যাদবপুর বিশ্ববিদ্যালয়
JADAVPUR UNIVERSITY

DISTRACTION MONITORING WRISTBAND

CONTRIBUTORS

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“No one wants to be distracted intentionally... Focus shifts are now deeply ingrained in our subconscious.”

– Chandrayee Nandi, B.Sc. Chemistry, Presidency University

Consumer’s Perspective :

- **Shifts in Focus Are Unconscious**: Our users aren't attempting to get distracted. It's an unconscious, reflexive drift, affecting performance & mental well-being.
- **Unleashing the Potential**: Many students graded 'average' possess greater potential than toppers—concentration is the missing link.

Real-World Context and Accessibility:

- **Challenging Environments**: Distractions increase in noisy, crowded, or environments with limited resources.
- **Affordable & Durable**: The solution should be able to survive harsh conditions and be affordable in regions with minimal access to tech.
- **Non-Intrusive Family Support**: Opportunity to improve guardian-consumer relations gently.
- **Sleek & Culturally Accepted**: Adoption has to do with design; it must align with cultural standards for wearable technology.
- **A Dream Solution:** An affordable, robust, and covert solution that raises awareness without adding to the digital overload.

EMPATHY

DEFINING OUR PROBLEM

To design our product by thoroughly understanding the challenges faced by young students in third-world countries in maintaining focus and academic performance due to various distractions.

Problem Statement

Students in third-world countries face significant distractions from social media, smartphones, and environmental noise, thus reducing focus and academic performance.

Target Users

Students above the age of 8, in classroom or home study environments in third-world countries

Our Solution

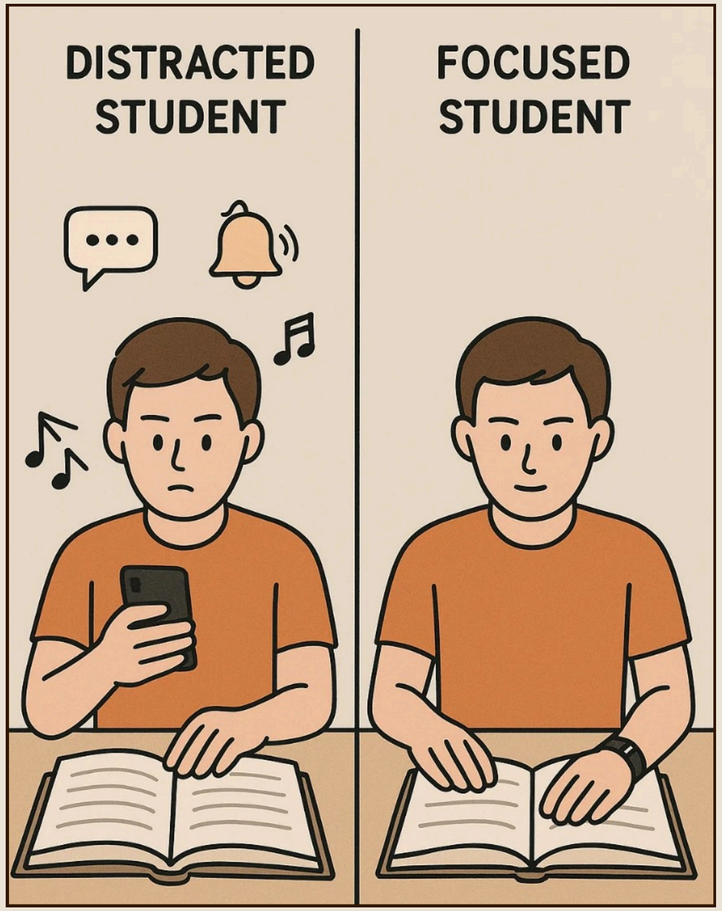
We aim to develop an affordable, non-intrusive wristband to monitor physiological signs of distraction and provide real-time feedback to improve focus during study sessions.

Core Issue

Frequent environmental distractions, which causes the subjected person to unintentionally lose focus periodically

Key Constraints

- Cost: The device must be of low cost (less than ₹1000/unit) to ensure accessibility.
- Technology: Simple, low-power sensors and processors suitable for limited infrastructure.
- Cultural Sensitivity: Non-disruptive design respecting local norms (e.g., unobtrusive, gender-neutral).



