WORKER SAFETY & HAZARD DETECTION IN GUJARAT INDUSTRIAL ZONES

THE SHORT CIRCUITS

HRITHIK - 24BEC0001

KANISHK - 24BEC0439

VIKRANT - 24BEC0597

THE CRITICAL SAFETY CHALLENGE

GUJARAT'S INDUSTRIAL LANDSCAPE

Gujarat hosts over 400,000 industrial units across major zones like Ankleshwar, Vapi, and Dahej. These facilities face constant safety risks that threaten worker lives and operational continuity.

- Chemical exposure incidents
- Equipment malfunction hazards
- Environmental safety breaches
- Emergency response delays
- Accidental Falls

SOLUTION : ESP32-POWERED WEARABLE SAFETY SYSTEM

Our wearable safety system leverages the versatile ESP32 microcontroller to provide real-time environmental and physiological monitoring for industrial workers.

INTEGRATED SENSOR SUITE

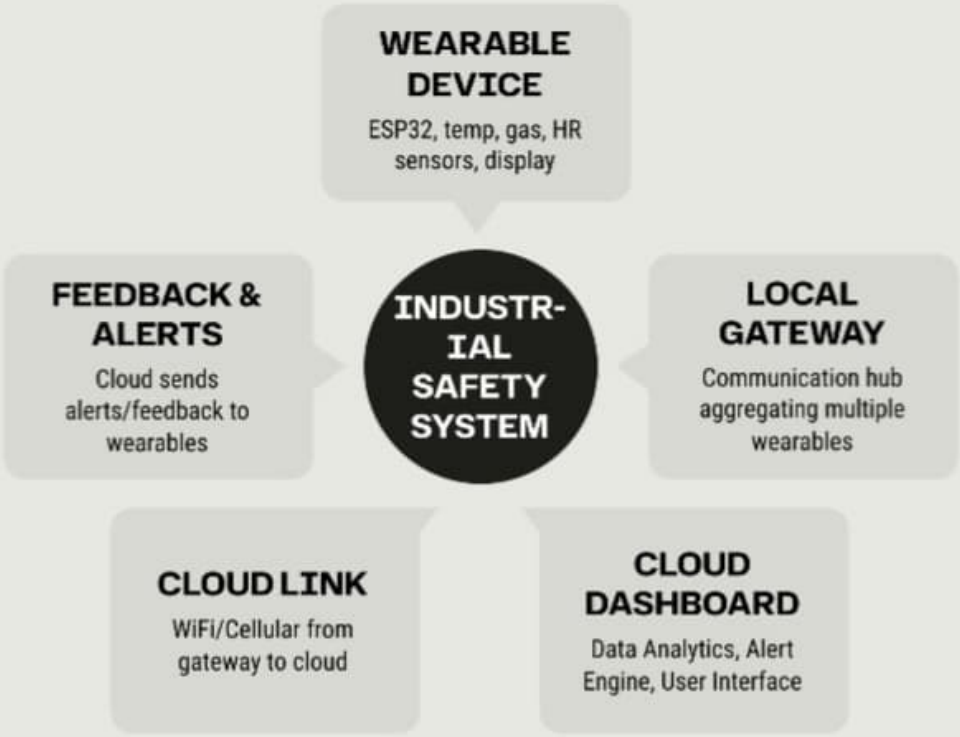
- **DHT11 Sensor (Temperature & Humidity)**: Monitors ambient temperature with an accuracy of ±2°C and humidity within a 20-80% range. Crucial for detecting uncomfortable or hazardous environmental conditions.
- **MPU Sensor (Accelerometer/Gyroscope)**: Provides 3-axis acceleration and gyroscope data for motion detection and fall detection. Essential for monitoring worker activity and potential accidents.
- **IR Sensor (Proximity/Obstacle)**: Detects proximity and obstacles, enabling safety zone monitoring and collision avoidance.

ESP32 CORE & CONNECTIVITY

The ESP32 microcontroller is the system's core, processing sensor data and providing powerful wireless capabilities. It uses Wi-Fi and Bluetooth for connectivity, ensuring real-time transmission of critical safety data and alerts to monitoring stations for immediate action.

