
A Smart Sensor in the IoMT for Stress Level Detection

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Outline of the Talk

- ❖ Introduction
- ❖ Motivation
- ❖ Novel Contributions
- ❖ The Proposed Novel iStress System For IoMT
- ❖ Flow of iStress Model
- ❖ CE implementation and Validation
- ❖ Conclusions and Future Research

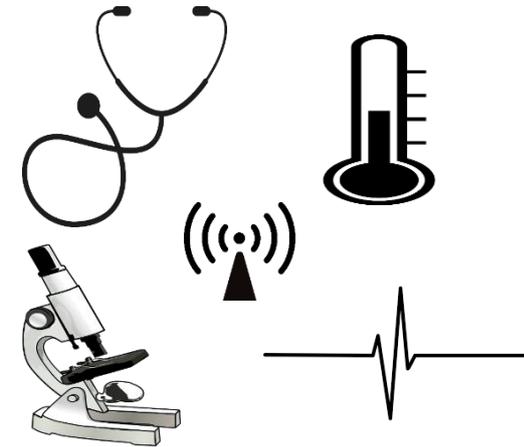
Introduction

✓ Internet of Things



- The Internet of Things is a network of devices where **each device in the network is recognizable** and connected.

✓ Internet of Medical Things



- The Internet of Medical Things is a network of medical devices where **each device in the network is recognizable** and connected.

Introduction

✓ Applications of IoT and IoMT



Posture Recognition



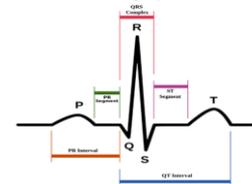
Decision Making



Smart Supply Chain



ECG Monitoring System



Connected Health



Research Motivation

✓ Why is Stress an important factor to consider?

When there is an encounter with sudden **stress**, your brain floods your **body** with chemicals and hormones such as adrenaline and cortisol.

- ❖ Lack of Energy
- ❖ Type 2 Diabetes
- ❖ Osteoporosis
- ❖ Mental cloudiness (brain fog) and memory problems
- ❖ A weakened immune system, leading to more vulnerable to infections



