

iFeliz: An Approach to Control Stress in the Midst of the Global Pandemic and Beyond for Smart Cities using the IoMT

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Outline of Talk

- Introduction
- Motivation
- Importance of Stress
- Existing Solutions - their Issues
- Proposed Solution
- Novel Contributions
- Architecture of iFeliz
- Proposed Methodology of iFeliz
- Implementation of iFeliz
- Conclusions and Future Research

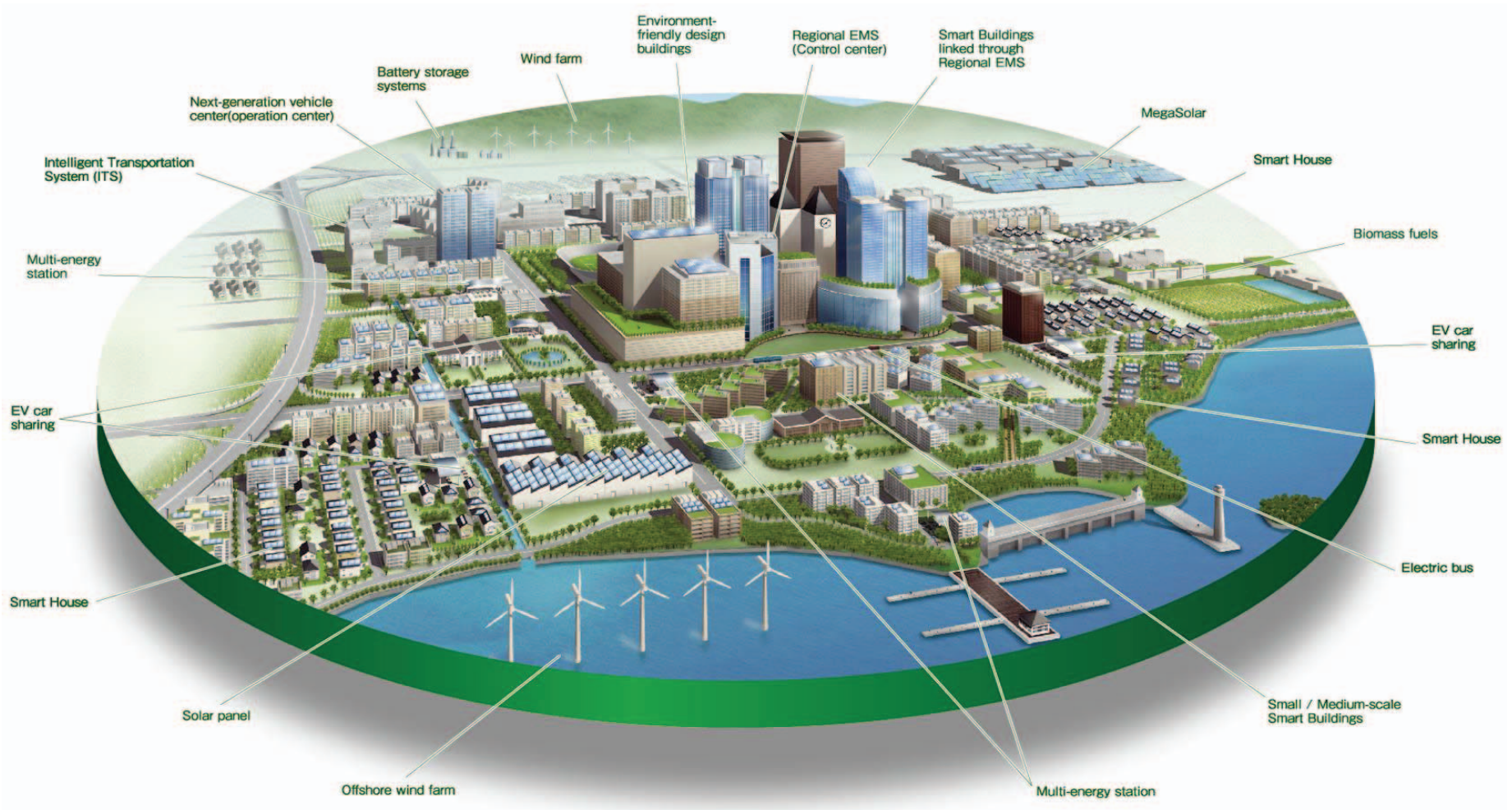
INTRODUCTION

What is a Smart City?

- **Definition - 1:** A city “connecting the physical infrastructure, the information-technology infrastructure, the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city”.
- **Definition - 2:** “A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operations and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects”.

Source: Mohanty 2016, CE Magazine July 2016

Broad Picture of Smart City



Source: <http://edwingarcia.info/2014/04/26/principal/>

Idea of Smart City

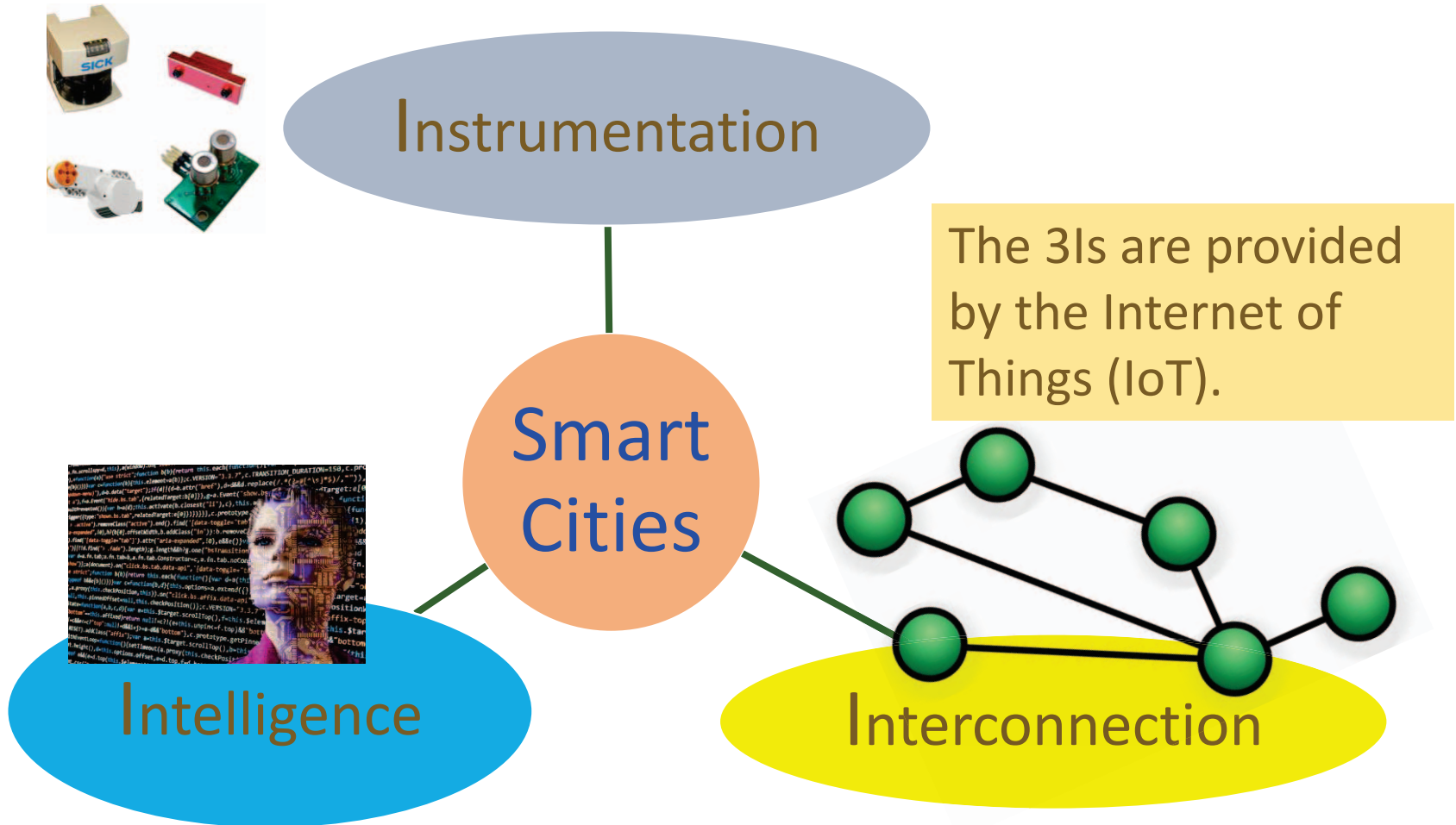
- A smart city can be envisioned as a technology paradigm in which traditional networks and services are made more flexible by improving its operations.
- The components of smart cities include smart transportation, buildings, infrastructure, energy, healthcare etc.

