be extended later to SD card or serial output).

✨Bonus Challenge:

- Add a **tilt sensor** to detect if the equipment rack was moved (perhaps a technician tried to bypass the light-safe area).
- Use the **servo motor** to close a protective shutter if excessive light is detected.
- Integrate a **magnetic sensor** to ensure the darkroom doors stay closed — and alarm if opened when lights are on.

Project - 3

🏭 NutriMix: The Automated Nutrient Blending Plant

📍 Background:

NutriMix Industries is a high-tech factory that produces **custom nutrient powders** for athletes, patients, and infants. These powders are a **precise blend of proteins, vitamins, and minerals** — and even the slightest error in the mixing or contamination can lead to **serious health issues**, product recalls, and lawsuits.

The company uses automated machines to dispense powders into mixing bowls and blend them based on recipes. However, for **safety and quality reasons**, certain steps **must be manually acknowledged by a technician** — but without traditional buttons (which can be unhygienic in powdery environments).

⚠️Current Problem:

There have been instances where:

- Technicians **missed** a step or walked away while the next ingredient was being dispensed.
- Machines **overloaded or overheated** due to lack of human confirmation.
- A **rogue or accidental trigger** caused double dispensing of a vitamin, leading to failed quality checks.

The company is looking for a **touch-based safety acknowledgment system** — something contactless and more hygienic.

🔧Your Mission:

You're now the **Automation & IoT Engineer** at NutriMix.

Design a smart safety and confirmation system using **Arduino and a Touch Sensor**. Your system should:

- Require the technician to **touch a sensor** before the machine proceeds to the **next blending step**.
- **Use NeoPixel LEDs to show different system statuses:**
    - Blue = waiting for touch
    - Green = touch confirmed, proceed
    - Red = no touch for too long or double touch (error)
- Trigger a **buzzer** if the machine is activated without a touch confirmation.
- Display status updates on an **OLED screen** (e.g., "Awaiting Confirmation", "Mixing Vitamin B12", "Error: Skipped Acknowledgment").
- Lock out the process (e.g., with a **servo motor**) if a step is skipped.

✨Bonus Creativity Challenges:

- Combine with a **temperature sensor** to ensure powders are mixed only under optimal thermal conditions.
- Add a **magnetic sensor** on drawer compartments — if someone opens the wrong drawer, raise an alert.
- Add a **light sensor (LDR)** to detect if the technician walks away (ambient light changes due to their shadow disappearing).
- Use a **touch sensor as a safe "reset" switch** after an emergency shutdown — instead of an unhygienic button.

🧠Student Challenge Prompt:

"Imagine you're the last line of defense between a child receiving safe nutrition or falling ill. Can you build a simple touch-based confirmation system that blends health with hygiene and safety?"

Project - 4

🧊 CryoCare Labs: Secure Bio-Sample Storage Facility

📍 Background:

Welcome to **CryoCare Labs**, a cutting-edge biomedical storage facility that stores **rare human DNA samples**, **stem cells**, and **organ tissues** at **sub-zero temperatures** using advanced cryogenic freezers.

These samples are used in:

Critical medical research
Life-saving transplants
High-stakes legal cases (DNA evidence)
Space biology experiments

Each freezer stores material worth **₹50 lakhs or more**, and some of it is **irreplaceable**.

To maintain sample integrity:

- Freezers **must stay closed** and undisturbed.
- Access is strictly **controlled**.
- Any **unauthorized opening or tampering** must trigger **immediate alerts**.

Recently, one of the technicians **forgot to shut a freezer door completely** — causing a **partial thaw** and **₹30 lakhs worth of damage**. Security needs a **sensor-based system** to monitor freezer access **in real time**.

🔧Your Mission:

You've just been hired as the **IoT Security Specialist** for CryoCare Labs.

Design a **Freezer Access Monitoring System** using a **magnetic sensor (Hall sensor)** and Arduino.

