

HW 3**Mayank Kumar****Product description:** Design a wearable bio-feedback device.**Aim:** Measure and transmit data of “vital signs” to a Smartphone or a VR Headset.**Abbreviation Used:** S = Serial No., Lvl = Level, M = Measurable, O = Observable, NA = Neither measurable nor Observable, VR = Virtual Reality.

“The device” or “device” points to the wearable bio-feedback device.

S	Lvl	Lvl	Requirements	Type
1	L0		It shall support at least 2 modes. 1. VR mode – Data transmission rate will be higher to calibrate user experience during VR playback or gaming. 2. Normal/Standby mode (NMode) – When VR headset is not in use.	M
		L1.1	In Normal mode rate of transmission and data monitoring should happen at every 10 min.	M
		L1.2	VR Mode should increase the rate of transmission and data monitoring to 1s. VR headset will use the data to configure the display and show notifications.	M
		L1.3	In both of the modes, user should have freedom to choose which vital sign he/she want to monitor.	M
		L1.4	User shall be able to start a new VR session through mobile application.	M
2	L0		Other than modes in S1, it should support custom mode.	M
		L1.1	User should be allowed to start a custom session with configuration of his/her choice.	M
3	L0		It shall measure heart beat in beats per minute.	M
		L1.1	Upper bound of the heart rate shall be 210 beats per minute.	M
		L1.2	Lower bound of the heart rate shall be 30 beats per minute.	M
		L1.3	It shall provide the accuracy of $\pm 10\%$.	M
		L1.4	Heart rate display precision shall be 1 beat per minute.	M
		L1.5	In Normal Mode (NMode), it should measure heart beat at interval of 10mins. In VR Mode, it should measure heart beat at interval of at least 1s.	M
		L1.6	User should be able to disable the automatic heart beat monitoring. He/ She should be allowed to measure the heart beat wherever he/ she wants to check.	M
		L1.7	Automatic heart rate data monitoring will be enabled by default.	M
		L1.8	User should be able to check the heart beat on request.	M
		L1.9	User should be able to switch to per day, per week mode for data display.	M
4	L0		It shall measure temperature of the user.	
		L1.1	It shall allow unit selection through APP and VR Headset.	M
		L1.2	It should provide display precision of 0.1 °C and 0.1 °F	M
		L1.3	It should provide accuracy of ± 0.2 °F.	M
		L1.4	User should be able to check temperature on request.	M
		L1.5	Automatic temperature measurement should happen at interval of 1 hr.	M

		L1.6	User shall be able to disable automatic temperature measurement.	M
		L1.7	User should be able switch to per day, per week mode for data display.	M
5	L0		It shall measure calories burnt. Aim: It will motivate users to use the device more frequently. They can track calories burnt during their activities while using the device or while playing games on the VR headset.	M
		L1.1	Mobile app should keep the track of calory burn per hour.	M
		L1.2	User can switch to per day, per week mode for data display for calories burnt.	M
		L1.3	It should have display precision of 1 calory.	M
		L1.4	It shall have measurement accuracy of $\pm 20\%$.	M
6	L0		It shall measure number of steps taken by user.	M
		L1.1	It should have display precision of 1 step.	M
		L1.2	It shall have accuracy of ± 20 steps.	M
		L1.3	User should be allowed to disable the step monitoring through mobile app.	M
7	L0		It shall measure the blood oxygen levels.	M
		L1.1	It shall be displayed in %.	M
		L1.2	It shall have the display precision of 1%.	M
		L1.3	Users shall be given clear instruction on how to measure blood oxygen level manually.	M
		L1.4	Device should be able to measure the blood oxygen level automatically at every one hour.	M
		L1.5	User should be able to disable the automatic monitoring of blood oxygen level.	M
		L1.6	User shall be given a disclaimer about accuracy of the data. Source: Link	M
8	L0		It shall measure breathing rate of the user.	M
		L1.1	It shall be displayed in breaths per minute.	M
		L1.2	It shall provide a display precision of 1 breath per min.	M
		L1.3	It should provide an accuracy of ± 5 breaths per min.	M
		L1.4	It should monitor breathing rate automatically at every one hour.	M
		L1.5	User shall be able to disable automatic monitoring of breathing rate.	M
9	L0		It shall have accelerometer and gyroscope.	M
		L1.1	Device shall be calibratable.	M
		L1.2	User shall be given instruction to calibrate the device in the owner's manual.	M
		L1.3	Default calibration data shall be stored on the device memory.	M
		L1.4	User shall be able to factory reset the calibration parameters.	M
10	L0		It shall give notification to user if vitals are crossing min and max threshold, or if any other irregularities are found.	M
		L1.1	It should be able to push notifications to VR headset and Mobile app.	M
11	L0		It shall consider fashion statement while designing the band and the main unit of the device.	O
		L1.1	Band and main unit should be detachable to provide customization to users.	M
		L1.2	Color options should be available.	M
		L1.3	Colors to be decided along with design team.	O