IDEATION

Main challenges:

Distraction is neither quantizable nor an emotion that can be scaled. So, we have to assume that the measurements of sudden changes in physiological parameters like heart rate, skin temperature and conductance, and stress can reliably indicate distraction. To keep the cost low, only an analog sensor-based device can be designed, which, with significant firmware updates and additional app support, can be expanded for future endeavors.

Sensors and components:

Heart rate monitor: PPG Sensor (Green LED, Photodiode, RC filters, Transimpedance Amplifier)

Galvanic Skin Response: GSR Sensor (Two Ag/AgCl electrodes, Amplifiers, ADC, RC filters)

Accelerometer: ADXL 345

Microcontroller: ESP32-PICO-D4

Power supply: Battery (150 mAh LiPo Single pouch cell, 3.3-3.7 V), Power Management Unit (TP4056 LiPo Charger Module), Low Dropout Regulator (AMS1117-3.3 Surface Mount Device)

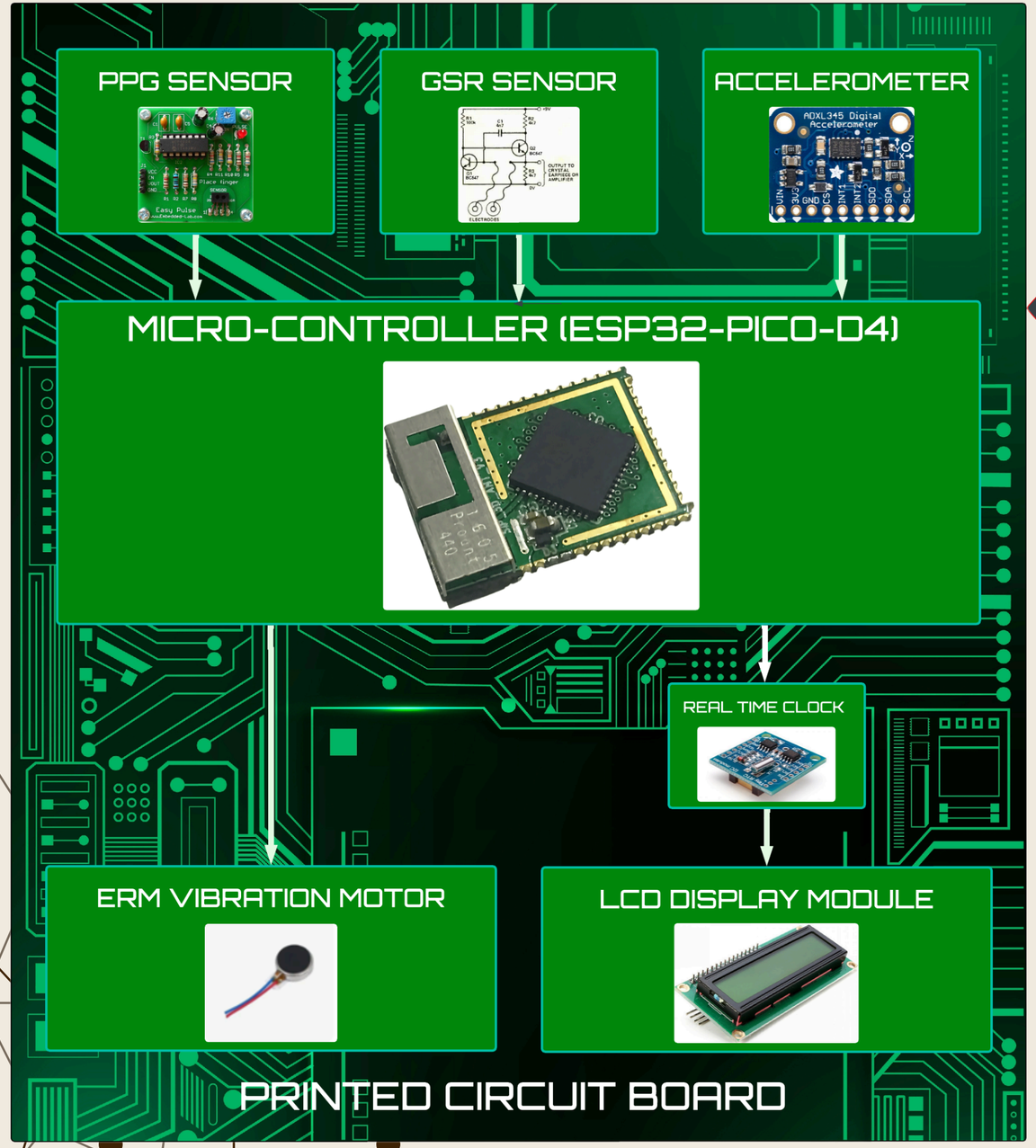
Outline working principle

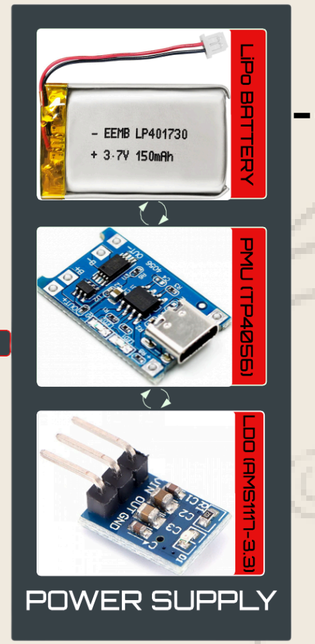
- From the **PPG sensor** used, heart rate variability (HRV) is derived from the variation of heartbeats with time in **RR intervals**, whereas **lower HRV** indicates **stress** & higher HRV indicates a **focused state.**
- For **GSR**, a higher conductance indicates excitation/stress/using a phone. (measures skin resistance/conductance, indirectly giving the idea of sweat gland activity).
- **Low HRV** coupled with **high skin conductance** indicates distraction.
- In a high-movement scenario, HRV or GSR might not be reliable, so using an ADXL 345 (accelerometer), we can override the HRV/GSR readings in high-motion scenarios
- **Feedback**—Using the I2C **LCD Display Module** and haptic feedback with a **Coin Vibration motor**, we can effectively give different feedback for varying degrees of distraction.

OUR INNOVATIVE SUGGESTIONS

- Adaptive haptic feedback: Use of varied haptic patterns (e.g., short pulses, long buzzes) to indicate different levels or types of distraction (e.g., mild vs. severe) by using a PWM signal in the vibration motor.