Smart Cities ←

Regular Cities

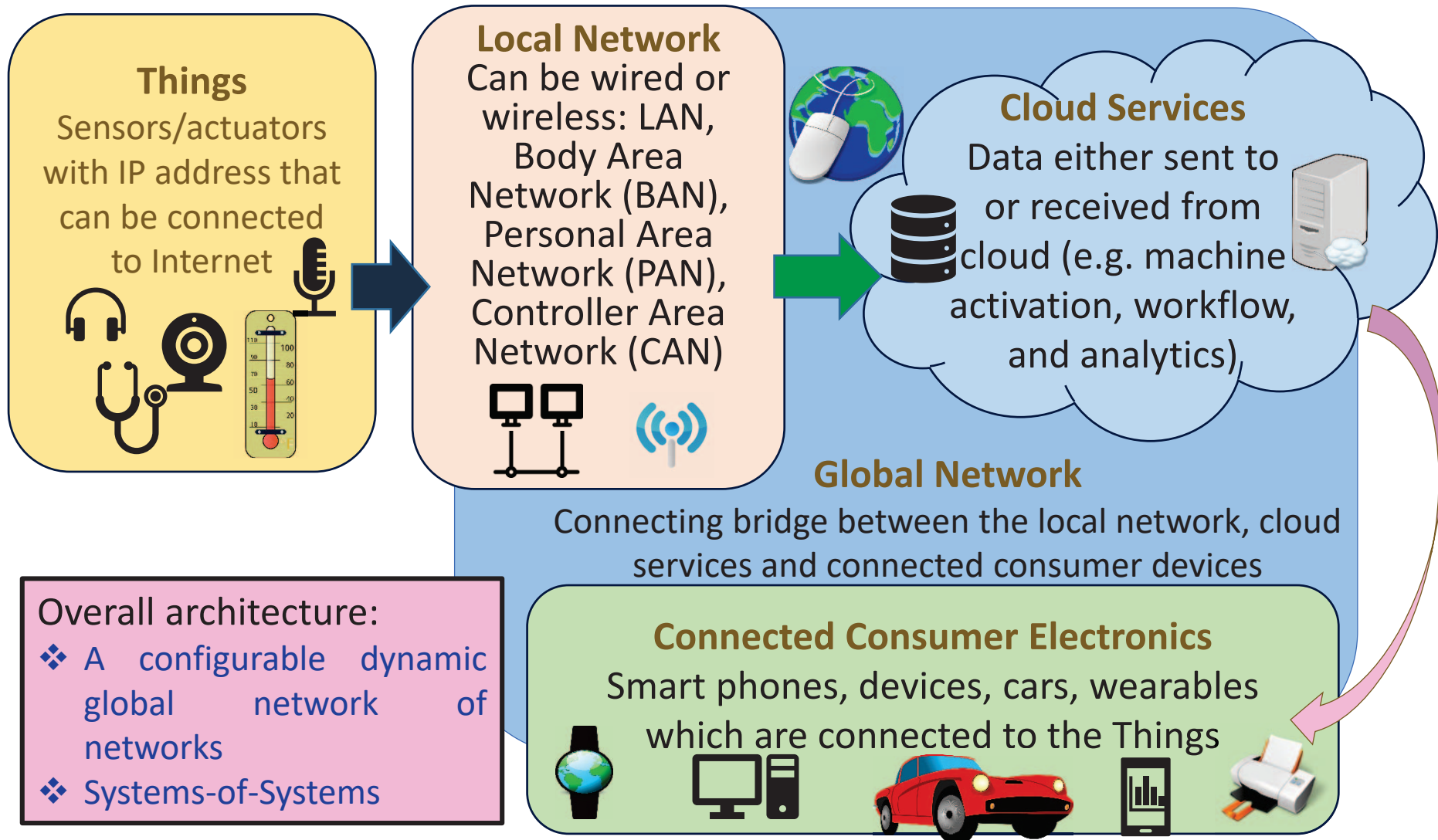
- + Information and Communication Technology (ICT)
- + Smart Components
- + Smart Technologies

Components of Smart City



Source: Mohanty 2016, EuroSimE 2016 Keynote Presentation

Technology in Smart City



Source: Mohanty ICIT 2017 Keynote

Smartness of a Smart City

- Smartness in a Smart-City is not just installing digital interfaces in infrastructure but also using technology and data provided to enhance and improve the quality of life.
- Smart-City is a system of three layers: infrastructure, smart-devices or applications which are capable of data analysis and the technology which includes connected networks of devices and sensors.
- Technological innovations could possibly provide a solid foundation to smart cities.
- Though a city has every smart component that is in order to be called a smart city, the true state of smartness can be achieved when both the users and the technology benefit.

MOTIVATION

Motive of iFeliz

- Being able to live happily and peacefully should not be as difficult as it is in today's world.
- There is always so much happening around with the global pandemic and other current events that every human being is affected one way or another.
- Having emotions and reacting to events is good if there is a healthy stress response.
- When a person does not know how to cope with stress, technology should be able to provide a solution.
- Often, people do not realize that they are under stress until the very last moment.
- In order to avoid these mishaps, iFeliz, a stress control system is proposed.

How Smart is Too Smart?

- The smartness of a smart city is still a rough area as there is not one specific answer for how much is too smart.
- To be able to Improve the quality of life of users and enabling them with an option of taking control over their lives should be also considered an important factor for any city to be smart.

Commercial Use of iFeliz

- ❖ A happy businesswoman keeping stress levels in control with the use of iFeliz for a better growth both personally and professionally.
- ❖ The idea is to be potentially happy and relaxed during pandemics like COVID-19 or even after it.



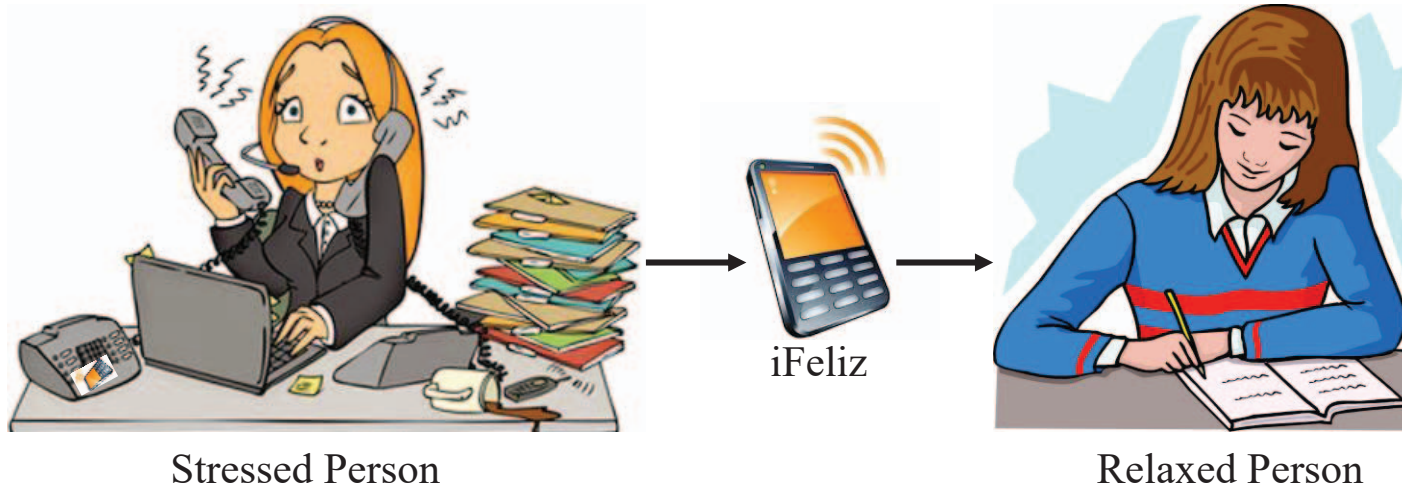
iFeliz – Stress Control
mobile application notification

Why to Control Stress?