		L1.4	User should be able to wear this device in applications other than VR.	O
12	L0		It shall be worn on head and around neck.	M
		L1.1	Packaging should be considered for usage on both head and around neck.	M
13	L0		It shall be water, sweat and dust resistant.	M
		L1.1	It shall be washable.	O
		L1.2	It shall be IP6X compatible.	M
14	L0		It shall have Bluetooth and Wi-Fi to support connectivity and Data transmission.	M
		L1.1	It shall be able to establish two-way communication between mobile App and VR headset.	M
		L1.2	It should have cellular connection support.	M
		L1.3	It should be able switch to a protocol which is faster/stronger during a particular activity. By default, Wi-Fi shall have priority.	M
15	L0		Battery shall last up to 5 hrs. in VR mode, up to 15 hrs. in Normal Mode	M
		L1.1	It should take 1 hr. to charge up to 50% of the battery.	M
		L1.2	Battery weight to body ratio should not be more than 3/20.	M
16	L0		It shall provide software updates over the air.	M
		L1.1	User shall be able to check for updates on Mobile App.	M
		L1.2	User shall get push notification on mobile app if updates are available.	M
		L1.3	User should get notification of software update in VR, if VR headset is connected.	M
17	L0		It shall process the data onboard before the transmission to VR headset or App.	M
		L1.1	Data latency should not be more than 1 secs.	M
18	L0		It shall protect user privacy through data encryption during data transmission.	M
		L1.1	There should not be any impact on data latency due to the encryption.	M
19	L0		Device shall offer at least 8 GB on device memory.	M
		L1.1	It should offer memory upgrades of 16GB, 32 GB.	M
		L1.2	User should be allowed to push the data to cloud service of their choice.	M
20	L0		Device shall be safe to use in different conditions like gameplay, outdoor wearing (fashion statement to be considered), watching movie.	O
		L1.1	It shall work without any functional loss between 0 and 35 ° C.	M
		L1.2	It should work without functional loss if temperature is below 0 °C and above 35° C for 5 mins.	M
		L1.3	There should not be any data loss if temperature is between -5°C to 45°C	M
21	L0		Once paired with VR headset, it shall be able to provide haptic feedback based on the scenes user is experiencing.	M
22	L0		It shall be charged through C-type charging cable.	M
		L1.1	It should have LED to indicate charging and charged states.	M
		L1.2	The charging cable shall be detachable from the adaptor.	M
Additional features for premium pack				
23	L0		Once paired with mobile phone, it should allow user to receive calls.	M
		L1.1	User should be allowed to configure if calls are accepted through VR headset or the device.	M

24	L0		It should have mini-speakers and a microphone.	M
		L1.1	Speakers should be used for taking calls and instruction transmission from VR headset.	M
		L1.2	Microphone should be used for taking calls.	M
25	L0		It should have a button to accept calls.	M

Following literatures were reviewed to understand wearable devices while writing the requirements:

1. Wearable Design Requirements Identification and Evaluation: [Link](#)
2. Design checklist for wearable device: [Link](#)
3. Neck wearable: [Link](#)
4. Reflectance based oximeters: Practical issues and Limitations - [Link](#)
5. Course materials