- Charging Module: A LiPo battery paired with a PMU enables charging via a Type-C USB cable, making it user-friendly.
- Temperature sensor: As skin conductance varies with ambient temperature, for accurate readings, we need to normalize GSR readings for different ambient temperatures.
- Eco-friendly materials: Use of sustainable materials like, recycled ABS or Silicone straps to appeal to environmentally conscious users and mitigate e-waste.
- Low Power & TDM: ESP32's ESP.deepSleep() & light sleep modes significantly reduce substrate current, lowering power consumption during idle states. Also, the PPG LED is controlled via time-division multiplexing to suppress ambient noise effectively.
- Audio feedback functionality: A beep sensor can be included, which beeps for excessive distraction (well above the margin of permissible distraction).
- Focus mode: With a simple firmware upgrade, we can implement a focus mode for variable time intervals like 15 or 30 minutes to encourage consumers to stay focused and provide strong haptic feedback upon distraction
- Reward-based system: With further firmware upgrades and app support, as well as utilizing the Wi-fi and Bluetooth connectivity of ESP32 MCU, a reward-based system can be implemented where the user is awarded focus points upon completion
- Community and Leaderboard: With Bluetooth and Wi-Fi support, a local leaderboard-based community can be introduced using the mobile app to encourage consumers to stay focused

PROTOTYPE





- In 2-layer PCB. On top side, the LCD display, Microcontroller & power supply controller embedded, whereas the PPG, GSR, Accelerometer & ERM vibration Motor gets embedded into bottom side.
- The PCB will have through-hole vias, made with halogen-free FR-4 and a lead-free HASL finish
- Will stay within injection molded recycled ABS, attached with a recyclable silicone strap, making whole weight under 60g.