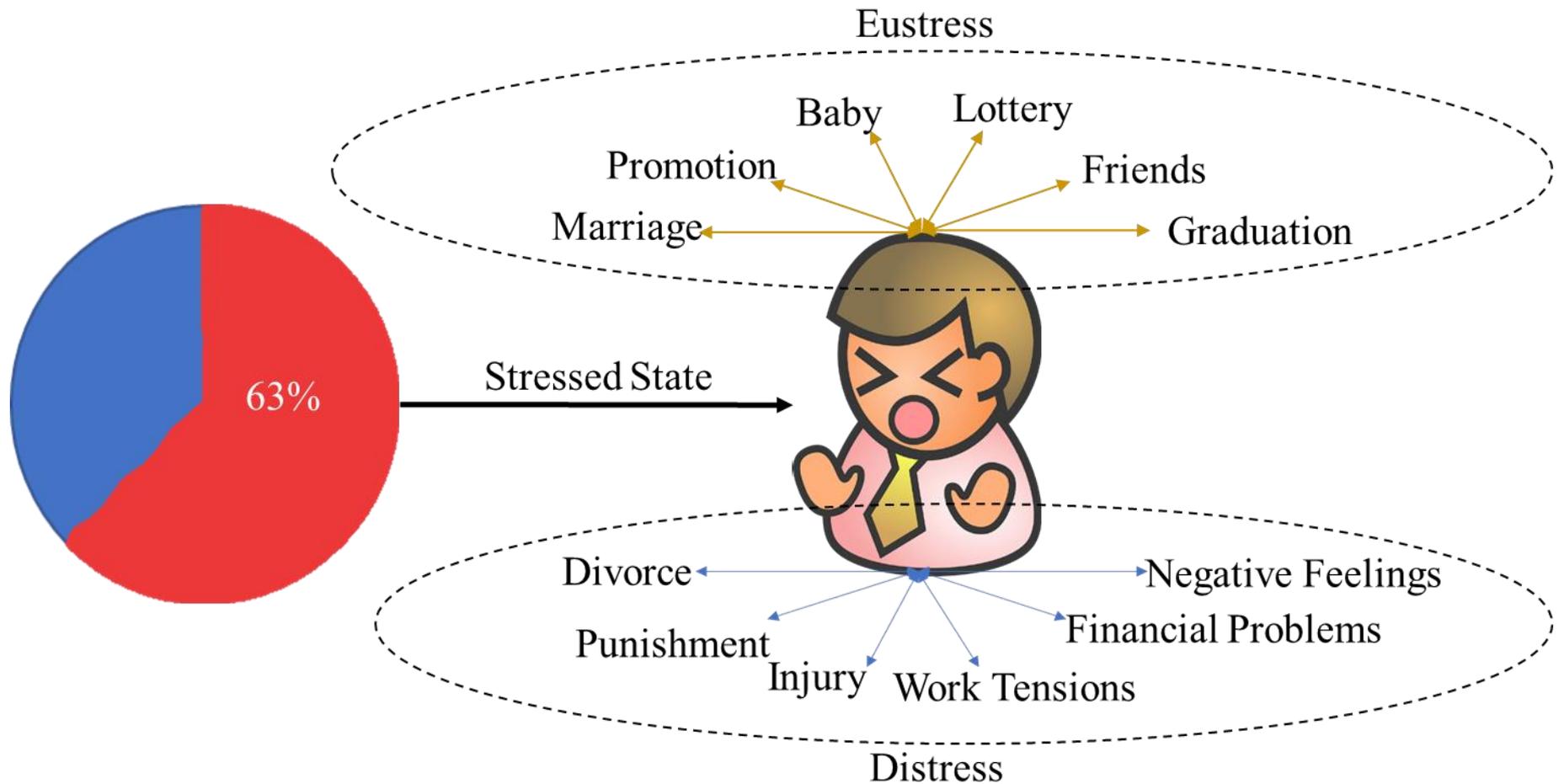
Distress



Eustress

Stress is the **body's reaction** to any change that requires an adjustment or response.

Stressors of Stress



Symptoms of Stress

Sweating



Fatigue



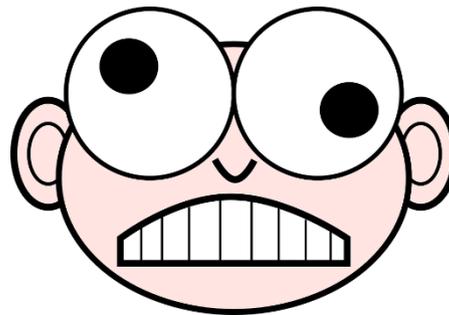
Weight Gain



Difficulty Concentrating



Chest Pain



Gambling



Confusion



Anger



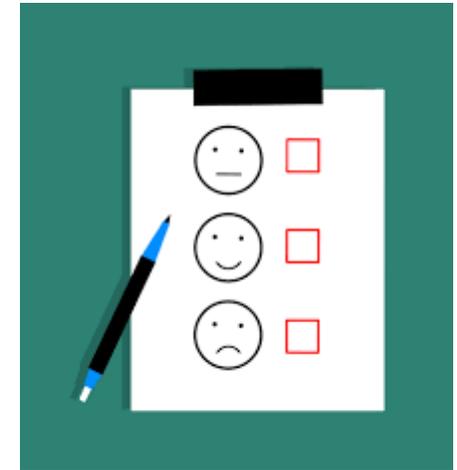
Anxiety



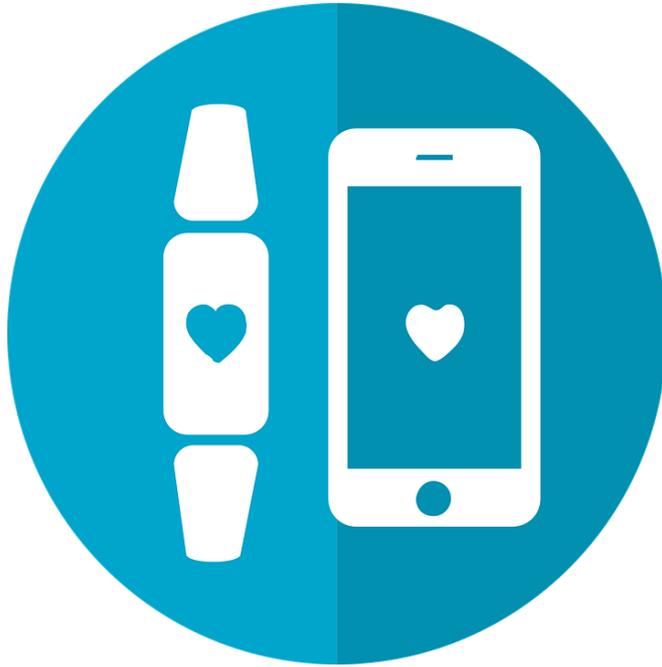
Alcohol



How to Monitor Stress?