- An approach to stay happy and calm by addressing chronic stress through everything that is happening in today's life.
- Stress is considered an important factor for many chronic diseases.
- Prolonged stress can cause fatal diseases like cancer, anxiety, depression, obesity, PTSD, PCOS, Type II diabetes, osteoporosis, and memory problems.

Pictorial representation of iFeliz

- ❖ iFeliz is proposed to improve the smart healthcare domain thereby improving the smartness of smart cities.



EXISTING SOLUTIONS – THEIR PROBLEMS

NOTABLE WEARABLES AVAILABLE IN THE MARKET

Wearable	Sensors Used	Features	Drawbacks
Xiaomi Mi Band 4	Heart Rate sensors	Tracks the number of hours slept and makes suggestions based on the calories burned.	No stress monitoring or control suggestions; Generalized application. Slow response to spikes in heart rate.
Garmin vivosmart 4	Heart rate, pulse oxymeter sensor	A function that tracks stress levels based on previous activities	No stress control suggestions or remedies. Price could deter consumers as market value is high.
Moodmetric Smart Ring	Electrodermal activity	Uses an algorithm that maps stress data into a number between 1-100.	No stress control suggestions or remedies. Not very affordable for everyone as the market price is high.
Muse 2	EEG	Sound therapy	User is always required to wear the band, does not consider other physiological parameters.
Thync Relax Pro	EEG	Deep sleep and relax modes by emitting higher and lower electric pulses to maintain the relaxed state.	High market price for the device plus an additional monthly charge for app usage. Restricted usage for pregnant woman or individuals with a pacemaker.
Lief Smart Patch	Heart Rate Variability (HRV).	When stress levels reach a high value, the app plays soothing sounds and sends vibrations through the patch.	Sticker underneath the sensor is not reusable thereby increasing the price. Does not measure cortisol levels in perspiration. User is not allowed data access.

STATE-OF-THE-ART LITERATURE.

- ❖ Aside from wearables, there are many research articles that address stress monitoring methods.

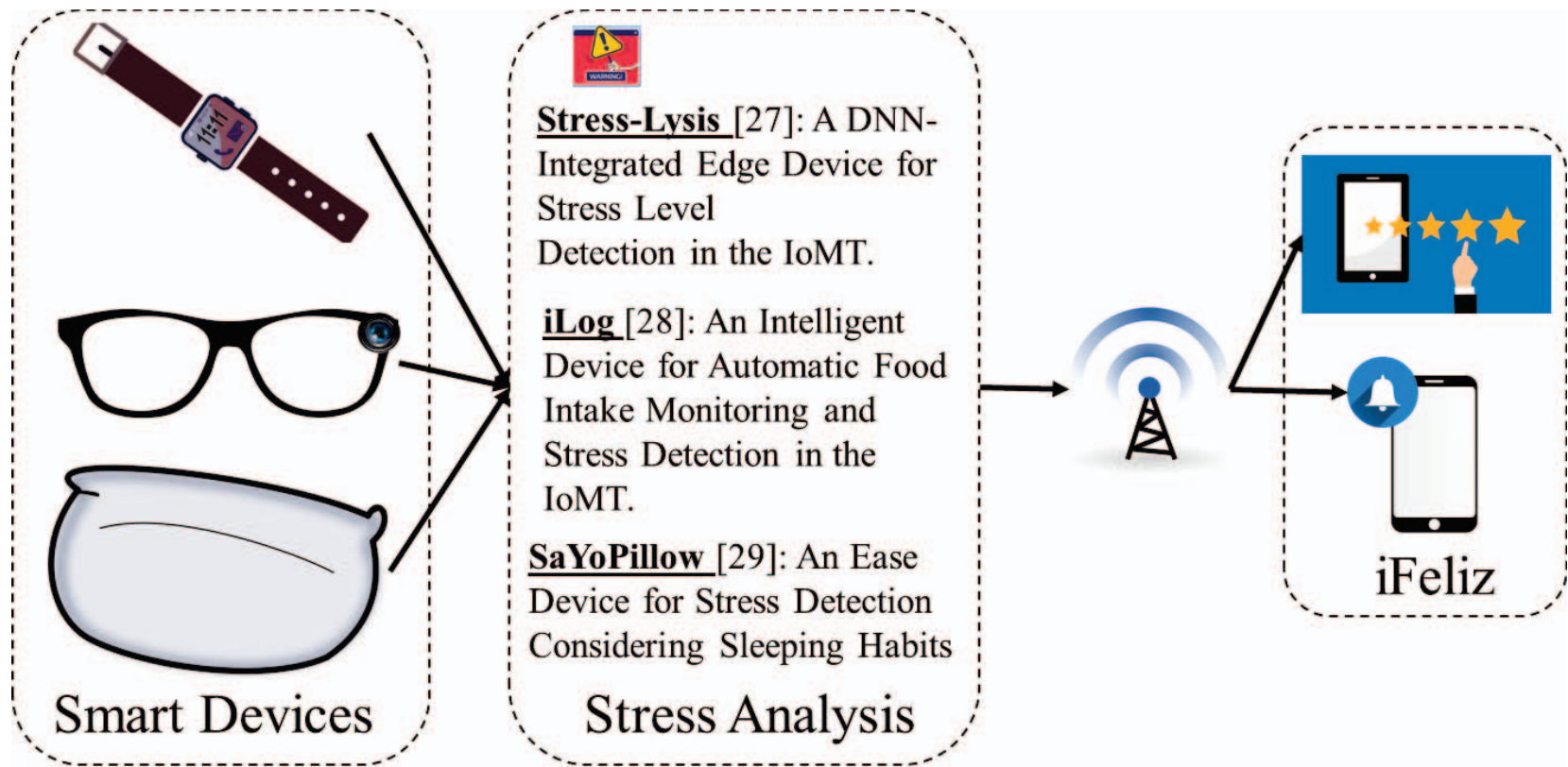
Research	Sensors Used	Action	Drawbacks
Anusha et al.	Electrodermal Activity (EDA)	Stress Monitoring	No Stress Control
Can et al.	Heart Rate, Skin Conductance, Accelerometer and Skin Temperature	Stress Monitoring	No Stress Control
Delmastro et al.	Physical Activity	Stress Detection	No Stress Control
Cheong et al.	Heart Rate and Temperature Sensors	Stress Detection	No Stress Control
Hao et al.	PPG and Accelerometer	Stress Detection	No Stress Control
iFeliz (Current Paper)	PSG, Food Images, Body Temperature, Accelerometer, Humidity	Stress Detection	Stress Control

Research Question:

How to have an accurate and rapid **Stress Monitoring and Control** system at the user end (at *IoT-Edge*) and store the data at the cloud end (at *IoT-Cloud*)?

PROPOSED NOVEL SOLUTION

Device Prototype of iFeliz



Issues Addressed in iFeliz

- Various emotional levels are considered for stress state analysis.
- Different remedies for different states of stress are defined.
- Short-term approaches for immediate stress state control are proposed which don't require any input from the user.
- Long-term approaches for detailed analysis of emotions experienced during the day are provided to the user.

Novel Contributions

- A mobile application interface completely dedicated to stress management with no user input.
- Provides an interface which uses real time location of the user to provide appropriate remedies.
- A potential extension of any product that gathers data from the user.
- Four different approach methods which can address immediate and analyzed stress.
- A protocol to analyze stress states and stress levels to suggest remedies and actions to control stress.
- Provides user access to the analyzed data.
- Allows users to understand the fluctuations of stress and get back control over their body.

BROAD PERSPECTIVE OF STRESS CONTROL IN iFELIZ

iFeliz using IoMT

- The broad idea behind iFeliz is to allow the users to understand the importance of stress.
- In order to understand the importance of stress, the user must know the way stress affects the human body.

