Kundan ji

1

INITIAL PROJECT REPORT

FOR

THE DISBURSEMENT OF 20% OF TOTAL COST

BIHAR STATE DISASTER MANAGEMENT AUTHORITY

PATNA

AND

INDIAN INSTITUTE OF TECHNOLOGY

PATNA

R. ABHISHEK <rabhishek@bsdma.org>

Fwd: IIT Patna: INITIAL PROJECT REPORT FOR THE DISBURSEMENT OF 20% OF TOTAL COST

1 message

kundan kumar kaushal <kkaushal@bsdma.org>
To: "R. ABHISHEK" <rabhishek@bsdma.org>

Thu, Sep 14, 2023 at 10:23 AM

---------- Forwarded message ---------
From: **Rajiv Misra** <rajivm@iitp.ac.in>
Date: Wed, 13 Sep, 2023, 8:05 pm
Subject: IIT Patna: INITIAL PROJECT REPORT FOR THE DISBURSEMENT OF 20% OF TOTAL COST
To: vice_chairman@bsdma.org <vice_chairman@bsdma.org>, udaykant misra <dr.udaykantmisra@gmail.com>, kkaushal@bsdma.org <kkaushal@bsdma.org>
Cc: Director IIT Patna <director@iitp.ac.in>

Dear Sir,

As per the MoU between BSDMA and IIT Patna 'Page No. 5, Payment Schedule Section-1', a 20% of the total cost i.e. Rs 53.8629 lacs is payable to IIT Patna by BSDMA to mark the completion of Stage-1 of the project (Submission of the initial report within 15 days of signing the MoU).

Kindly release an amount of Rs 53.8629 lacs to IIT Patna to initiate the Stage- 2 of the project (Submission of prototype in the next 30 days).

I have attached the initial project report for your reference.

Thanks,
Regards,
Prof. Rajiv Misra
IIT Patna

Adoption of IOT-Edge and AI based Technologies for Natural Disaster Management in Bihar.pdf
2030K

E 2098710, Date- 20-09-2023

Facilitating adoption of IoT-Edge and AI based Technologies for Natural Disaster Management in Bihar

September 2023

Adoption of IoT-Edge and AI based Technologies for Natural Disaster Management in Bihar

1. Introduction

Weather and its unpredictable patterns have always posed challenges, but with the advent of climate change, these challenges have intensified. Bihar, steeped in its rich history and vibrant culture, often finds itself grappling with these extreme events, specifically floods, lightning, and earthquakes. These natural disasters disrupt everyday life, jeopardizing livelihoods, displacing families, and at times even leading to loss of life.

Floods: Every year, several parts of Bihar are submerged due to heavy monsoons and overflowing rivers. Floods not only displace thousands but also damage crops, drown livestock, and destroy infrastructure. Roads become impassable, villages get cut off, and there's an increased risk of waterborne diseases.

Lightning: Rapid heating and cooling of the atmosphere, especially during the monsoon, lead to thunderstorms and lightning strikes. It gives off a lot of energy, making heat and loud thunder sounds. This can be harmful to people, animals, and even damage things like phones, computers, and other electric setups. Bihar also witnesses a high frequency of lightning strikes, especially during the monsoon. The major hotspots are Kaimur, East Champaran, Gaya, Patna, Arwal and Muzaffarpur districts. People continue to be affected by the problem of lightning and have been unable to address it effectively. The survey shows that in rural areas, tribal members and farmers working outdoors are the most likely to get hit by lightning.

The main reasons people die from lightning are standing under trees, indirect strikes, and direct hits. Current lightning warning systems use satellites and radar, making them costly because of the data processing involved. Many in rural areas don't get these alerts. This is because many don't use smartphones, might not be able to read, or simply don't know about the dangers of lightning or the existence of alert apps. So, it's crucial to educate the rural communities about the risks of lightning and the importance of alerts.

Earthquakes: Bihar is part of the seismically active zone. Earthquakes can lead to a wide range of catastrophes, from building collapses to ground fissures. Furthermore, they can cause secondary disasters like landslides, especially in terrains with elevation. Even minor tremors can induce panic among residents. Thus there is huge importance of timely alerts to mitigate their impact.

The major districts affected are Araria, Darbhanga, Madhubani, Sitamarhi and Supaul which lie in Zone V - a very high risk zone. The south-western districts of Aurangabad, Bhojpur, Buxar, Gaya, Jahanabad, Kaimur, Nawada, and Rohtas lie in Zone III. Remaining districts including state capital Patna lie in Zone IV- High risk zone.

Therefore, intensifying efforts to educate rural communities about these natural calamities and the **paramount importance of alerts** through smart devices can significantly reduce potential damage and loss of life.

So, there is a need to develop a **Low-cost All-weather alert system** in rural areas to alert and create awareness in advance about lightning, thunder storm, earthquake, floods, heat waves, cold waves through multi-modal alerting methods. The suggested system will eventually be trained to spot dangerous weather conditions in advance using AI and to warn people of these conditions.