Existing Products



Muse-EEG



Related Research

Research	Method	Stressors
Osman et al [17]	Biological Sensors	Group of games
Sano et al [18]	Wearables	Mobile usage
Chatterjee et al [19]	Computer Vision Techniques	Respiration rate
El et al [20]	Biological Sensors	Linguistic Outputs
Wijsman et al [21]	Wearables	Respiration, skin conductance
Choi et al [22]	Biological Sensors	Heart Rate Variability

Issues of Existing Solutions

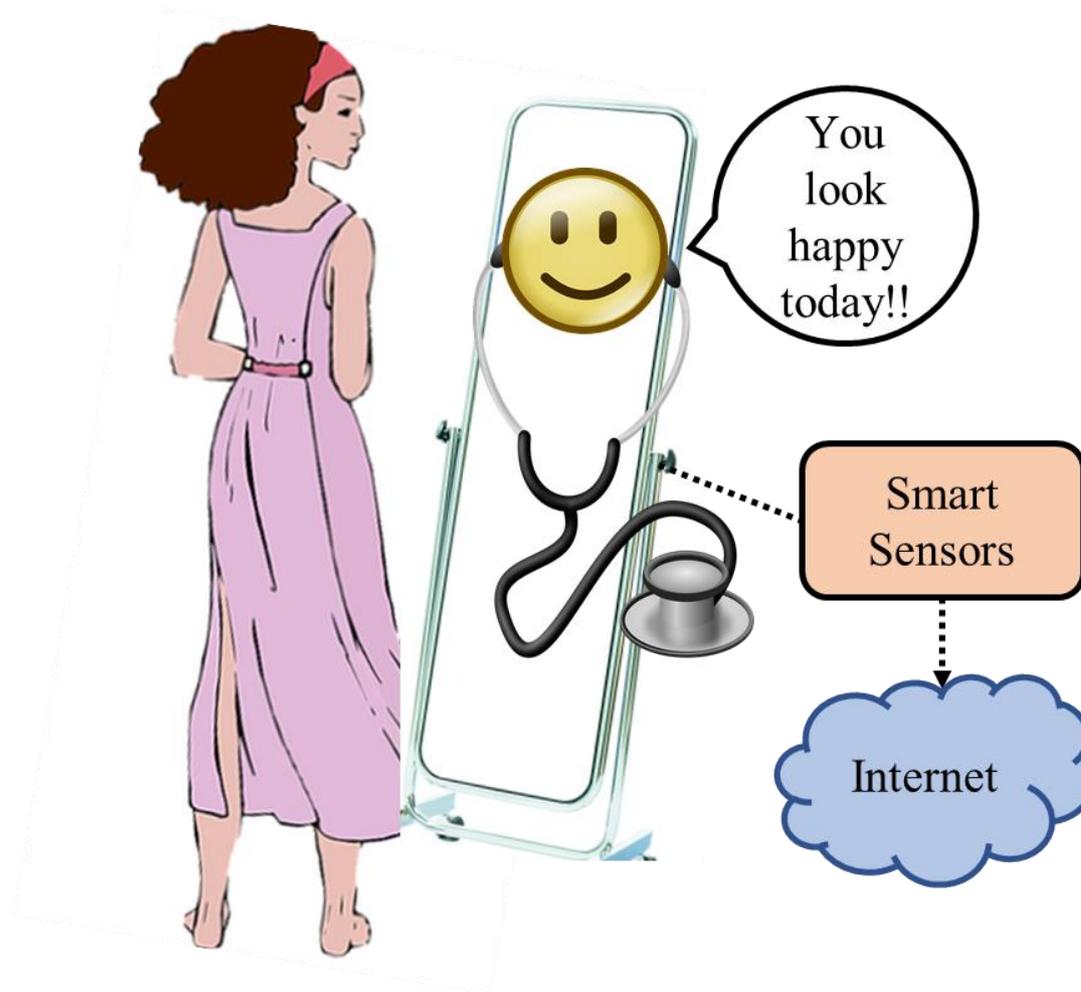
- ❖ Lack of **Detection Accuracy** of Stress Level.
- ❖ Lack of **having multiple stressors** for effective stress level analysis.
- ❖ No **Unified detection** of the problem.
- ❖ Fully **automated** features.
- ❖ Fully **utilization of technology** which can be a part of the product.
- ❖ Storage availability of the detected parameters for **future usage**.
- ❖ **Self-Aware** systems.

The Research Question Addressed in this Paper

- How to have an **accurate and rapid** Stress Level Detection system that *acquires and models sensor data, and detects stress level* at the user end (at *IoT-Edge*) and stores the data at the cloud end (at *IoT-Cloud*)?

Proposed Solution- iStress

✓ Conceptual Overview of the iStress System.



