A FINAL YEAR PROJECT REPORT

on

Human Stress Detection

Submitted in partial fulfillment of
the requirements for the award of the degree of

Bachelor of Technology
in
Information Technology

Submitted by

Ravindra Rajendra Yadav (1930331246041)
Suyash Sudarshan Shinde (1930331246007)
Rushikesh Namdeo Waghule (1930331246045)
Janavi Vasant Bangare (1930331246001)

Under the guidance of
Prof. S. R. Hivre

Department of Information Technology
Dr. Babasaheb Ambedkar Technological University,
Lonere-402103, Dist. Raigad, (MS) INDIA.

27 June 2023

DECLARATION

We hereby declare that the project report "Human Stress Detection", submitted for partial fulfillment of the requirements for the award of degree of B. Tech. of the Dr. Babasaheb Ambedkar Technological University, Lonere is a bonafide work done by us under supervision of Prof. S. R. Hivre. This submission represents our ideas in our own words and where ideas or words of others have been included, we have adequately and accurately cited and referenced the original sources. we also declare that we have adhered to ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in our submission. we understand that any violation of the above will be a cause for disciplinary action by the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously formed the basis for the award of any degree, diploma or similar title of any other University.

Place:
Date:

Ravindra Rajendra Yadav (1930331246041)
Suyash Sudarshan Shinde (1930331246007)
Rushikesh Namdeo Waghule (1930331246045)
Janavi Vasant Bangare (1930331246001)

CERTIFICATE

This is to certify that the report entitled **"Human Stress Detection"** submitted by **Ravindra Rajendra Yadav (1930331246041), Suyash Sudarshan Shinde (1930331246007), Rushikesh Namdeo Waghule (1930331246045), Janavi Vasant Bangare (1930331246001)** is approved for the partial fulfillment of the requirements for the degree of ***B.Tech.in Information Techonolgy*** of Dr.Babasaheb Ambedkar Technological University, Lonere - 402 103, Raigad (MS).

Prof. S. R. Hivre (Guide)	Dr. Sanjay S. Sutar (Head of Department)

Examiner (s)

1. _____

2. _____

Place: Dr. Babasaheb Ambedkar Technological University, Lonere - 402 103.
Date:

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Ravindra Rajendra Yadav (1930331246041)
Suyash Sudarshan Shinde (1930331246007)
Rushikesh Namdeo Waghule (1930331246045)
Janavi Vasant Bangare (1930331246001)

ABSTRACT

The problem of stress detection and classification has attracted a lot of attention in the past decade. It has been tackled with mainly two different approaches, where signals were either collected in ambulatory settings, which can be limited to the period of presence in the hospital, or in continuous mode in the field.
A sensor-based continuous measurement of stress in daily life has a potential to increase awareness of patterns of stress occurrence. In this work, we first present a data-flow infrastructure suitable for two types of studies that conforms with the data protection requirements of the ethics committee monitoring the research on humans. The detection and binary classification of stress events is compared with three different machine learning models based on the features (meta-data) extracted from physiological signals acquired in laboratory conditions and ground-truth stress level information provided by the subjects themselves via questionnaires associated with these features. The main signals considered in current classification are electro-dermal activity (EDA) and Galvanic Skin Response (GSR) signals.
The importance on prediction of phasic and tonic EDA components is also investigated. Our results also pave the way for further work on this topic with both machine learning approaches and signal processing directions.

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Chapter 1

Indroduction

Stress detector classifies a stressed individual from a normal one by acquiring his/her physiological signals through appropriate sensors such as Electrocardiogram (ECG), Galvanic Skin Response (GSR) etc,. These signals are pre-processed to extract the desired features which depicts the stress level in working individuals. Decision Tree Classifier algorithm is investigated to classify these extracted feature set. The result indicates feature vector with best features having a strong influence in stress identification. An attempt is made to determine the best feature set that results in maximum classification accuracy.
Stress management systems play a significant role to detect the stress levels which disrupts our socio economic lifestyle. As World Health Organization (WHO) says, Stress is a mental health problem affecting the life of one in four citizens.
Human stress leads to mental as well as socio-fiscal problems, lack of clarity in work, poor working relationship, depression and finally commitment of suicide in severe cases. This demands counselling to be provided for the stressed individuals cope up against stress. Stress avoidance is impossible but preventive actions helps to overcome the stress.
Currently, only medical and physiological experts can determine whether one is under depressed state (stressed) or not. One of the traditional method to detect stress is based on questionnaire.