2. Proposed Systems Design of AI-IoT Device - आपदा संजीवनी

This project proposes development of आपदा संजीवनी (**AI-IoT based All-weather alert device**) to warn/alert people in advance about lightning, thunderstorm, earthquake, floods, heat waves, cold waves event through multi-modal alerting signals such as voice command, LED indications and haptic sensing,

Currently, there are alert systems based on geospatial data, SMS to warn people about lightning or severe weather. However, these alerts often don't reach rural communities because of limited access to information and weak network connections. Thus, **LTE-M, Low Power Wide Area Network (LPWAN) technology which allows the use of an LTE installed base with extended coverage**, presents an intriguing solution for this application. It has very low power consumption and allows data to be obtained from various network stations at remote locations.

Difference between
LTE — 4G
LTE-M - 4G optimized

LTE-M module, microcontroller, power supply, charging circuit, miniature speakers, LED indicators, vibration modules, cloud server are the basic building blocks of weather alert systems.

2.1 Why LTE-M communication ?

LTE-M is a low-power, wide-area (LPWA) cellular technology tailored for the IoT. The protocol is optimized for low-bandwidth cellular communication, ideal for connecting simple devices to the internet. These devices transmit minimal data over extended durations while consuming little power. LTE-M typically has a latency between 50-100ms. Its two variants, M1 and M2, support data rates of up to 2984 bits and 4008 bits, respectively. It operates within standard cellular bands and offers several benefits tailored for our IoT device, including:

- **Cost-Efficiency:** Devices that utilize LTE-M are often less expensive to manufacture and deploy due to their simplicity and the standardized nature of the technology.
- **Direct Integration with Cellular Infrastructure:** LTE-M can leverage existing 4G LTE networks, which means there's no need to establish a separate network infrastructure.
- **Scalability:** Given its design, LTE-M is ideal for large-scale IoT deployments, allowing for the connection of millions of devices in a cohesive manner.
- **Bi-Directional Communication:** LTE-M supports two-way data transfer, enabling both the sending of data from devices and the receiving of commands or updates.
- **Mobility and Handover:** Devices using LTE-M can smoothly transition between cell towers, making it suitable for mobile use cases.
- **Improved Security:** Operating within the cellular bands and infrastructure provides inherent security features, including authentication and encryption.
- **Adaptive Data Rates:** LTE-M adjusts data rates based on the needs and conditions, optimizing both communication speed and power usage.

- **Very Low Power Consumption:** LTE-M incorporates energy-saving functionalities, allowing devices to enter a "sleep" mode when not transmitting data. As a result, a device can operate for several years on a compact battery.

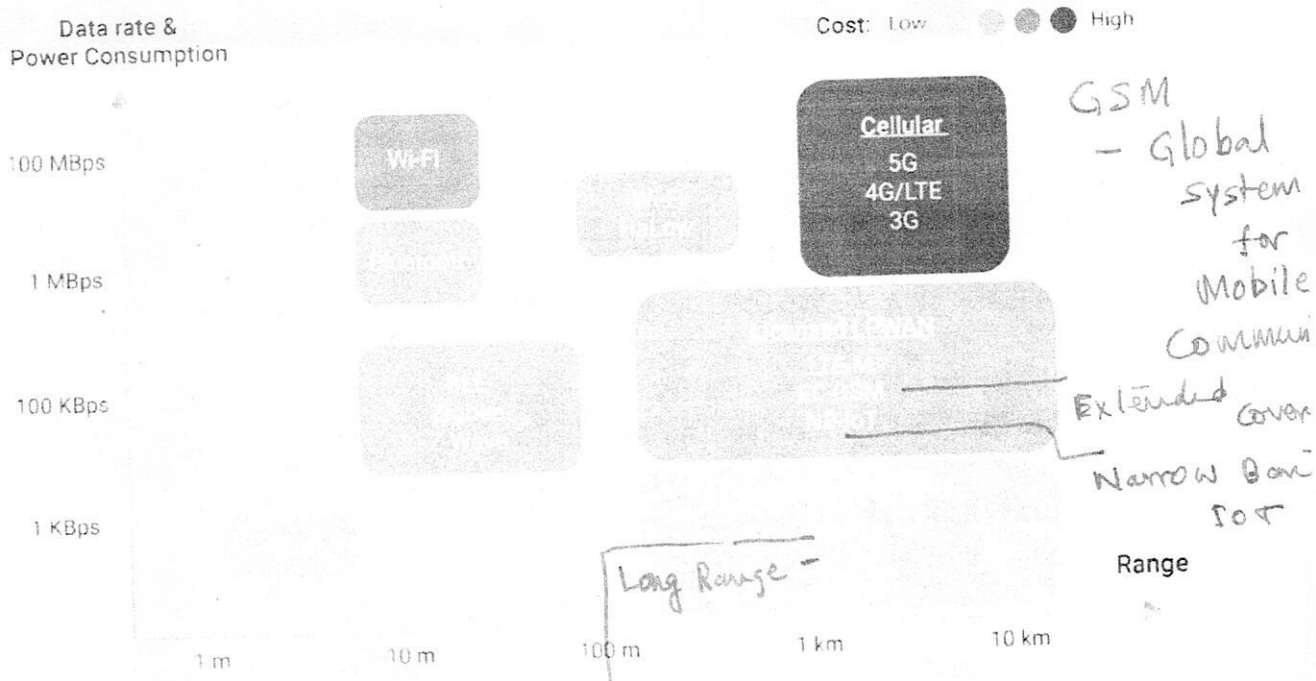
Device Receive Bandwidth	1.4 MHz
Downlink Peak Rate	1 Mbit/s
Uplink Peak Rate	1 Mbit/s
Latency	10-15 ms
Power Requirement	Very low
Duplex Mode	Full/Half Duplex
Device Transmit Power	20/23 dBm

Simplex Sender can send the data but can't receive

Sender can send the data and can also received the data but at a time.