Novel Contributions

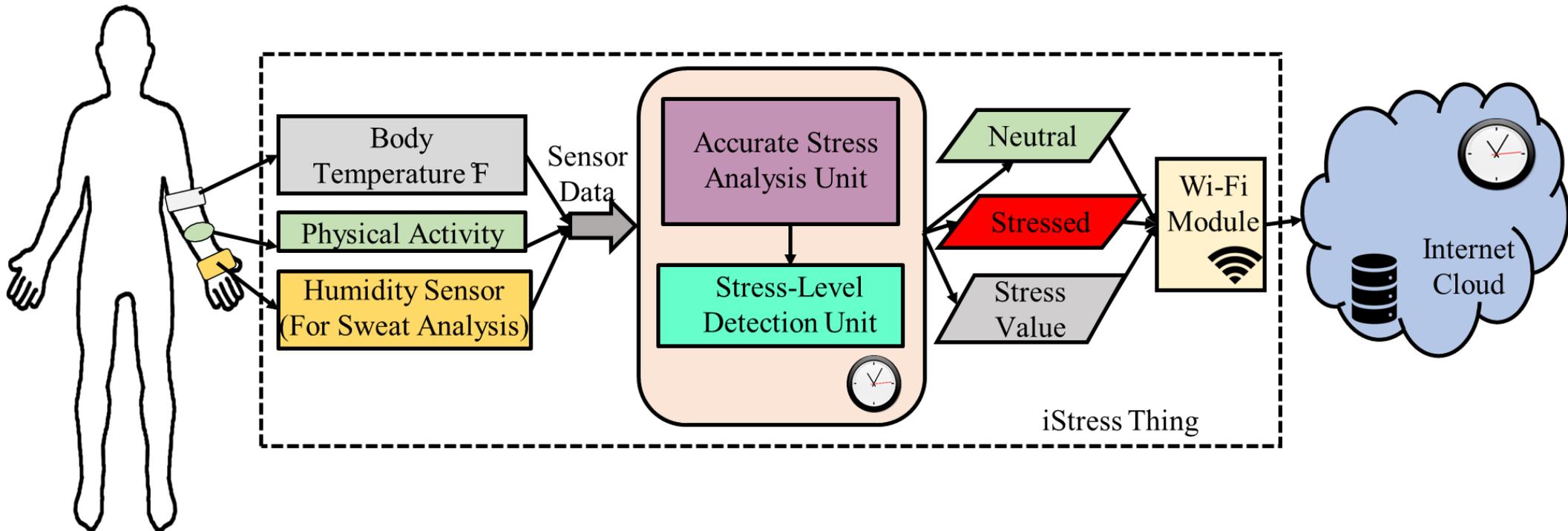
- ❖ Stressor – Physical Activity.
- ❖ A novel sensor that uniquely quantifies the body temperature, rate of motion, and body sweat accurately and quickly to detect stress level is presented.
- ❖ A novel IoMT-enabled system for stress analysis at the edge and not at the cloud is proposed, thus advancing the state-of-the-art in the IoMT.