1.1 System Overview

1.1.1 Problem Statement

Stress has been a significant issue of the general public. Near 82% Indians are experiencing weight by virtue of work, wellbeing and money related concerns, a worldwide prosperity study (2019) directed by medical care major Cigna Corporation has found. Distressing occasions, for example, family and relationship clashes, lawful issues and employment cutback frequently go before self-destructive way of behaving. Endeavors have been made for a really long time by the analysts to identify pressure utilizing different techniques so the pace of suicides and sorrow can diminish.
It was seen that general media information was not considered for the pressure discovery as stress was recognized for the most part from the discourse signal and the feeling acknowledgment was finished utilizing general media information. In any case, the after effects of the inclination state acknowledgment from skin response can be further developed utilizing profound learning strategies which will be additionally used to recognize response.
The purpose of this project is to use extensive database to increase the performance of stress detection system to the extent that it can interpret user data history with a higher precision, so it can give adequate measures and advices to the user. The scope for this project in order to increase the performance of the stress detection system, is to create a platform for automatization in regards to classifying and analyzing users data to immediate spot patterns or behavior that is stress related and can indicate if or what measures are needed.

1.1.2 Proposed System

The proposed system is designed by collecting data from sensors. Using this dataset machine learning Decision Tree Classifier algorithm is applied using and the model is saved.

Components of the Proposed System

I. The first step is collecting the data from the data sources. In our case, the data has been collected using Galvanic Skin Response (GSR) sensor.
II The second step is pre-processing the data in order to get a normalized dataset and then labelling the data rows.
III In the third step, the result of the second step, the training and testing dataset, is fed to the Machine Learning algorithm.

The Machine Learning Algorithm builds a model using the training data and tests the model using the test data. Finally, the Machine Learning Algorithm produces a trained model or a trained classifier that can take as an input a new data row and predicts its label.
The below diagram, shows the main steps and components of the proposed machine learning system.