Sender can send receive the data simultaneously.

LTE-M Specifications



GSM - Global system for Mobile Communication

Extended coverage

Narrow Band IoT

Long Range -

Coverage comparison of different communication network

LPWAN protocols for IoT

2.2 Working Methodology

The LTE system includes (IoT devices), eNodeB (Network Station) and Cloud Application Server. In this setup, data flows both ways: from the end node to the application server and back. Its architecture is derived from the LTE architecture, but it is optimized for low complexity devices with low bandwidth needs.

End Node (EN): End nodes are typically made up of sensors, a microcontroller, a LTE module and a battery. They are designed to be low power and capable of narrowband communication.

E-UTRAN (Evolved UMTS Terrestrial Radio Access Network):
eNodeB: These are the base stations in LTE. For LTE-M, they can be the same as standard LTE base stations but will be equipped to handle LTE-M devices. The eNodeB handles radio communications with the End Node **(EN).**

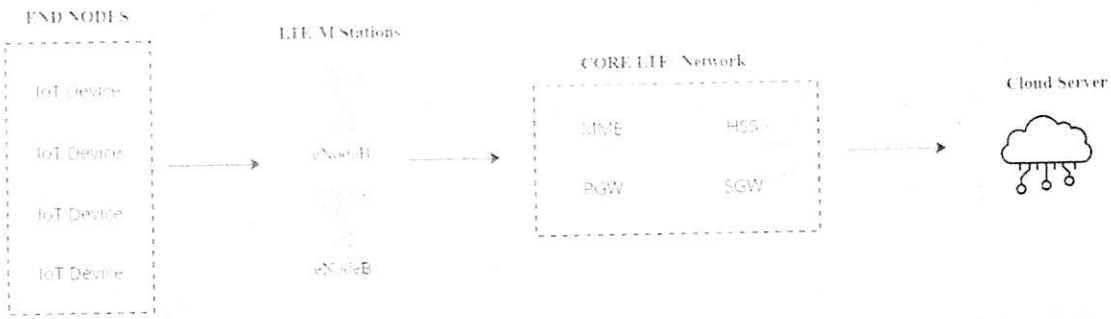
Evolved Packet Core (EPC): This is the core network of LTE, responsible for routing data packets and connecting the LTE network to other networks like the internet.

MME (Mobility Management Entity): Manages user connections, handles UE mobility, and initiates paging if data for a UE arrives during its sleep cycle.

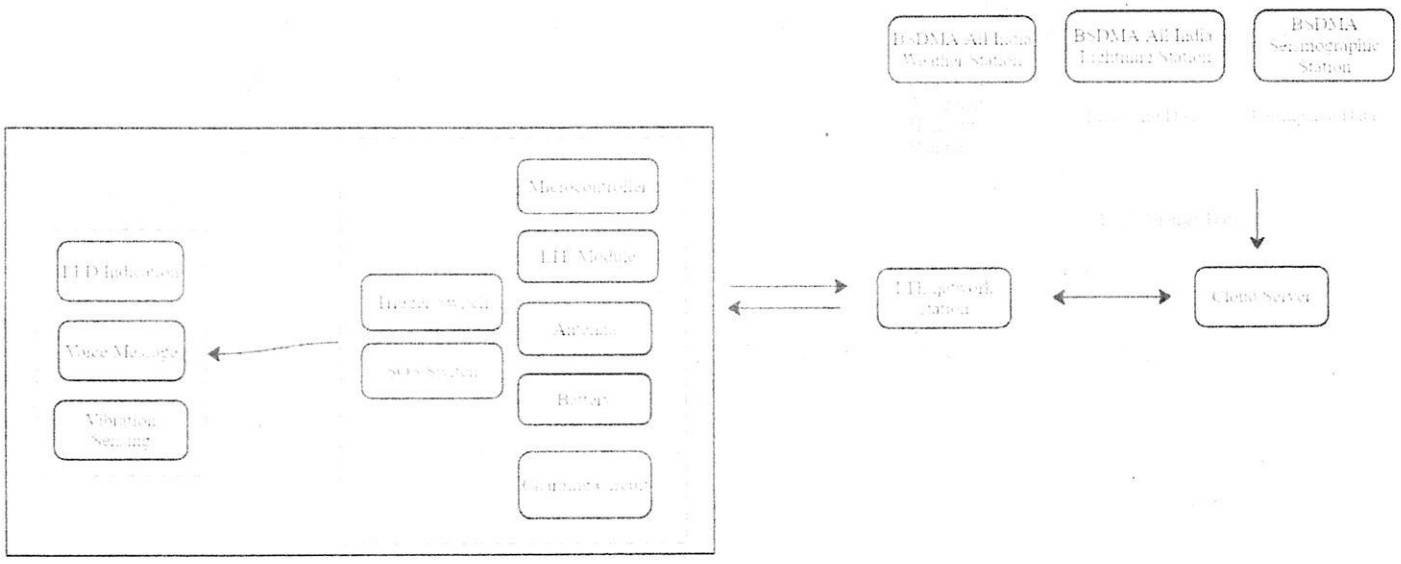
SGW (Serving Gateway): Routes data packets and maintains user contexts, especially when the user moves or changes eNodeBs.