SYSTEM ARCHITECTURE: REAL-TIME HAZARD DETECTION

Our solution employs a robust, multi-layered architecture designed for reliable data acquisition, processing, and communication, ensuring comprehensive worker safety and rapid hazard response.



DATA FLOW & TECHNICAL SPECIFICATIONS

INPUT FROM SENSORS

Environmental and physiological data captured in real-time by integrated sensors.

ESP32 PROCESSING

Raw data processed and analyzed by the ESP32 microcontroller.

CLOUD DASHBOARD

Processed data visualized and analyzed on the central monitoring dashboard.

FEEDBACK & ALERTS

Immediate alerts triggered for workers and feedback sent to devices.

The system is designed for efficiency and endurance in industrial environments:

- **Power Consumption:** Optimized for low power
- **Data Transmission:** Near real-time updates (configurable, default every 5-10 seconds) for critical parameters, ensuring immediate alerts.
- **Reliability:** Redundant communication pathways and local data caching to prevent data loss in intermittent connectivity scenarios.

REAL-TIME ALERTING & EMERGENCY RESPONSE

Our system provides comprehensive hazard detection and a multi-tiered alert protocol to ensure rapid response and minimize risks in industrial environments, protecting workers and assets.

HAZARD DETECTION

Wearable sensors continuously monitor for critical deviations: **temperature thresholds, gas leaks, heart rate anomalies,** and **man-down events**. Custom thresholds ensure relevance to specific conditions.

LOCAL DEVICE ALERT

Upon detection, an **immediate haptic feedback** (vibration) and **audible alarm** are triggered directly on the worker's wearable device, prompting instant awareness.

SUPERVISOR NOTIFICATION

If the local alert is unacknowledged within a configurable timeframe (e.g., 10-20 seconds), a detailed notification is sent to designated supervisors via the central monitoring dashboard and mobile applications.

EMERGENCY TEAM DISPATCH

Further escalation, if the supervisor alert goes unaddressed or deemed critical, automatically dispatches local emergency response teams with precise location data for rapid intervention.

RESPONSE & RESOLUTION

Protocols include real-time communication with the affected worker, immediate on-site assessment, and comprehensive incident logging for post-event analysis and continuous improvement.

CONFIGURABLE ALERT THRESHOLDS & PARAMETERS

- **Temperature:** Customizable upper/lower limits (e.g., >38°C or <10°C).
- **Heart Rate:** User-defined safe zones and deviation triggers (e.g., >120 bpm, <40 bpm, or sudden +/-20 bpm changes).
- **Man-Down:** Duration of inactivity and orientation anomaly before alert activation (e.g., 30 seconds of no movement + horizontal posture).

HARDWARE COMPONENTS

Our wearable safety device integrates several key hardware components to ensure comprehensive monitoring and immediate alert capabilities in industrial environments.

ESP32 MICROCONTROLLER

The core processing unit, managing data from sensors and controlling alerts and communication.

DHT11 SENSOR

Monitors ambient temperature and humidity to detect environmental hazards and discomfort.

MPU (MOTION PROCESSING UNIT)

Detects falls, unusual movements, and inactivity for critical man-down alerts.

BUZZER

Provides immediate audible alarms for local alerts directly to the worker.

IR SENSOR

Used for proximity detection, enhancing situational awareness in hazardous zones.

LED INDICATORS

Provides visual alerts and status feedback to the worker for various conditions.

OUR INTELLIGENT SAFETY SOLUTION

An integrated IoT and AI-powered platform that continuously monitors industrial environments, detects potential hazards in real-time, and triggers immediate safety protocols to protect workers.

REAL-TIME DETECTION

Instant identification of gas leaks, equipment failures, and environmental hazards

SMART ALERTS

Automated emergency notifications to workers, supervisors, and safety teams

PROJECT ADVANTAGES

The ESP32 wearable safety system offers numerous benefits, distinguishing it as an effective and innovative solution for industrial worker safety.

REAL-TIME MONITORING

Continuously tracks temperature, motion, and heart rate, allowing immediate detection of hazardous situations.

WEARABLE & PORTABLE

Compact design ensures it can be comfortably worn on wrist/arm for personal safety.