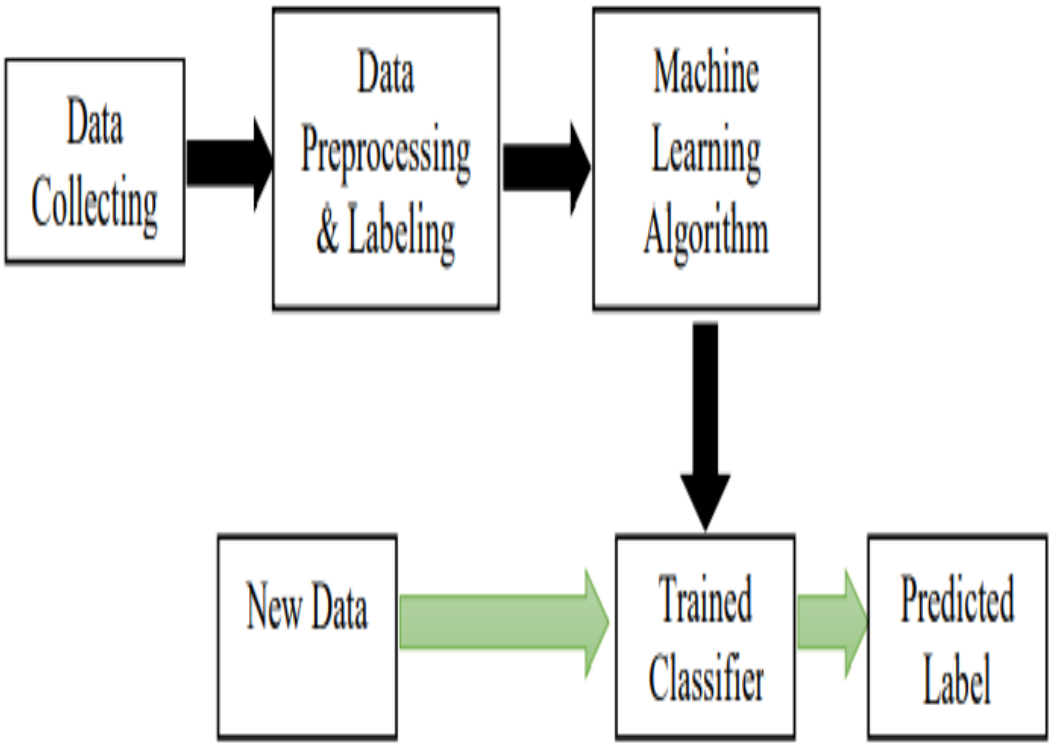

Figure 1.1: Some Steps and Components of the Proposed System

Chapter 2

Technologies Used

2.1 Sensors and Micro-controllers

2.1.1 Arduino Uno

The Arduino UNO is a standard board of Arduino. Here UNO means 'one' in Italian. It was named as UNO to label the first release of Arduino Software. It was also the first USB board released by Arduino. It is considered as the powerful board used in various projects. Arduino.cc developed the Arduino UNO board.
Arduino UNO is based on an ATmega328P microcontroller. It is easy to use compared to other boards, such as the Arduino Mega board, etc. The board consists of digital and analog Input/Output pins (I/O), shields, and other circuits.
It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