PGW (PDN Gateway): The connection point between the LTE network and other networks, like the internet. It also allocates IP addresses to UEs.

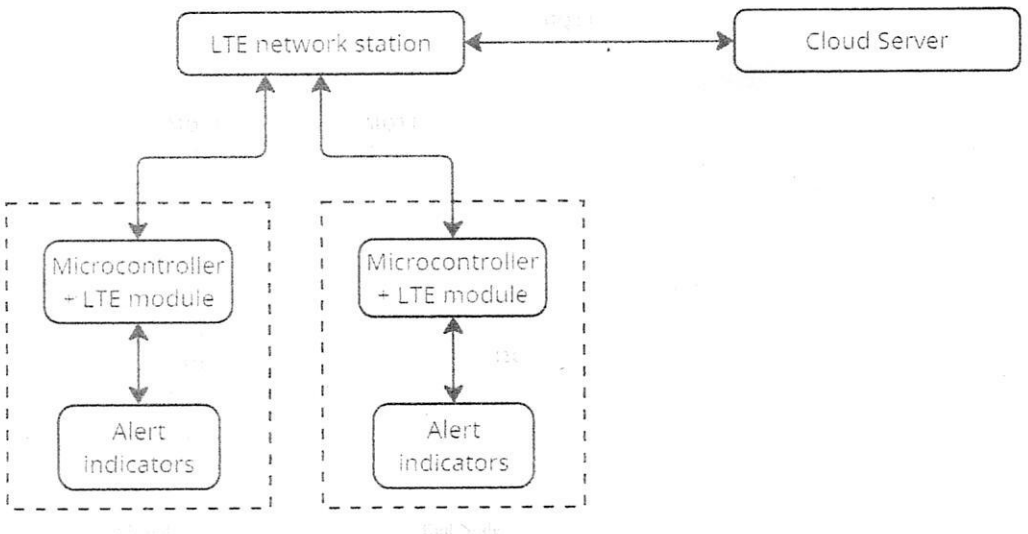
HSS (Home Subscriber Server): A central database for user information and subscriptions.



3. LTE Based Weather Alert Warning System



Architecture of the Proposed System Design



Communication scheme of the proposed system

This network architecture is composed of three main components (Cloud Server, LTE network station, Data stations) that enable the transmission of an alert from a Weather data station to a destination (IoT device - end node) over a long distance.

The cloud application server will integrate the BSDMA weather, lightning, and seismographic data stations via API. This integration will be carried out in close partnership with the BSDMA authority to ensure access to data concerning lightning and earthquake events.

The IoT device responsible for transmitting alert signals with LTE-M is tiny and easy to wear and does not cause any discomfort. Moreover, devices are of low cost which makes the proposed system affordable for its users.

4. Design Specifications of the IoT Device

As previously highlighted, many individuals in remote regions face the threat of severe weather events without receiving timely alerts due to weak network connectivity. This lack of information can lead to serious incidents or even fatalities.

To tackle this pressing concern, we propose implementing a LTE-based emergency weather alert system. This innovative solution operates on lower bandwidth and covers a very wide area, Should unfavorable weather conditions arise, the device autonomously activates multiple alert mechanisms, such as haptic feedback, voice notifications, and LED signals, prompting the user to seek shelter.

Additionally, users can manually send out an SOS alert if they find themselves in distress. This not only provides GPS-based guidance to the nearest safe location but also notifies the emergency rescue teams to assist if required. Lastly, this are the integral components of IoT device.

- **LTE Module** - The LTE Modem acts as a node that functions to send data to the network station . In this device, the LTE modem will be used with a working frequency of 1.4 MHz.

- **Microcontroller** - ESP32 microcontroller acting as a main processing unit in the device.

- **Power Supply** - Li-ion polymer cells will be used primarily to power the device with battery life of at least 15 days.

- **Alert Signal Module -** The SPKM.10.8.A, a 10mm miniature speaker module with a maximum power consumption of 300 mW and a noise sensitivity of 75 dB, will be utilized for vocal alert notifications. For haptic notifications, the C08-00A vibromotor with a 2G amplitude is chosen. A high-intensity, low-power LED from Wurth will be employed for alarm indications.

- **Switches** - Alert switch will be used for acknowledging the alerts received from network stations. SOS switch will be used to send emergency help signals to network stations.