WHY IS STRESS AN IMPORTANT FACTOR?

Why is Stress an Important Factor?

- Stress can be defined as a reaction of the human body to a situation.
- The common elements to stress are *Novelty* for something a person has never experienced before, *Unpredictability* of the situation that may occur, *Threat* to the ego when a person's competence is questioned and *Sense* of not having control over the situation.
- Under these situations, a stress hormone called cortisol is released in the human body.

Why is Stress an Important Factor?

- The circumstances which allow the secretion of cortisol are called stressors. There are four types of stressors:
 - Physiological Stressors - which put the strain physically on the body.
 - Psychological Stressors - which have an impact on the mental health of a person.
 - Absolute Stressors - Effect on humans because of natural calamities, such as 9/11 or COVID-19, and
 - Relative Stressors - Effect on specific humans because of work pressure, exam pressure, traffic, insomnia, etc.

HOW TO RECOGNIZE STRESS?

How to Recognize Stress?

- Stress is broadly categorized into distress, which is negative stress and eustress, a positive stress.
- Stress can be further classified in three different categories: acute stress, episodic acute stress and chronic stress.
- Acute stress is short-term while episodic acute stress is the repetition in the frequency of occurrence of acute stress.
- Chronic stress is the result of prolonged exposure to stressors.
- When a stressful situation occurs, the levels of stress hormones rises to meet the demands of the situation and fall once it is dealt with.

How to Recognize Stress?

With prolonged exposure to chronic stress, the human body experiences:

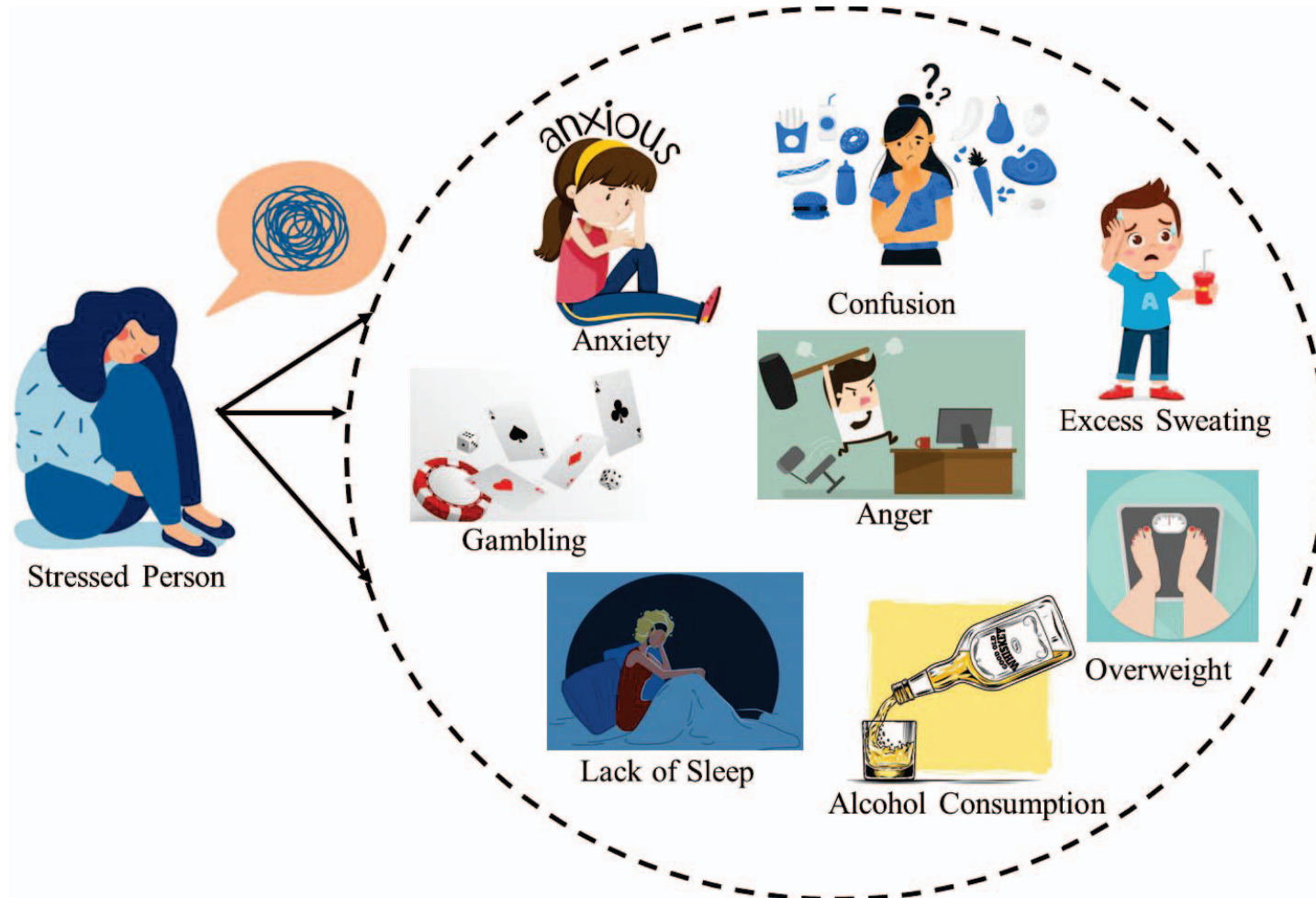
- The wear and tear of stress response - for being activated more than once in a small period.
- Habituation - where the human body is habituated to function under stress.
- Prolonged Response – the human body fails to go back to its base state.
- Inadequate Response – the human body loses its ability to respond to stress in the future.

How to Recognize Stress?

❖ Chronic stress is categorized in three different stages.

Stages	Effects on Human Body
Stage 1	Increase in Heart Rate, Breathing, Blood Sugar Levels, Blood Pressure Levels and Problems with Digestion.
Stage 2	Continuous Anxiousness and Worry, Overwhelming Feelings, Lack of Concentration, Increase of Alcohol Consumption, Uncontrollable Smoking, often Flu and Cold, Imagining the Worst of Everything and Memory Loss.
Stage 3	Heart diseases, Insomnia, Depression, Cancer and Burnout.

Symptoms of Stress



ARCHITECTURE FOR STRESS CONTROL IN iFELIZ

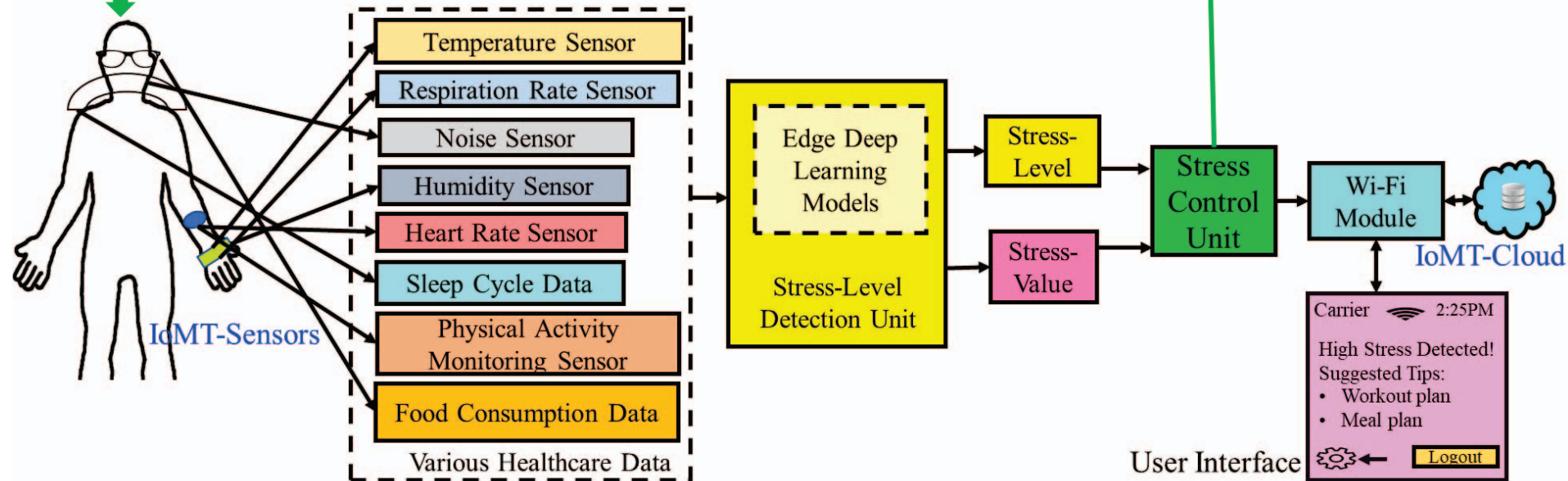
Architecture of iFeliz

- The architecture of iFeliz has all the physiological data that is collected by the various sensors, the sleep cycle data and the food consumption data for analyzing and monitoring stress level fluctuations.
- The raw physiological sensor data is fed to deep learning edge models where the data processing and analysis is performed.
- After the analysis, the stress level is characterized.
- This characterized data is sent to the user for visualization through a mobile application interface.
- The feedback through short-term and long-term advice is provided to the user through iFeliz.