Your system should:

- Detect when a **magnet** (attached to the freezer door) moves away from the sensor (i.e., door opened).
- Trigger a **buzzer** and flash a **red LED** when the door is opened.
- Display a message on the **OLED** like "Freezer Door Open! Critical Alert."
- Use a **NeoPixel** to show freezer status: green (closed), red (open), blue (maintenance).
- Add a **touch sensor** for authorized personnel to **temporarily override** the alert for maintenance.
- After 10 seconds, if the door remains open, activate a **servo motor** to close a mechanical latch automatically.

✨Bonus Challenges:

- Log the **number of times** the door is opened (using a counter on the OLED).
- Combine with a **temperature sensor** to raise a second alert if the temperature rises beyond -20°C.
- Add a **sound sensor** to detect loud bangs or shouts in the lab — potential emergencies.
- Combine with a **tilt sensor** in case someone tilts or moves the freezer without authorization (theft attempt).
- Students can also design a **smart access tracker** using RFID or a QR scanner later on.

🧠Inspire Your Students:

"What if your freezer mistake cost a life-saving treatment or derailed a space experiment? Can your smart system keep science safe, 24/7?"

This scenario lets them dive into **security, biomedical ethics, automation, and environmental sensing** — all while learning the critical role of a simple magnetic sensor.

Project - 5

🚧 AutoSortX: The Smart E-Waste Recycling Plant

📍 Background:

At the edge of a futuristic smart city lies **AutoSortX**, an advanced, AI-driven **E-waste recycling facility**. Here, electronic waste — old phones, tablets, laptops, and circuit boards — is sorted and dismantled **automatically** to recover **valuable components** like gold, silver, copper, and rare earth metals.

Each **wrong item routed to the wrong bin** (e.g., a lithium battery going into a shredder) could:

- Cause a **chemical fire** or **explosion** 🔥
- Damage expensive machinery worth **crores** ⚙️
- Release **toxic gases**, endangering workers 😷
- Lead to **massive fines from pollution control authorities** 💸

Previously, human workers used manual gates to control the sorting path — but delays and errors were common.

🔧Your Mission:

You've been brought in as the **Automation Control Engineer**.

You must design an **Arduino-powered servo control system** that **intelligently opens and closes sorting gates** at the exact moment based on input sensor data.

🛠️ What Your System Should Do:

- **Use a servo motor to open/close a small gate that allows waste to drop into one of two bins:**
    - Bin A: Safe, recyclable material
    - Bin B: Hazardous or restricted material
- Use an **LDR sensor** to detect if a component is shiny (e.g., reflective = safe metal, non-reflective = plastic or battery).
- If **light level is high**, activate the servo to **open the gate to Bin A**.
- If **light level is low**, open the gate to Bin B and trigger a **buzzer alert** (for possible battery or unknown item).
- Display the result ("Safe Component Sorted" or "Hazardous Alert!") on the **OLED display**.
- Add a **touch sensor** that maintenance engineers can use to pause the system.
- **Add a NeoPixel LED ring showing:**
    - Green: All systems working
    - Blue: Sorting
    - Red: Emergency / Hazard detected

✨Bonus Creativity Tasks:

- Combine with a **tilt sensor** to detect jams or stuck gates.
- Add a **sound sensor** to detect unexpected machine noise (faulty motor).
- Use multiple servos to create a 3-way or 4-way sorting mechanism!
- Create a **reset mechanism** where a second servo resets the conveyor line.

🧠Challenge the Students:

"A single lithium battery in the wrong bin could cause a fire that halts the entire plant for days. Can you design a gatekeeper that never blinks?"

Let them think about **precision automation, environmental safety, mechanical-electronic integration**, and build something that mimics **real-world robotic sorting systems**!

Project - 6

🌆 MetroMind: The Smart City Traffic Control Hub

📍 Background:

In the heart of a rapidly growing smart city, the **MetroMind Control Hub** manages **traffic lights, air quality, noise pollution, and pedestrian safety** — all using IoT and automation.

The city has recently suffered:

Massive traffic jams
Increased road rage
High carbon emissions
Pedestrian accidents at intersections

Traditional traffic lights don't adapt to **real-time conditions** like sudden congestion, weather changes, or emergency vehicles.