S.No.	Component	Description	Availability
1.	Outer Casing	Exterior styling device in form of pendant with IP55 waterproof capability	Available
2.	LTE Module	LTE Cat M1 with option of integrated e-Sim	Available (Higher Lead Time)
3.	Microcontroller	MCU for triggering alerts in warning situations	Available
4.	Battery	Li-ion polymer cells, 3.7 V 2200 mAh	Available
5.	Charging Circuit	Fast charging circuit with current and voltage protection	Available
6.	Vibromotor	C08-00A vibromotor with a 2g's amplitude	Available
7.	LED indicators	Wurth-high-intensity, low-power LED	Available
8.	Miniature Speakers	SPKM.10.8.A,10mm miniature speaker module,	Available

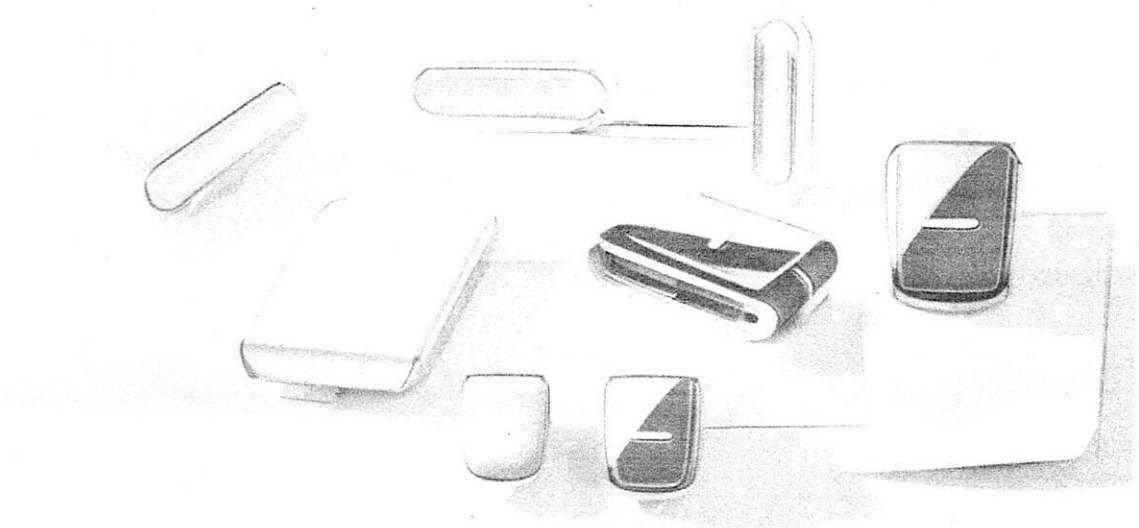
Technical Specifications of the Components

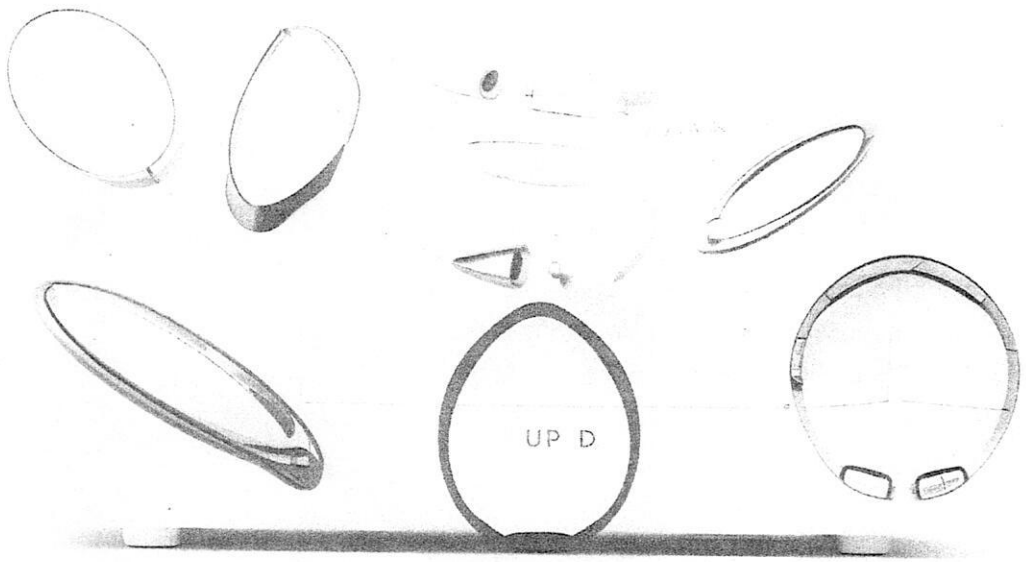
We explored using **Satellite connectivity** to enable the device to connect to the internet in regions without cellular coverage. However, in India, satellite internet isn't available

due to either regulatory restrictions or the absence of established regulations. Both Jio and Starlink are currently working towards introducing satellite internet services in India.

In India, there isn't a commercially available **thermoelectric charging module** for procurement. We are considering sourcing a thermoelectric charging solution (which charges devices using body heat) from international vendors.

5. IoT Device Exterior Design Concept





Above figure shows different ideation forms for the device. The device is designed to be worn as a **pendant, strap, or clip, ensuring user comfort**. Once the hardware architecture design is complete, we will determine the final dimensions of the device.