Issues Addressed in this Research

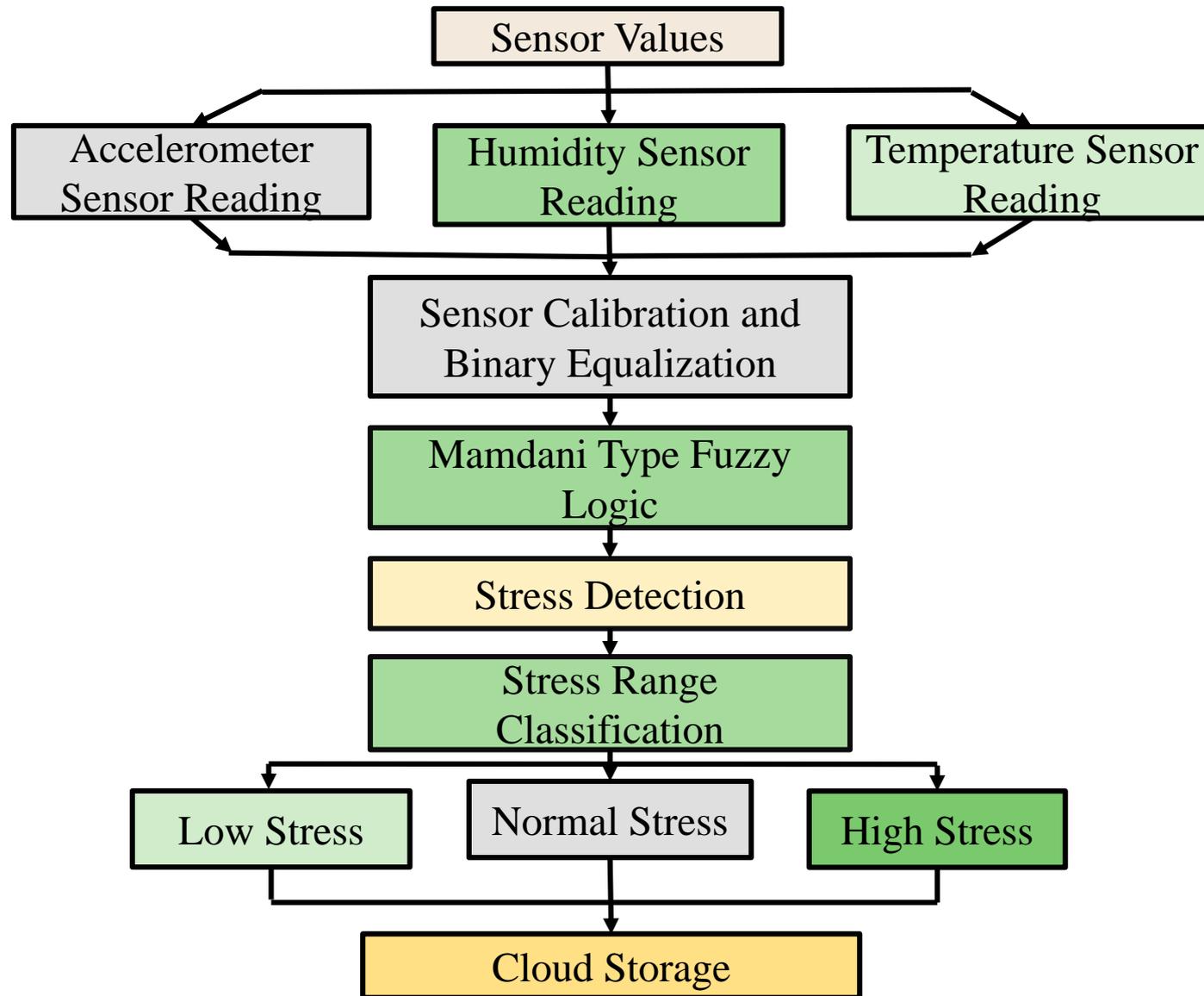
- ❖ Advancement through this paper in [Electronics](#).
- ❖ Significant Improvement in the [Accuracy](#) of Stress Level Detected
- ❖ Considered [Multiple Stressors](#) for the detection.
- ❖ Provided [cloud storage access](#) for future purposes.
- ❖ Proposed a [self-aware system](#) which is intelligent enough to detect the stress levels.
- ❖ An [edge level system](#) is presented with which the performance, accuracy and stabilization of the system can be maintained.

The Proposed Novel iStress System

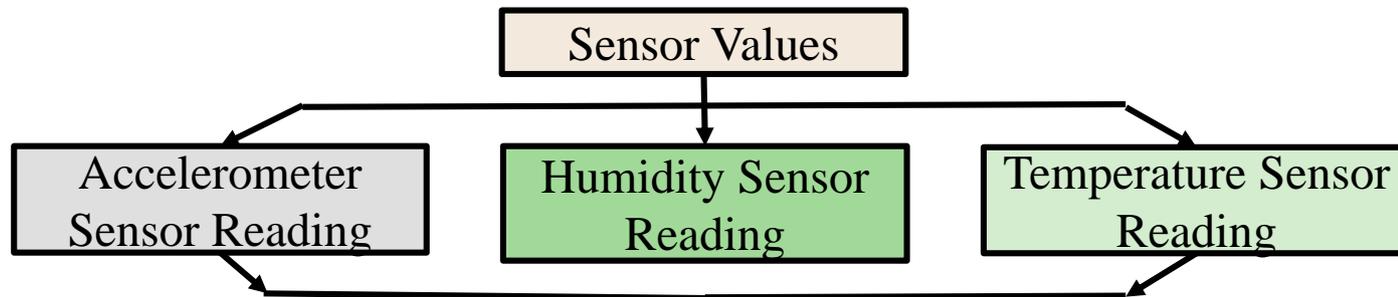
✓ Proposed Architecture of the iStress System.