The city council wants to launch an experimental **Smart Intersection System** in one busy zone — and they're hiring young minds to build a prototype.

🔧Your Mission:

You're now a **Smart City Engineer** working with MetroMind.

Design an **interactive traffic and environment alert system** using **NeoPixel LEDs and sensors** to visualize what's happening at a city junction in real time.

🛠️ Project Requirements:

Use an **Arduino + NeoPixel ring/strip** to represent a city intersection's condition:

1. Air Quality Monitoring (using DHT11 for now)

- Temp > 28°C or Humidity > 60% → **NeoPixel turns orange** (heatwave warning)
- Normal levels → **Green**

2. Noise Detection (Sound Sensor)

- Loud honking or yelling → **NeoPixel turns red** and buzzer sounds
- Quiet environment → Blue calming effect (pulsing light)

3. Traffic Congestion Estimation (using Touch Sensor or LDR)

- More touches or higher light = more "cars detected"
- Color gradient on NeoPixel from **green (free)** → **yellow (busy)** → **red (jammed)**

4. Emergency Vehicle Mode (activated by Tilt Sensor)

If the pole tilts suddenly → Emergency detected → Flashing **white lights** (clearing path)

5. Night Mode (LDR)

If ambient light is low, system goes into "Night Mode" with **dimmed NeoPixels**

6. OLED Display:

- **Display messages like:**
    - "Traffic Jam! Please Wait"
    - "Emergency! Clear the Road!"
    - "Normal Traffic Flow"

✨Bonus Features:

- Use **different NeoPixel animations**: rotating lights, color wipe, breathing effect, etc.
- Add a **reset button (touch sensor)** for traffic police to clear the alert manually.
- Simulate a **crosswalk countdown timer** using sequential NeoPixel lights.

🧠Inspire Your Students:

"What if your lights could 'talk' to cars and people — warning them, guiding them, and protecting them? Can you make light smarter than ever?"

Project - 7

🔊 SafeHatch: Underground Mining Safety Alert System

📍 Background:

Deep beneath the earth's surface, at **SafeHatch Mines**, hundreds of miners work daily in **hazardous environments** filled with heavy machinery, narrow tunnels, and unstable structures. Communication is difficult due to:

- Echoes and poor radio reception underground
- Constant machinery noise
- Lack of visibility in smoky or dusty conditions

In emergency situations (e.g., **rockfalls, machinery failure, gas leaks**), **quick sound-based alerts** are the only way for miners to signal danger or call for help — especially if trapped.

Recently, the mine experienced an incident where a worker was injured, and no one heard his cries for help. The result: **delayed rescue and a major lawsuit**.

🔧 Your Mission:

You are now a **Safety Systems Engineer** hired to build a **Sound-Activated Emergency Alert System** using Arduino.

🛠️ Your Prototype Should:

- Use a **sound sensor** to detect sharp, sudden noises (e.g., shout, clap, metal crash)
- **If a sound above a threshold is detected:**
    - Trigger a **buzzer** to notify nearby teams
    - Turn on **red flashing NeoPixel LEDs** (to alert visually in low light or smoky conditions)
    - Display **"Emergency Sound Detected!"** on an **OLED screen**
- Add a **Touch Sensor** for manual override/reset
- **Use a DHT11 sensor to monitor temperature and humidity (mines can overheat or become too humid — risk of heatstroke or gas buildup)**

  If temp > 30°C or humidity > 70%, show "Unsafe Environment" on OLED and change NeoPixels to orange

- Include a **Magnetic Sensor** to detect if safety hatch/door has been opened (escape route check)

✨Bonus Challenges:

- Track how many times loud sounds are detected (OLED counter)
- Add a **Servo Motor** that opens a small safety gate when noise is detected
- Combine with **LDR sensor** to log sound events only during low-light hours (e.g., night shifts)
- Use **NeoPixel animation** to simulate different emergency levels: pulsing red = danger, solid red = ongoing alarm, rainbow = system check

🧠Inspire Your Students:

"In a world of stone and steel, where radios fail and people rely on sound — can your system become their voice in the darkness?"

This project brings together real-life risk, emotional impact, and multi-sensor integration with sound as the hero.