6. Working Procedure of the IoT Device

E-1: Data Stations are connected to the main cloud server through API integration which includes data from weather stations, BSDMA lightning stations and seismographic stations.

E-2: If any abnormal weather condition appears, the data station will send the alert signals to the cloud which is then transmitted to the device through LTE network stations.

E-3: LTE network stations will send data to the microcontroller through the LTE module for creating alerts through activating voice module, vibration module and LED module. This will alert users about extreme weather conditions.

E-4: Once the user receives the alert in the IoT device, he has to acknowledge the alert through the alert switch in the IoT device that warning is acknowledged, else alert will continue to warn through indicators every 30s.

E-5: This data will be transmitted to the network station and then to the main cloud server along with the GPS location of the IoT device.

E-6: If there is any emergency situation the user has to press the SOS button to indicate the need of help, this data will be uploaded to the main server through network stations.

E-7: The cloud server will then send information to the concerned authority to provide immediate help.

E-8: Additionally, there will be a safe location guidance system which will help users to guide to safe location through voice command in IoT devices. This will work by detecting the GPS location of the device.

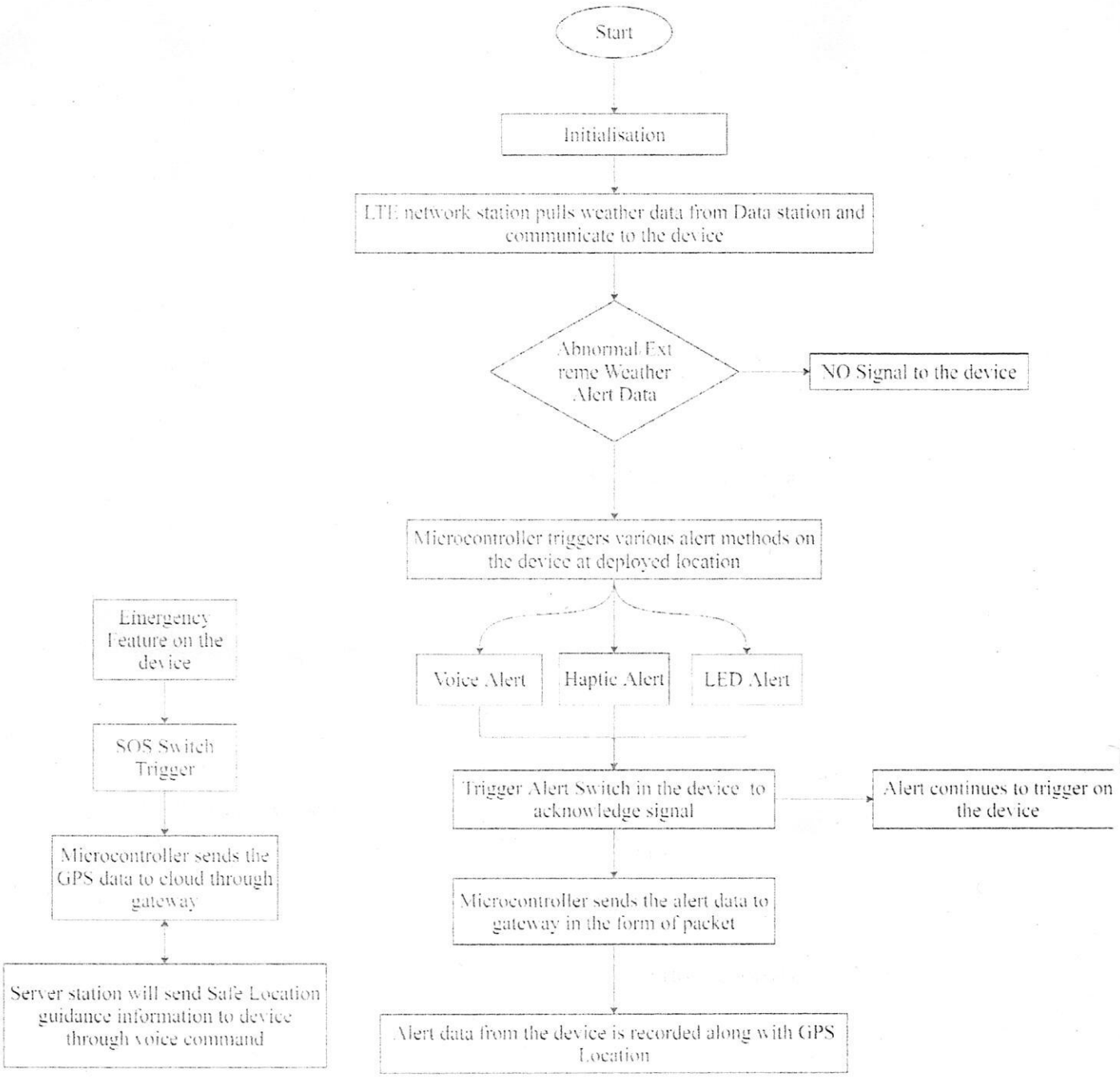
7. Features of the All-Weather Alert IoT Device - आपदा संजीवनी

1. Compact and Portable, can be tied into hand or waist /used as a pendant.
2. Live Interconnection with weather stations for alarming Thunderstorms, Heavy Rain, Lightning, earthquake, heat wave, and cold wave through API integration
3. Alarming Indicators - Voice Message, Vibration Sensing and LED indication.
4. Auto Weather Data Update from Cloud (Response time - 100 to 200 milliseconds).
5. Live OTA updates
6. Connection through LTE Module and network station for network connectivity.
7. Battery Capacity - More than 15 days (use of flexible polymer cells)
8. Devices will be 'ON' during 'on-body' condition.
9. Al and ML integration of data to give early warning predictions.
10. It has the capability of a safe guidance assistance system to provide immediate help during emergency/SOS triggers.