Architecture of iFeliz

Generate workout plan, meal plan, sleep schedule, display stress relief paintings, play music in the background, suggest videos to play, quick 2 min breathe exercise, display positive and inspirational quotes, nearby therapy dog's location, automatic slide show of photos from gallery. **Long-Term Advice**

Physical exercise, yoga, meditation- heavy breathing, specific music, shower, Massage appointment, Nap, pet time. **Short-Term Advice**

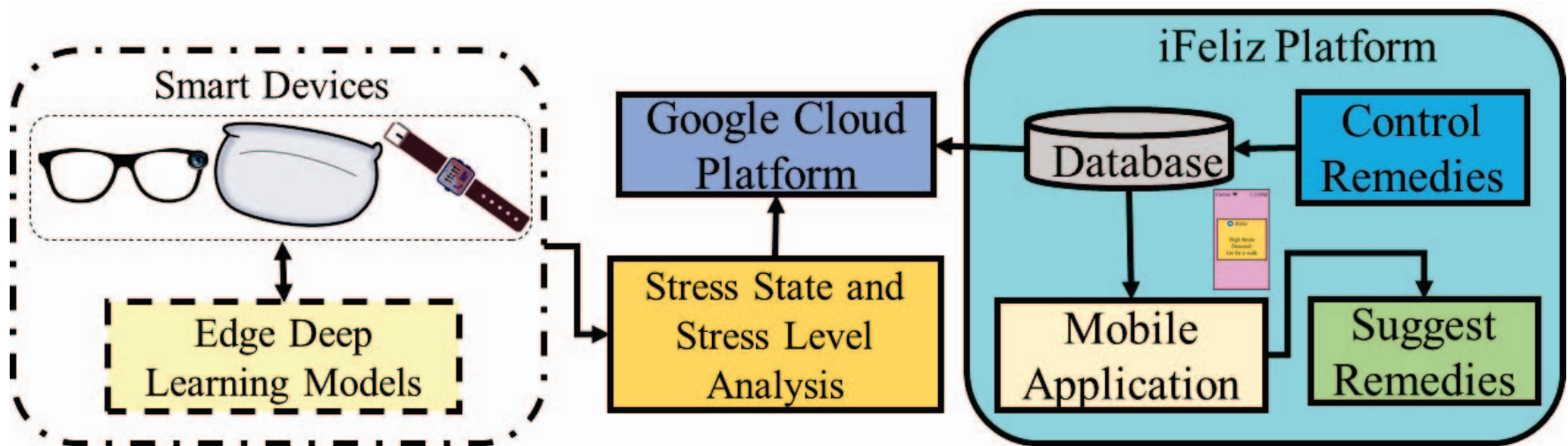


SYSTEM LEVEL MODELING FOR STRESS CONTROL IN iFELIZ

System Level Modeling in iFeliz

- The classified stress level data from the edge devices using deep learning models is sent to the cloud platform.
- From here, the database interconnected with the platform has the stress control remedies, both short-term and long-term.
- The control remedy data from the database are taken when required by the approaches.
- The suggested remedies are then displayed to the user through a mobile application.

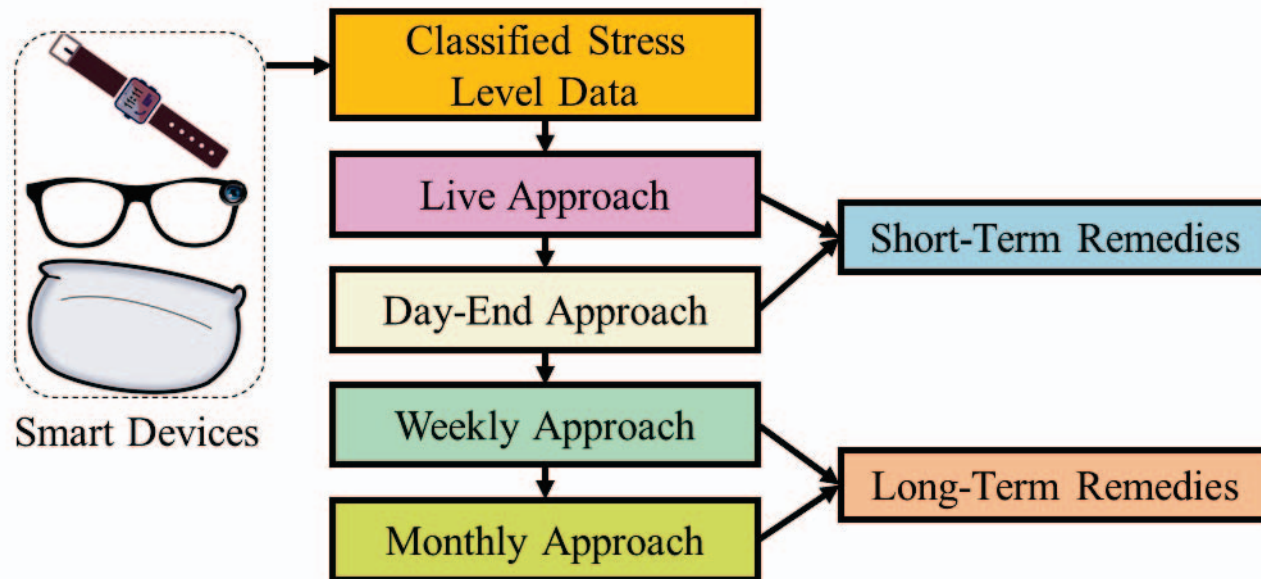
System Level Modeling in iFeliz



HOW TO CONTROL STRESS?

Approaches for Stress Control

- Incorporating self monitoring methods for stress in the IoMT provides a way to lay a strong foundation for developing a smart city.
- iFeliz proposes:
 - Short- Term Remedies and
 - Long - Term Remedies