The Proposed Novel iStress Flow



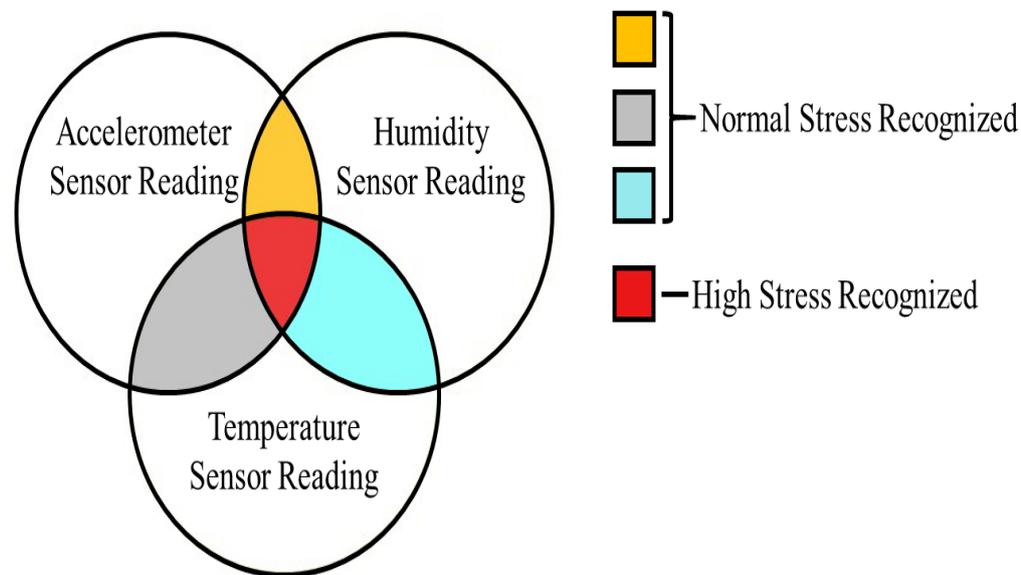
Flow of the iStress Model



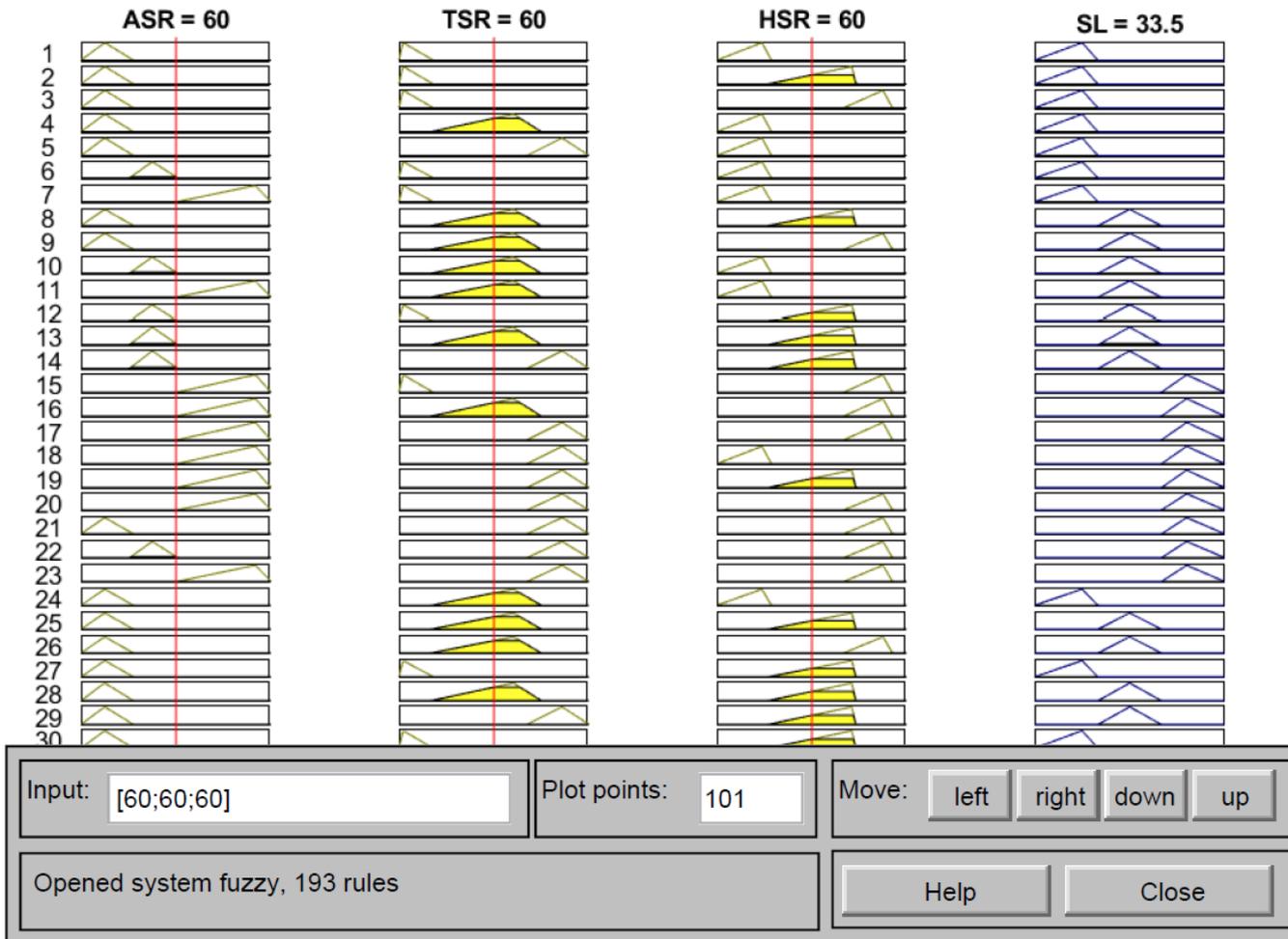
- ❖ The general step rate of a person in a strenuous physical workout is high if it is greater than **100 steps per minute**.
- ❖ When a person is not stressed and is in normal condition the proposed accelerometer sensor value is **reduced to 50 steps per minute**.
- ❖ The lower the temperature of the human body, the palm portion of the hands becomes cold. **Colder palms** are a symptom of a person under stress.