The IoT Disaster Alerting Pendant Device with Location-Based Alerts, and Safe Guiding Assistance epitomizes safety-focused wearable technology. By integrating user guidance during disasters, this device ensures not only information but also actionable steps to protect individuals from potentially life-threatening situations. This project strives to create a wearable device that empowers users with essential information, guidance, and safety during adverse weather conditions.

The device shall be active only during on-body conditions (wearable conditions). The user may send the signal of the alert by pressing the alert switch, which should indicate to the server that the alert has been received by the user. The server shall monitor the health of the device and in case of malfunctioning, shall issue alerts.

By adding AI into this device, the system is able to predict the weather conditions and alert the people in advance to reduce weather disasters.



Flowchart of operating process of the weather alert system

7. Maintenance of the device

Software Updates: Regularly release of firmware and software updates to improve functionality and address potential vulnerabilities.

Hardware Assistance: If your device malfunctions, you can exchange it at the closest hub station available while the original device undergoes repair.

8. Training For Natural Disaster Events

Training for natural disaster events using Augmented Reality (AR) and Virtual Reality (VR) offers immersive and realistic scenarios without exposing participants to actual risks. These technologies can dramatically improve preparedness, response capabilities, and awareness. Here's how you can leverage AR and VR for natural disaster training:

Scenario Creation:

- **VR:** Simulate natural disaster scenarios such as hurricanes, earthquakes, floods, or wildfires. Users can experience the event firsthand, learn to identify signs of impending disasters, and understand the impact.
- **AR:** Overlay disaster-related information on the real world, such as escape routes or the location of emergency supplies.

Evacuation Drills:

- **VR:** Train individuals to evacuate buildings, homes, or even whole areas safely. Virtual environments can change dynamically, forcing the user to adapt to varying situations.
- **AR:** Overlay evacuation routes on real-world environments, helping users visualize the best paths in real-time.

Search and Rescue:

- **VR:** Train first responders in search and rescue operations, letting them practice in collapsed buildings or flood-hit areas without actual risk.

- **AR:** Help first responders by highlighting trapped individuals, dangerous zones, or even showing structural weaknesses in buildings during a real operation.

Medical Assistance:

- **VR:** Medical teams can practice providing care in disaster-hit areas, dealing with a range of injuries and illnesses specific to the disaster.
- **AR:** Offer real-time information about patients, such as vital stats, potential injuries, or medical history.

Public Awareness:

- **VR:** Engage the public by letting them experience a natural disaster virtually, driving home the importance of preparedness.
- **AR:** Provide overlays on smartphones or AR glasses about nearby emergency resources, safe zones, or historical data about natural disasters in their area.

By integrating AR and VR into natural disaster training programs, it becomes possible to train more effectively and efficiently, improving disaster preparedness and saving lives.

9. Additional Cost

Cloud Server operating cost - We are working out commercials with different vendors for cloud connectivity platforms. Upon finalization, we will release the operating cost of the cloud server.

SIM Subscription charges - Given that LTE operates on a cellular network, there will be subscription fees for the M2M IoT sim. The estimated cost is around Rs. 1000 annually for each user.

GOVERNMENT OF BIHAR
BIHAR STATE DISASTER MANAGEMENT AUTHORITY
(DISASTER MANGEMENT DEPARTMENT)
Patel Bhawan, 5th Floor, D/E Block, Nehru Patna-23
Letter No-3/6-Aapda/Vividh/Pra.-04/2023...../Auth.

बिहार सरकार

Letter No.

Dated:-

From,

Minendra Kumar (IAS)
Secretory,
Bihar State Disaster Management Authority

To,

The Director,
Indian Institute of Technology, Patna,
Bihta, Patna, Bihar-801106

Sub:- **Regarding timely meeting of deliverables of Novel and Innovative Device for generating Natural disasters alerts .**
Ref.: BSDMA letter no. 1397 dated 12/06/2024
MoM with IITP on developing lightening alert pendent; dated 19.09.2023

Sir,

It is to inform that as per the MoU the Novel and Innovative Device for generating Natural disasters alerts, has not yet been up-to date in its prototype itself. At the review meeting held on 19 June 2024 with IIT, Patna team at BSDMA, the prototype device was not found satisfactory on the following aspects:

1. The device body is much fragile
2. The device is not found charging with the body therm(thermoelectricity)
3. The color signaling of the device is not as per determined parameters
4. The sound level (pitch) alert is very low
5. The sound message alert of natural disasters including thunderstorm, heavy rain, heat wave and cold wave are not incorporated

Additionally, IIT Patna is lagging on the time bound meeting of the deliverables of MoU and the reason/s for the same is/are not appropriately informed in advance to BSDMA. The BSDMA is working for the welfare of the common people and expects IIT Patna will help BSDMA in its endeavor by complying with MoU's timeline.