Short-Term Approaches

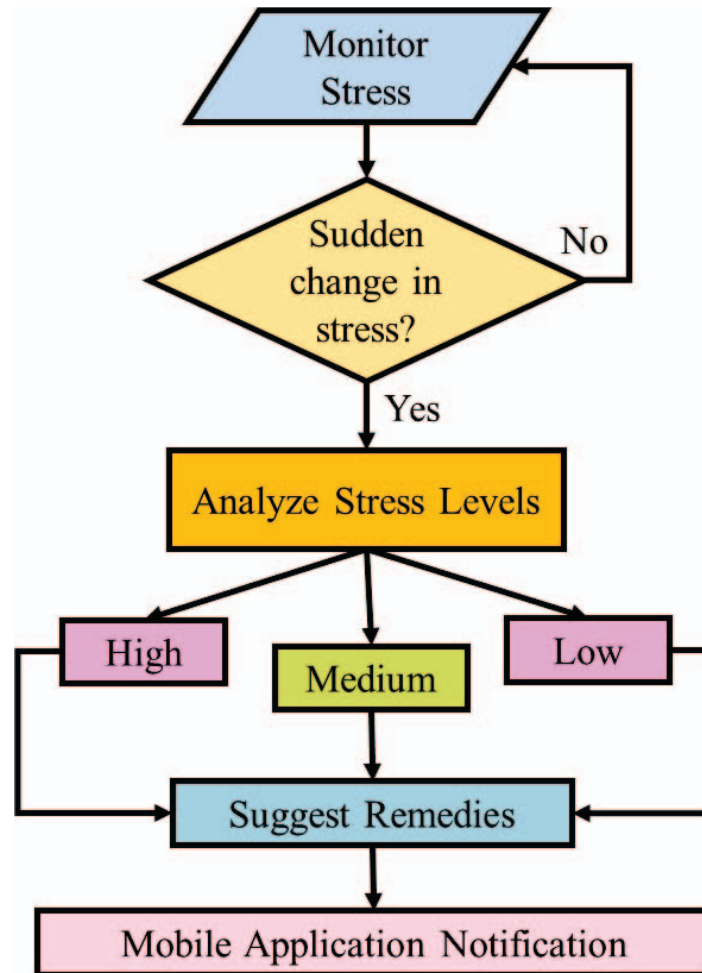
1. Live approach

- The on the spot approach is proposed which will automatically provide control remedies according to the stress state of the person.
- This is used to reduce additional inputs from the user.
- The remedies are provided in the notification panel freeing the user from location constraints.

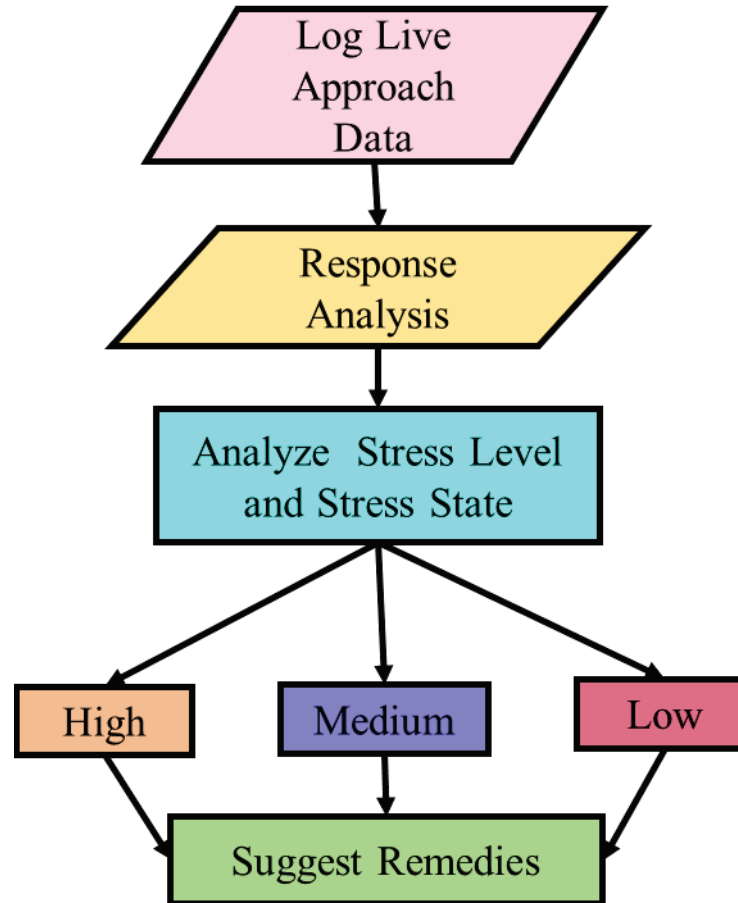
2. Day-End approach

- This approach has the detailed analysis of the emotions that are experienced by the user.
- As per the stress levels monitored by the live approach, the stress count of the user is provided along with the stress state remedies.

Live Approach



Day-End Approach



Short-Term Remedies

Low Stress (Alarm Reaction)	Medium Stress (Resistance)	High Stress (Exhaustion)
1 min meditation	3 min meditation	15 min meditation
1 min heavy breathing	3 min heavy breathing	15 min heavy breathing
30 sec smile	1 min smile	10 heavy laughter's
Scroll through photos	Read motivational quotes	Watch funny videos
-	Read a book	Write how you feel

Long-Term Approaches

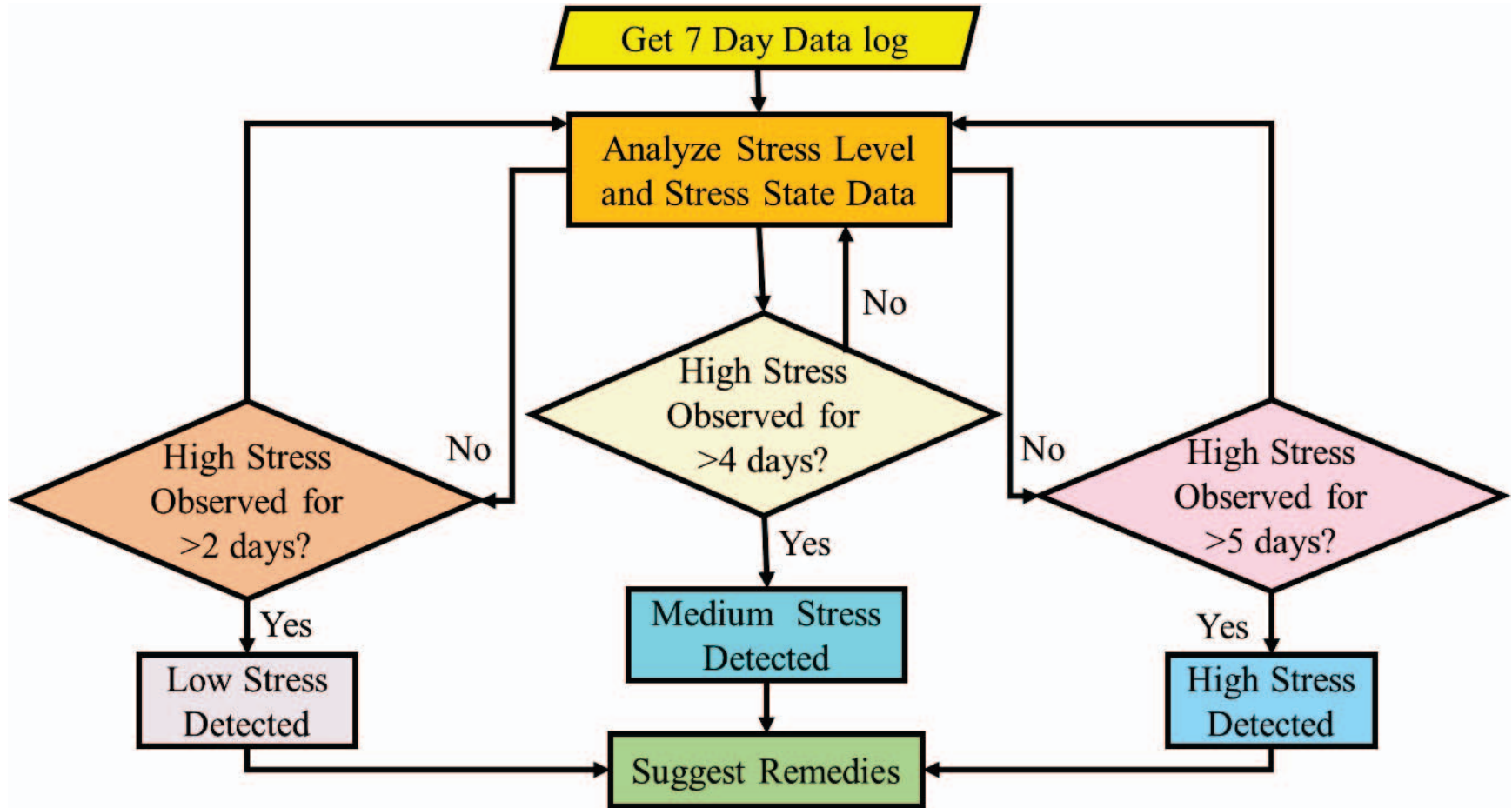
1. Weekly approach

- The on the spot approach is proposed which will automatically provide control remedies according to the stress state of the person.
- This is used to reduce additional inputs from the user.
- The remedies are provided in the notification panel freeing the user from location constraints.