Sensor Calibration

Sensor	Low Stress	Normal Stress	High Stress
Accelerometer (steps/min)	0-75	75-100	101-200
Humidity (RH%)	27-65	66-91	91-120
Temperature °F	98-100	90-97	80-90

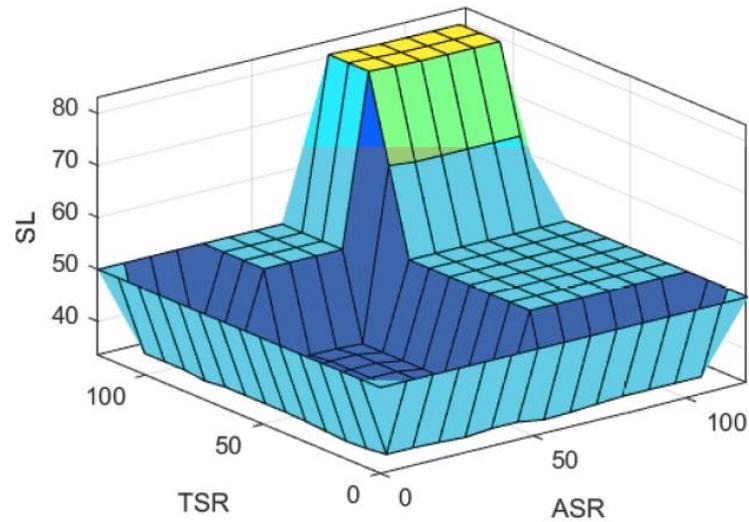


Grid Partitioned View of Rules



- ❖ The system is trained by a set of 150 rules
- ❖ ASR- Accelerometer Sensor Reading
- ❖ TSR- Temperature Sensor Reading
- ❖ HSR- Heart Rate Sensor Reading
- ❖ SL- Stress Level

Surface Plot of iStress



X (input):	ASR	Y (input):	TSR	Z (output):	SL	Evaluate
X grids:	15	Y grids:	15			
Ref. Input:	[60 60 60]	Plot points:	101	Help	Close	
Ready						

Stress Detection in iStress

COM3 (Arduino/Genuino 101)

Stress is High >60%-100%
Humidity: 97.22953 Temperature: 32.433 Accelerometer: 101

Stress is High >60%-100%
Humidity: 97.16853 Temperature: 32.373 Accelerometer: 109

Stress is High >60%-100%
Humidity: 97.13803 Temperature: 32.393 Accelerometer: 119

High Stress Detection

COM3 (Arduino/Genuino 101)

Stress is Normal >30%-<60%
Humidity: 92.93203 Temperature: 32.122 Accelerometer: 88

Stress is Normal >30%-<60%
Humidity: 90.94203 Temperature: 32.002 Accelerometer: 98

Stress is Normal >30%-<60%
Humidity: 89.98903 Temperature: 28.172 Accelerometer: 120

Medium Stress Detection

COM3 (Arduino/Genuino 101)