Project 8

WildGuard – Smart Poacher Detection in Wildlife Reserves

🐅 Background:

This is a text placeholIn the dense forests of central India, WildGuard Rangers are in a race against time to protect endangered animals like tigers, elephants, and blackbucks. Poachers often enter reserves under the cover of night, bypassing patrol routes. Animals are tracked with GPS collars, but the perimeter zones remain vulnerable. The forest department needs a smart, low-power, Arduino-based system that detects unauthorized human movement, strange sounds, or tampering, and sends instant alerts to rangers.der - click this text to edit.

🔧 Your Mission:

Design a Poacher Detection System for forest use using Arduino and basic sensors. 🛠️ System Features: Sound Sensor to detect sudden human or vehicle noise (e.g., whispers, motorcycles) Tilt Sensor to detect if trees or sensor poles are disturbed Magnetic Sensor to know if trap cages or gates are opened LDR Sensor to track night-time light sources (torches, vehicle headlights) Buzzer + Red LED/NeoPixel to simulate alarm (or frighten intruders) OLED to display time of last event and status Touch Sensor for ranger to confirm and reset the alarm

Project 9

CareBot – Smart Elderly Support System for Homes 👵 Background:

Background

In many homes, elderly people live alone, and may experience falls, fainting, or forget to shut doors, switch on fans, or hydrate during hot days. A silent fall in the bathroom or confusion in the night can go unnoticed for hours — or worse.

Families want an affordable Arduino-based assistant that can monitor environmental safety and allow non-verbal communication for seniors.

🔧 Your Mission:

Build a CareBot system that quietly monitors an elderly person's room and supports them. 🛠️ System Features: DHT11 to detect dangerous heat/humidity levels — triggers a buzzer if too high Sound Sensor to detect distress calls or glass breaking Tilt Sensor placed on walking stick or wheelchair — if sudden movement, trigger "fall alert" Touch Sensor used by elder to trigger help call or confirm "I'm OK" Magnetic Sensor to detect bathroom door left open too long NeoPixel visual cue: Blue = safe, Orange = warm, Red = needs attention OLED Display showing messages like "Please Drink Water", "Fall Detected!", or "Room Temp Safe"

Project 10

🛰️ Project 3: SkyFarm – Intelligent Crop Monitoring in Vertical Farms

Background

In futuristic cities, crops are now grown in indoor vertical farms inside skyscrapers to save land and water. These farms depend on perfect lighting, temperature, and water flow, and are completely sealed from outside weather. A small error — like heat building up or light failing in one vertical layer — can destroy weeks of growth and ruin harvests worth lakhs of rupees. The agricultural startup SkyFarm has hired your team to build a Mini Farm Monitor System using Arduino.

🔧 Your Mission:

Design an automated vertical farm environment monitor using multiple sensors. 🛠️

System Features: DHT11 to monitor ambient temp and humidity LDR Sensor for light intensity in plant growth zone Touch Sensor as a "Reset/Water Now" button for farmer

NeoPixel showing plant zone status:

Green = Perfect growth

Blue = Low light

Orange = Too warm

Red = Alert!

Magnetic Sensor to detect if fertilizer cabinet has been opened recently

Tilt Sensor to monitor plant tray — if knocked/slanted, alert and flash red

OLED Display showing status like "All Plants Happy 🌱" or "Zone 3 Overheating!"

Capstone Project

🌍 AstraHab: The Off-World Survival Base

🪐 The Setting:

It's the year 2045. Humanity has established its **first permanent research colony on Mars**, called **AstraHab**. You and your team are the **Young Tech Pioneers**, chosen to build the **AI-powered safety and automation system** for this high-tech habitat.

Mars is **unforgiving**:

- **Extreme temperatures**
- **Toxic air**
- **Dangerous silence or unexpected noise**
- **Sealed doors and chambers**
- **Zero margin for error**

If the internal environment changes even slightly, it could result in **total habitat failure** — and loss of life.