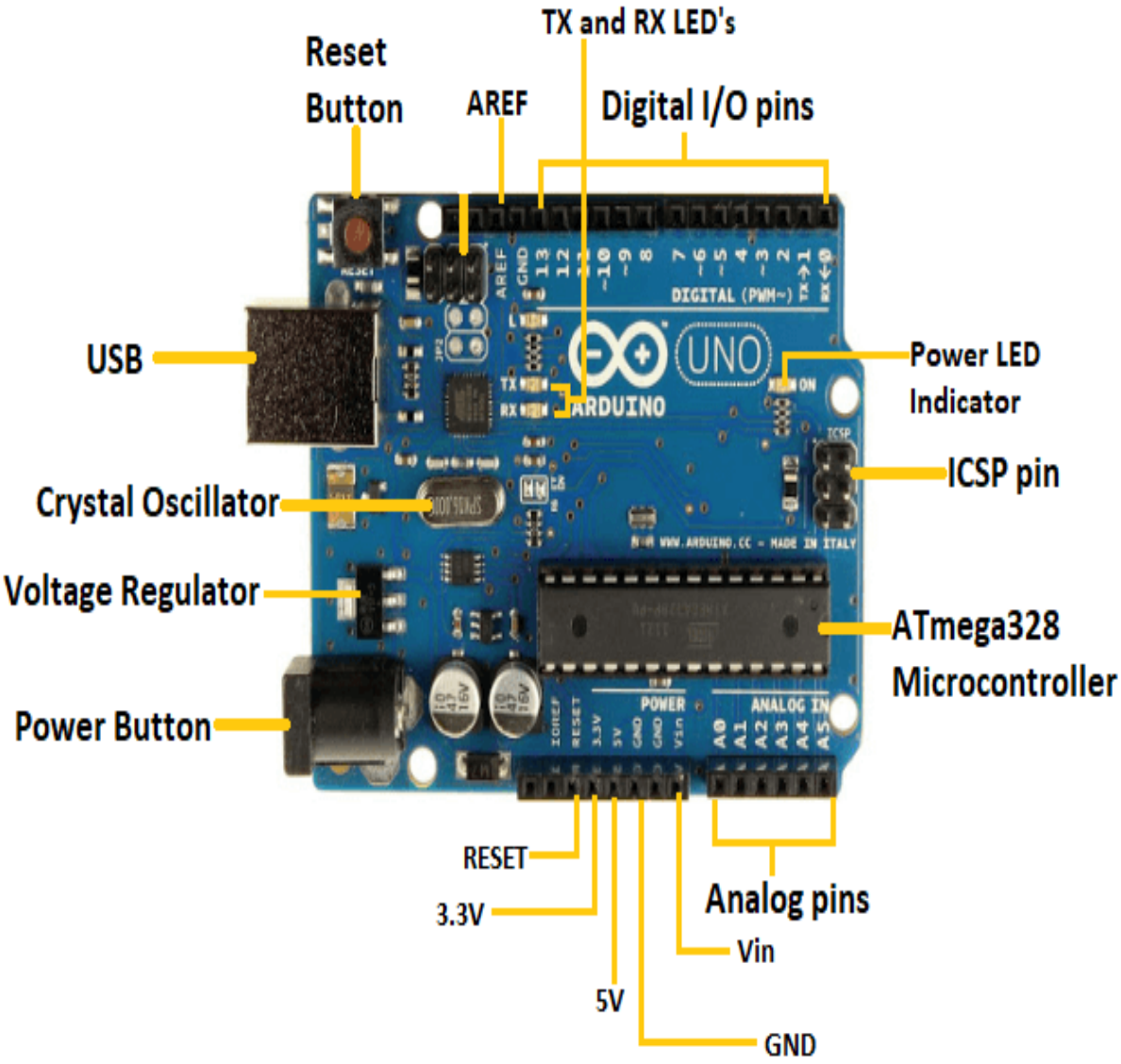

Figure 2.1: Arduino UNO

2.1.2 Galvanic Skin Response (GSR)

The Galvanic Skin Response (GSR), also named Electrodermal Activity (EDA) and Skin Conductance (SC), is the measure of the continuous variations in the electrical characteristics of the skin, i.e. for instance the conductance, caused by the variation of the human body sweating. Since sweat secretion cannot be consciously controlled, GSR is able to track autonomic arousals. This is what makes it a non-deceptive indicator of our emotions. It also explains its use along with other technologies, in lie-detectors.

Figure 2.2: Galvanic Skin Response

2.2 Algorithms

2.2.1 Decision Tree Classifier

It is called a decision tree because, it is similar to a tree, it starts with the root node, which expands on further branches and constructs a tree-like structure. Decision Tree is a Supervised learning technique that can be used for both classification and Regression problems, but mostly it is preferred for solving Classification problems.

It is a tree-structured classifier, where internal nodes represent the features of a dataset, branches represent the decision rules and each leaf node represents the outcome. The decisions or the test are performed on the basis of features of the given dataset. A decision tree simply asks a question, and based on the answer (Yes/No), it further split the tree into subtrees.

There are various algorithms in Machine learning, so choosing the best algorithm for the given dataset and problem is the main point to remember while creating a machine learning model. Below are the two reasons for using the Decision tree:

- Decision Trees usually mimic human thinking ability while making a decision, so it is easy to understand.
- The logic behind the decision tree can be easily understood because it shows a tree-like structure.