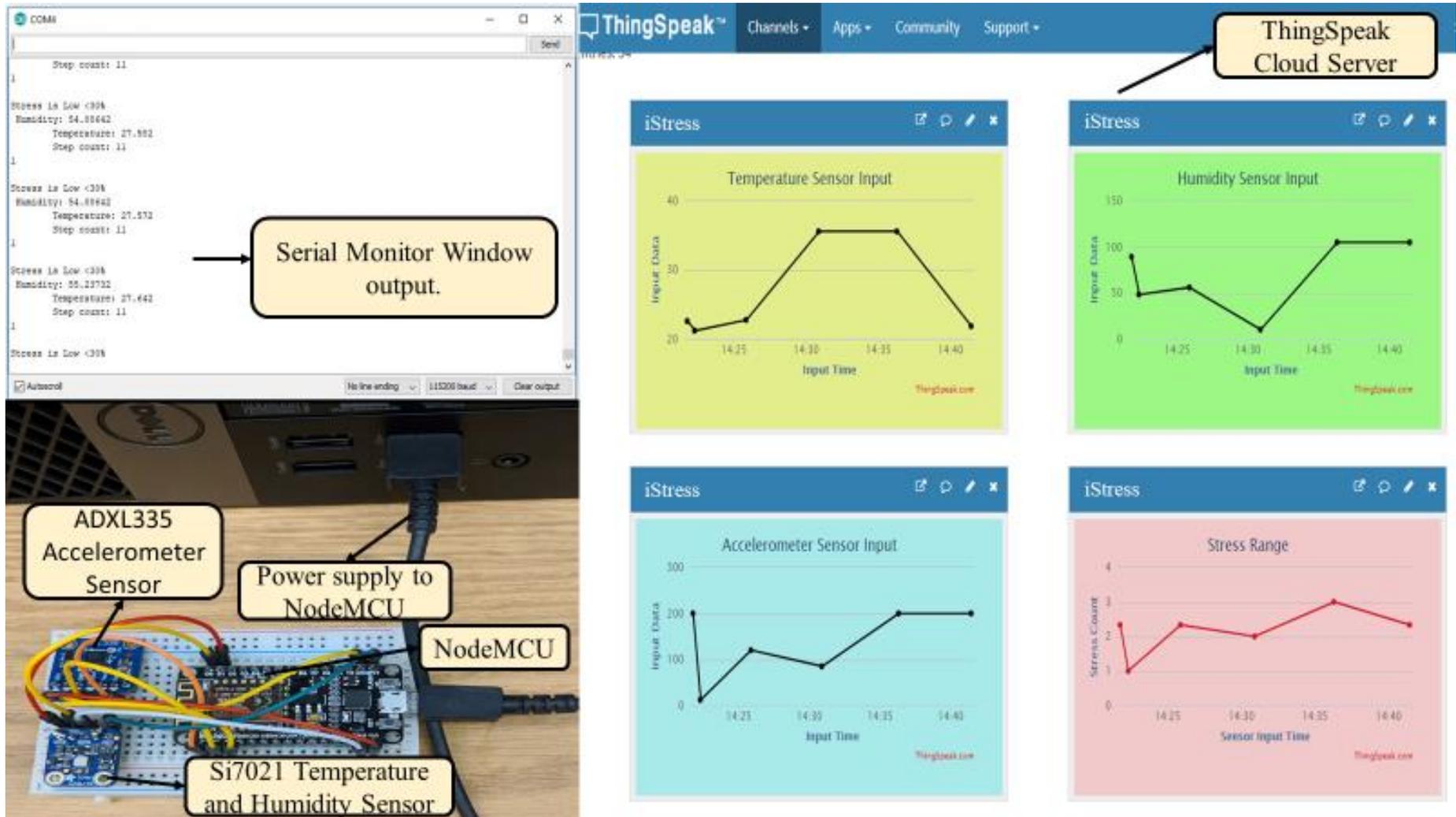
Stress is Low <30%
Humidity: 36.25541 Temperature: 25.452 Accelerometer: 25

Stress is Low <30%
Humidity: 44.21731 Temperature: 28.842 Accelerometer: 67

Stress is Low <30%
Humidity: 78.98903 Temperature: 32.172 Accelerometer: 120

Low Stress Detection

The Overall IoT-Enabled System



Comparison With Existing Research

Research	Stressors	Sensors/Things	Accuracy %	Cost	Energy Consumed	System complexity
Plarre, et al. [27]	Public Speaking, Maths	ECG, GSR	90.2	High	Moderate	Complex
Zhai, et al. [29]	Stroop Color Test	Pupil Diameter, Skin Temperature, GSR,	90.1	High	Moderate	Complex
Begum, et al. [30]	Verbal, Math	Finger Temperature	80	Moderate	Moderate	Moderate
This Paper	Physical Activity	Temperature Sensor, Humidity Sensor, Accelerometer Sensor	97	Moderate	Low	Low

Conclusion and Future Research

- The detected stress value is classified to three levels: low, normal and high.
- This method helps in improving and controlling the overall stress levels of a person.
- Implementation of the system incorporating deep learning concepts are suggestions for future research.

Thank You !!!