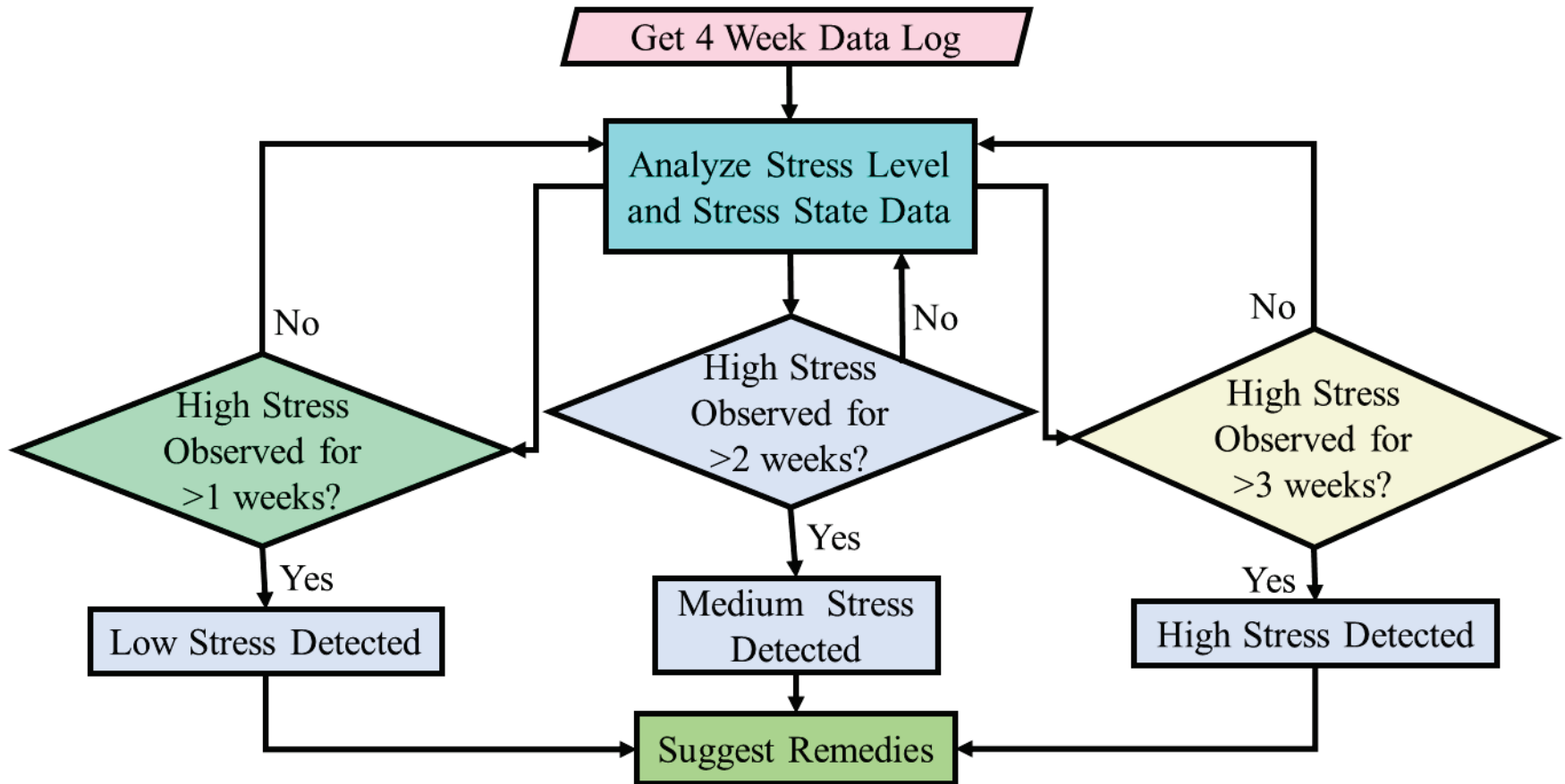
2. Monthly approach

- This approach has the detailed analysis of the emotions that are experienced by the user.
- As per the rate of feedback, the stress count of the user is provided along with the stress state remedies.

Weekly Approach



Monthly Approach



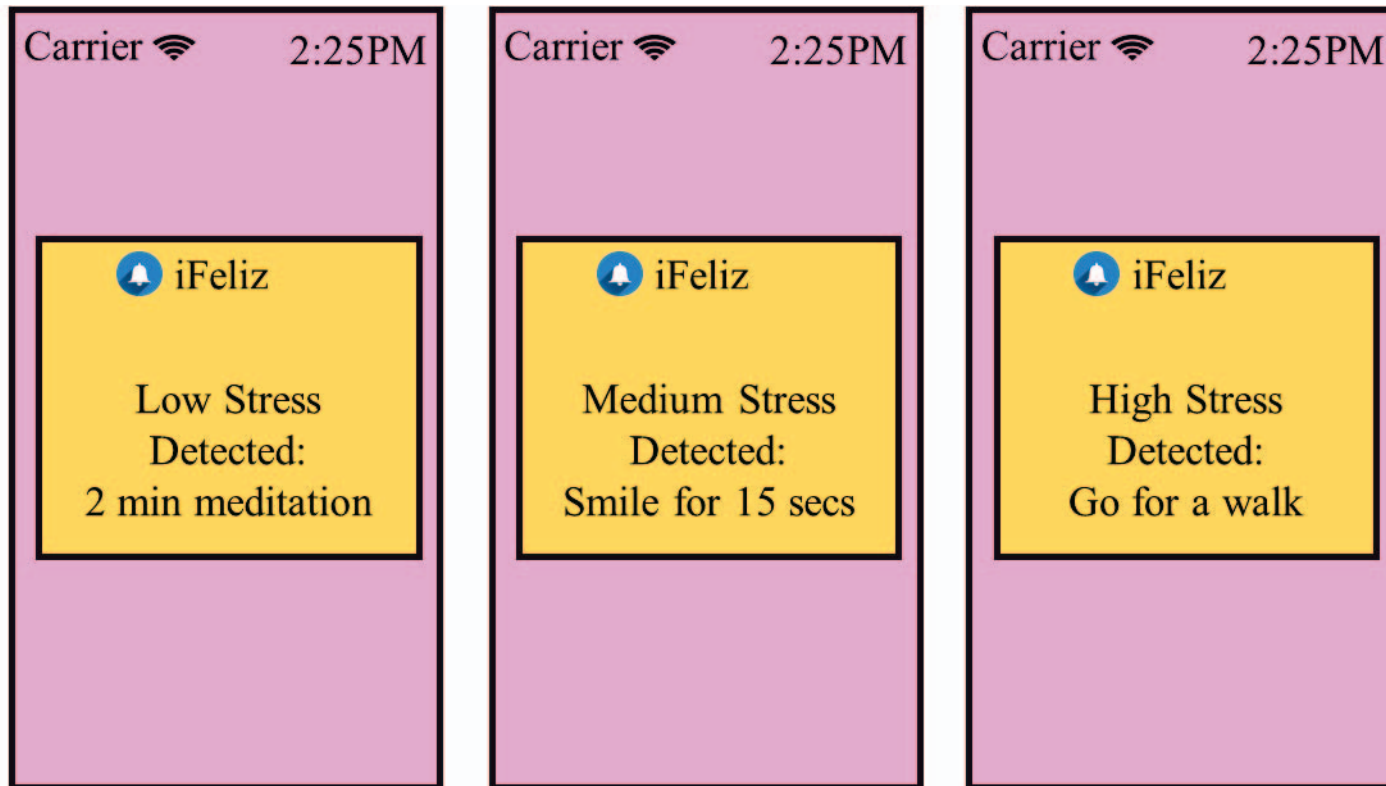
Long-Term Remedies

Low Stress (Alarm Reaction)	Medium Stress (Resistance)	High Stress (Exhaustion)
15 min meditation	Glance paintings	Customized Workout
15 min heavy breathing	Take a walk	Customized meal plan
1 min smile	10 min Laughter	Therapy dog's location
Scroll through photos	Take a nap	Listen to music
Do yoga	Have a run	Customize sleep plan
Listen to songs	Sing songs at least 2	Attend a Karaoke
Take a hot bath	Swim at least for 20 mins	Customized swimming sessions
Practice Painting	Paint using watercolors	Attend Painting Sessions

IMPLEMENTATION OF iFELIZ

-
- The data from the smart stress detection devices are taken. The data is analyzed by various methodologies.
 - The analyzed data is then categorized to stress state and stress level.
 - The control mechanisms of the stress, both long-term and short-term, are provided by the application interface.
 - A mobile application platform, flutter by google, is used to develop an interface.
 - The notification bar plays a significant role in the mobile application development.