🔧Your Grand Mission:

Design and build an **Arduino-based Multi-Sensor Smart Control System** that ensures:

- **Environmental safety**
- **Intruder detection**
- **System alerts**
- **Automatic responses**
- **Real-time feedback**

🛠️ Components & Roles:

Sensor/Module	Purpose
DHT11	Monitor air temperature and humidity inside the base.
Touch Sensor	Use as manual override or for astronaut check-ins.
Magnetic Sensor	Detect if airlock doors are opened/closed securely.
Sound Sensor	Detect unexpected sounds (e.g., explosion, tool drop, voice distress signal).
LDR Sensor	Monitor ambient light in the greenhouse module.
Tilt Sensor	

Detect if the base is disturbed (meteor impact, quake).

Buzzer

Alert when any parameter goes out of range.

Servo Motor

Automatically open/close airlock door or protective panel.

OLED Display

Real-time status of the base (enviro stats, alerts, door status).

NeoPixel Ring

Full-system visual indicator — shows mode and alerts.

🔄 **Smart System Behaviors:**

- ✅ **Normal Mode:**
  - NeoPixel = Green
  - OLED = "Environment Stable | All Systems OK"
- 🔥 **High Temp/Humidity Alert (DHT11):**
  - NeoPixel = Orange
  - Buzzer ON
  - Message: "Warning! Temp/Humidity Exceeded"
- 🌑 **Power Failure or Greenhouse Light Drop (LDR):**
  - NeoPixel = Blue
  - Servo closes the plant vault
  - Message: "Low Light! Switching to Safe Mode"
- 🎤 **Unexpected Sound Detected:**
  - NeoPixel = Red
  - Message: "Unidentified Sound — Investigate!"
- 🚪 **Airlock Door Left Open (Magnetic Sensor):**
  - Buzzer ON
  - Message: "Airlock Compromised!"
  - Servo tries to auto-close the door
- 🛰️ **Impact Detected (Tilt Sensor):**
  - Flashing Red NeoPixel
  - Buzzer ON
  - Message: "Possible Meteor Impact!"
- ✋ **Astronaut Touch Override:**
  - Buzzer OFF
  - NeoPixel = Yellow (Manual Mode)

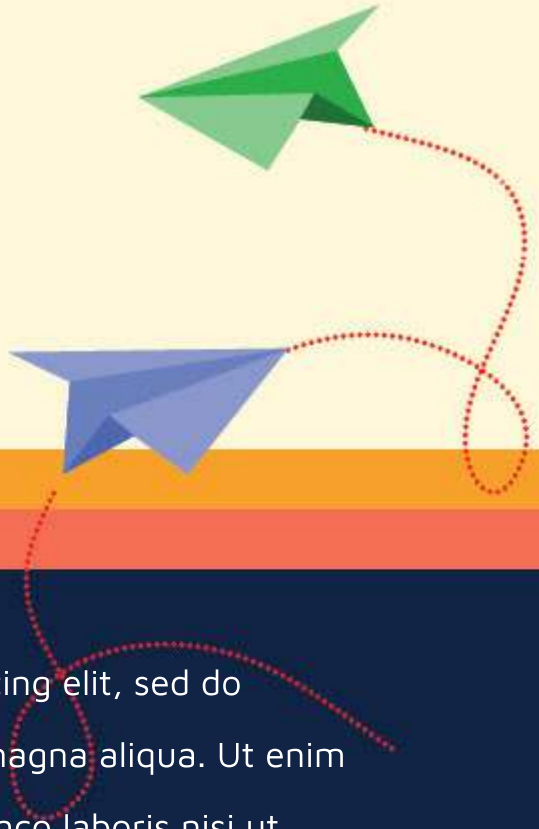
🧠 Inspire the Challenge:

"You're not just building a system — you're the first line of defense between human life and a hostile planet. Can your smart habitat think, react, and protect its crew even when no one is watching?"

💡 Stretch Goals (Optional):

- Add **SD card logging** of alerts for mission reports.
- Use **IR sensors** or ultrasonic sensors to detect astronaut movement.
- Add a **mode switch** to simulate Earth, Mars, and Emergency environments.

Vivamus vestibulum ntulla nec ante.



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