Warm regards

(Minendra Kumar)
Secretary

Latter No.-...../Auth

Patna, Date...../2024

Copy to: - PS to Hon'ble Vice Chairman/Member for inoformation.

10. Project Budget (With Phase 1 distribution)

Sr. No	Major Activity	Cost (in lacs)	20% Fund Distribution - Phase 1 (in lacs)
1	**AR/VR Technology Awareness**		
	AR/VR/Metaverse Equipment	10	
	AR/VR Content Development	10	
2	**E-Governance Solution for Disaster Events**		
	GIS, Portal, APP, Cloud,(Integration with BSDMA server for API), Advanced IoT development Center – power from human body, Location based, GSM module	100	12.808
3	**Advanced IoT Device Manufacturing**		
	IoT Pendant/Locket Disaster Management Early Warning gadget for farmers (supply IoT-Pendenet 10,000 devices, Rs 1000/device)	100	10
4	**Adoption of Best Practices, Manpower, Research**		
	Junior Research Fellow (03 nos)	12	12
	Project Assistant for field work (03 nos)	9	9
5	**Training For BSDMA**	8	0
6	**Contingency (3% of project cost)**	7.49	7.49
	Total(items 1-7)	**256.49**	**51.298**
	Institute overhead(5% of Total)	**12.8245**	**2.5649**
	Grand Total(1-7)	**269.3145**	**53.8629**

Cover Letter

To,
The Vice Chairman
BSDMA, Govt. of Bihar
Patna

13th September 2023

Subject - Disbursement of 20% of the total project cost to IIT Patna

Dear Sir,

As per the MoU between BSDMA and IIT Patna 'Page No. 5, Payment Schedule Section-1', a 20% of the total cost i.e. Rs 53.8629 lacs is payable to IIT Patna by BSDMA to mark the completion of Stage-1 of the project (Submission of the initial report within 15 days of signing the MoU).

Kindly release an amount of Rs 53.8629 lacs to IIT Patna to initiate the Stage- 2 of the project (Submission of prototype in the next 30 days).

Thanks,

Regards,

Prof. Rajiv Misra

IIT Patna

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Letter No-3/6-Aapda/Vividh/Pra.-04/2023...../Auth.

Government of Bihar

Bihar State Disaster Management Authority

(Disaster Management Dept)

D-Block, 5th Floor, Sardar Patel Bhawan, Patna-800023

From,

Secretary

Bihar State Disaster Management Authority, Patna.

To,

The Director,

Indian Institute of Technology, Patna,

Bihta, Patna, Bihar-801106

Patna, Date...../2024

Sub: - Novel and Pnnovative Pendent.

Sir,

Greetings from BSDMA.

It is encouraging that under an MoU with BSDMA (copy enclosed), IIT Patna has developed a novel and innovative pendent for issuing early warnings of various disasters. It is designed to provide timely alerts to labours, farmers, differently abled people and other vulnerable stakeholders. As per the MoU (Cl. 7), the device should have following features.

1. Compact and Portable, can be tied into hand or waist /used as a pendant.
2. Live Interconnection with weather stations for alarming Thunderstorms, Heavy Rain, Lightning, earthquake, heat wave, and cold wave through API integration.
3. Alarming Indicators - Voice Message, Vibration Sensing and LED indication.
4. Auto Weather Data Update from Cloud (Response time milliseconds) 100 to 200.
5. Live OTA updates.
6. Connection through LTE Module and network station for network connectivity
7. Battery Capacity - More than 15 days (use of flexible polymer cells)
8. Devices will be 'ON' during 'on-body' condition
9. Al and ML integration of data to give early warning predictions
10. It has the capability of a safe guidance assistance system to provide immediate help during emergency/SOS triggers.

This device is a testimony to the efficacy of the proper use of loT and first of its kind. The large-scale in-house production of this device is to be taken up by IIT Patna after the approval of prototype.

BSDMA team has precisely and critically analysed the usefulness and efficacy of this innovative device. The following are the observations:

I. The body of this device is fragile and needs to be made robust to sustain the vagaries of the weather, especially the rain on a long term basis.

II. Regarding the charging of the device by body therm, it does not appear to be adequate. Perhaps an external charging would be required

III. During alarm generation, the red light does not blink

IV. The content of alarm (for earthquake) needs to be changed.

V. Warning sound is abysmally low.

It is most sincerely felt that an urgent meeting at higher level must be called in IITP to ensure that (i) the device is improved as indicated above and (ii) BSDMA should be satisfied about the preparedness of IITP for mass scale production of the device.

Warm regards

hd/-
(Minendra Kumar)
Secretary

Latter No.-.....1397...../Auth Patna, Date..12.6../2024

Copy to: - PS to Hon'ble Vice Chairman/Member for inoformation.

Secretary
11/6/24