Live Approach View:



Day-End Approach View:

Carrier 2:25PM

iFeliz

Username:
Sarah

Password:

Gender:
Female
Male

Logout

Carrier 2:25PM

Log

Welcome Sarah!

Create a New Log
MM/DD/YYYY

Previous log

04/06/2020	04/09/2020
04/07/2020	04/10/2020
04/08/2020	04/11/2020

Weekly Log →
Monthly Log →

Logout →

Carrier 2:25PM

04/12/2020

Provide your level of emotion from 0 to 10; 0 being Low and 10 being High.

Emotion:	#:
Anger	7
Tired	4
Anxiety	5
Fear	6

Stress Value: 5.5

Submit

Carrier 2:25PM

04/12/2020

Welcome to iFeliz!

Medium Stress Detected!
Suggested Tips:

- Stretching usually helps
- Move around more, staying stationary can hurt you.
- Talk to someone you love about what's on your mind.
- Take a walk or jog around the neighborhood.

Logout

Weekly Approach View:

Carrier 2:25PM

iFeliz

Username:
Sarah

Password:

Gender:
Female
Male

Logout

Carrier 2:25PM

Log

Welcome Sarah!

Create a New Log

MM/DD/YYYY

Previous log

04/06/2020	04/09/2020
04/07/2020	04/10/2020
04/08/2020	04/11/2020

Weekly Log →

Monthly Log →

Logout →

Carrier 2:25PM

Weekly Log

04/13/2020

04/06/2020

03/30/2020

03/23/2020

Analyze Weekly Stress →

Submit

Carrier 2:25PM

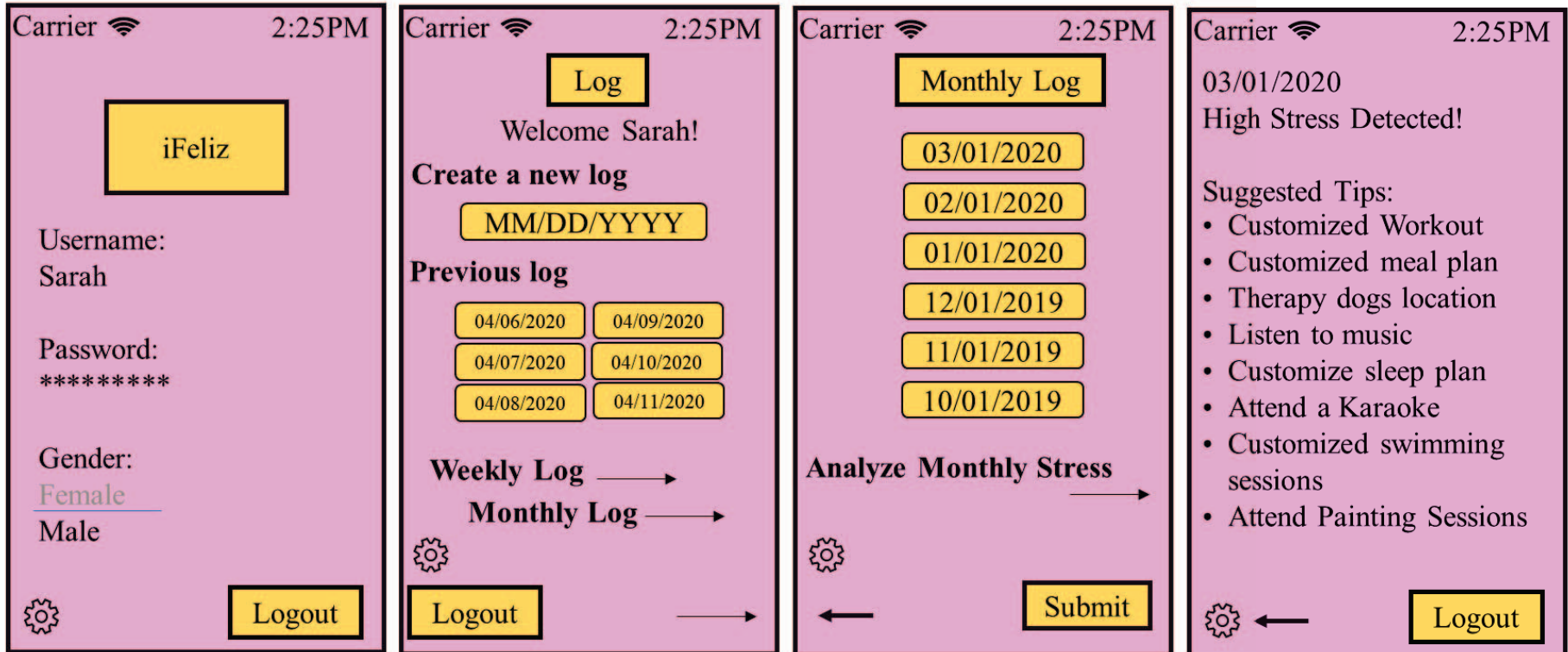
4/13/2020
Medium Stress Detected!

Suggested Tips:

- Glance paintings
- Take a walk
- 10 min Laughter
- Take a nap
- Have a run
- Sing songs at least 2
- Swim at least for 20 mins
- Paint using water colors

Logout

Monthly Approach View:



CONCLUSION

Comparison Of iFeliz

Research	Sensors	Features	Stress Detection	Stress Levels	Stress Control	Accuracy %
Anusha, et al.	Electrodermal Activity (EDA)	57	Yes	3	No	85.06
Can, et al.	Heart Rate, Skin Conductance, Accelerometer and Skin Temperature	NA	Yes	3	No	94.52
Delmastro, et al.	Physical Activity	21	Yes	2	No	85
Cheong, et al.	Heart Rate and Temperature Sensors	NA	Yes	NA	No	NA
Hao, et al.	PPG and Accelerometer	NA	Yes	3	No	81.8
Rachakonda, et al.	Image Data	4	Yes	2	Partially Yes	98
Rachakonda, et al.	Body Temperature, Steps taken and Humidity	3	Yes	3	Partially Yes	98.3
Rachakonda, et al.	Polysomnography, Sleep Duration and Snoring Range	8	Yes	5	Partially Yes	96
iFeliz (Current Paper)	PSG, Snoring Range, Sleep Duration, Images, Body Temperature, Steps taken and Humidity	15	Yes	3	Yes	97

Conclusions

- Stress analysis and control mechanisms are provided for short-term and long-term intervals.
- Depending on the stress state variation and the term of exposure of stress, stress is categorized in to low, medium and high levels.
- Depending on the respective state of stress, remedies are provided.
- The ability to incorporate the stress control remedies to any smart stress detection and analysis wearables or devices is provided.

FUTURE RESEARCH

- Introduce **security** in order to provide a secure backbone for the smart healthcare industries.
- Incorporate more **stressors** for stress detection such as **facial expression changes, posts in social media, fluctuations in emotional state** of a person etc.,.
- Add more **feasible** and **variety** of short-term and long-term stress **control** mechanisms which can be followed by any stressed individual with no **limitation of location**.
- Increasing the **scope** of the application from smart cities to **personalized user applications** is one of our plans to investigate in the future.
- Creating **personalized meal plans, workout plans, conducting virtual therapy sessions with the use of artificial intelligence, analyzing each situation of a person and informing** the user about the chances of potential **health hazards** is the main objective of our ongoing research on this technical domain.

Questions?

Thank You!