COST-EFFECTIVE

Uses affordable sensors (DHT11, MPU6050, IR module) and ESP32, making it cheaper than commercial safety systems.

IMMEDIATE ALERTS

Buzzer and LEDs provide instant feedback during emergencies or hazardous conditions.

CUSTOMIZABLE THRESHOLDS

Potentiometer or software can adjust alert thresholds for temperature or motion sensitivity.

DATA VISUALIZATION

16x2 LCD displays current readings; cloud dashboards allow remote monitoring.

SCALABLE

Can integrate additional sensors in the future (gas sensors, GPS, etc.) for advanced safety features.

MULTI-FUNCTIONALITY

Combines environmental monitoring, personal health tracking, and motion detection in a single device.

USER-FRIENDLY

Push buttons and LCD make it easy to operate and understand alerts.

HACKATHON-READY PROTOTYPE

Demonstrable, functional, and shows both software and hardware integration.

PROJECT FEASIBILITY

The ESP32 wearable safety system offers practical aspects that make its implementation straightforward and efficient:

EASY TO BUILD

Uses widely available sensors and ESP32, making it easy to build.

PORTABLE POWER

Can be powered by a small rechargeable battery, no heavy wiring required.

CLOUD INTEGRATION

Compatible with free platforms like ThingSpeak for cloud integration.

SIMPLE OPERATION

Minimal technical expertise required to operate and maintain.

CONCLUSION

- **REAL-TIME MONITORING**

  The wearable ESP32-based safety system effectively monitors temperature, motion, and heart rate in real time.

- **IMMEDIATE ALERTS**

  Immediate alerts through buzzer, LEDs, and LCD ensure quick response during hazardous scenarios.

- **PORTABLE & COST-EFFECTIVE**

  The system is portable, cost-effective, and user-friendly, making it suitable for everyday use.

- **CUSTOMIZABLE FEATURES**

  Customizable thresholds and push-button controls allow users to adapt the device to different environments.

- **CLOUD INTEGRATION**

  Cloud dashboard integration enables remote monitoring and data logging for enhanced safety analysis.

- **SCALABILITY**

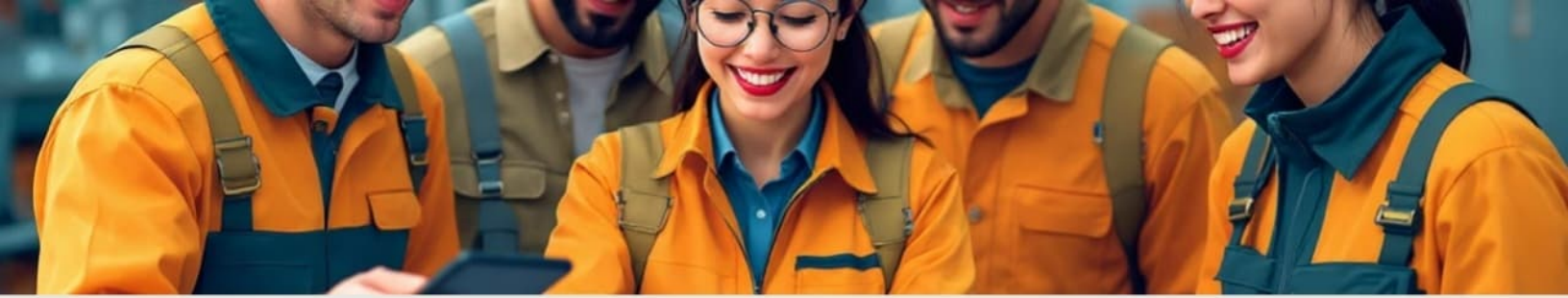
  The project is scalable, allowing future upgrades with additional sensors like gas detectors, GPS, or advanced health monitoring.

- **IOT SOLUTION**

  Demonstrates a practical IoT-based safety solution, combining hardware, software, and real-time alerts in a single wearable device.

- **ENHANCED PERSONAL SAFETY**

  Overall, it enhances personal safety, reduces risks, and provides a foundation for smart wearable safety solutions.



THANK YOU!

We appreciate your time and interest in our ESP32-Powered Wearable Safety System for enhancing worker safety in industrial zones