Total Cost: ₹795/-

Battery life: 8-9 hrs

Length: 150 mm
Width: 15 mm
Thickness: 8 mm

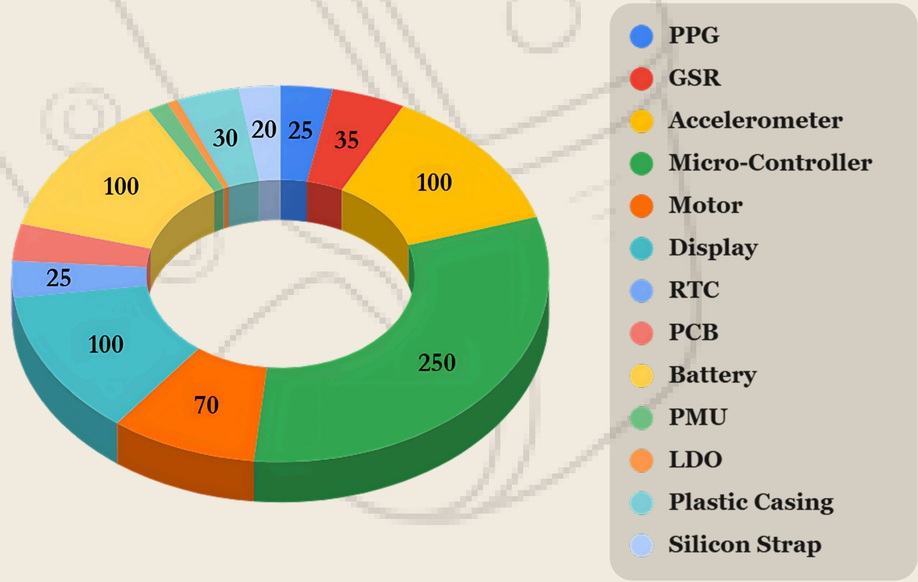


Figure: Pie Chart showing cost of components (in Rupees)

TESTING

We have simulated HRV & GSR signals, which were used to test the device under multiple scenarios, including calibration, noise resistance, logic accuracy, and long-duration performance. Key outcomes are as follows:

Signal Accuracy

Signals replicating skin conductance & heart rate while resting are pushed into the prototype. The system calibrated itself according to the baseline values for 30 seconds. Subsequently, thresholds were set up around those baseline values to simply determine the undistracted range. It was verified that if that baseline data matched the undistracted range in operating times. The system was run for some time & the natural drift of the baseline value was observed. This imposed the need for recalibration after several hours, as ambient temperature & humidity may affect the threshold values.

System Reliability

To simulate real-time situations, random noise & momentary signal spikes are introduced to the system, which cause frequent false triggering. Therefore, a denoise filter & debounce logic were incorporated to prevent those issues. After these additions, the detection logic was again tested by widely varying the HRV & GSR signals. This time the system performed well, triggering vibration only after sustained deviations beyond limits.

Response & Power Metrics

As a wearable device, heating is a concern but using low-power components & switching off components when not in use made for the least power loss as heat, & the device performed safely. Latency is a non-critical parameter here; still, the system performed reasonably well, with response times ranging within 800 ms.

FUTURE SCOPE

Connectivity & Display: In Future versions, we may include Wi-Fi/BLE and a small OLED screen showing focus stats and distractions. A microphone can also help detect noisy environments.

Smarter System: A simple ML model could help the device learn from each user and adjust itself over time for better accuracy.

Digital Alert System : The device may connect to phones & PCs to alert the user if they are distracted by screens while in focus mode

Smartwatch Integration : In future, the system can run on existing compatible smartwatches as a subscription based app, which also might add in revenue stream

App & Rewards: An AI-powered companion app might analyze data & suggest ways to reduce distractions and even offer rewards for staying focused—which can be aligned and enhanced based on user feedback

REFERENCES

[1] B.G. Lee, B.L.Lee, W.Y.Chung: Wristband-Type Driver Vigilance Monitoring System using Smartwatch

[2] S. Shruti, P. Darshini, R. Kannan : Anxiety Controlling Wristband

[3] TI ASLK V13 Demo on Heart Rate Monitoring

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THANK YOU