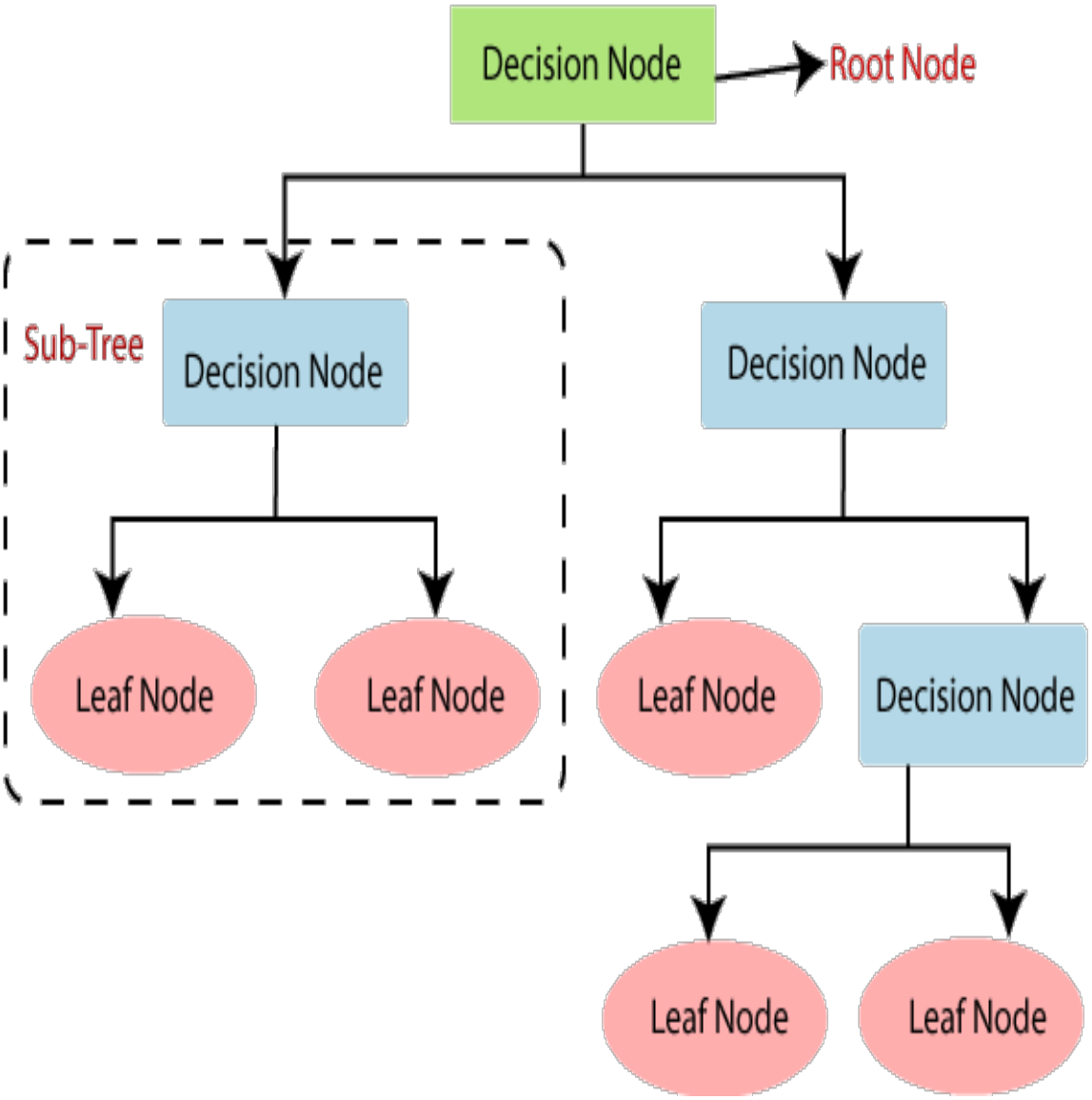

Figure 2.3: Decision Tree Algorithm

Chapter 3

Literature Survey and Methodology Used

3.1 Literature Review

In this section, we provide a literature review of the stress detection studies. Firstly, the controlled laboratory environment where the research has first started is investigated. This section is divided into subsections by taking the used physiological signal into account: Heart Activity, Electrodermal Activity, Brain Activity, Speech Data, Camera-Based studies and multi-modal measurement research.

We present the literature in unrestricted daily life. We provide an insight subsection for each environment which includes the most successful machine learning (ML) algorithms, discriminative physiological signals and features.

Sr. No.	Year	Authors	Focus of the Paper	Key Points in Coverage	Technique Used	Parameter Analysed	Research Gaps
1.	2022	Tanya Nijhawan et al.	Natural Language Processing and Machine Learning over Social Interactions	Decision tree, Latent Dirichlet Algorithm, Logistic Regression	Sentiment and Emotion Analysis, Data Exploratory Analysis, PyLDAvis.	Emotion: Anger, Sadness, Fear, Joy, Tweets.	Combination of other Health Parameters Are Underlined in this paper.
2.	2021	Shruti Gedam, Et al.	Wearable Sensors, Mental Stress	Physiological Signals, Wearable Sensor, Feature Extraction.	Fuzzy Decision Algorithm, WEKA, Kubios, MATLAB.	High, Low and Ultra Low Frequency. HR-Max, HR-Min.	Best Sensors and Advanced Machine Learning Techniques can be used for Further Research

3.2 Methodology Used

3.2.1 Data Collection

The temperature, blood pressure, heart beat values are sensed by the sensors and the sensor values are sent to the microcontroller for further processing and storing. The values of the sensor outputs are compared with the predefined values. Whenever the microcontroller encounters the abnormal value of any parameter, it alerts the person.

3.2.2 Dataset preparations

The dataset was gathered using a sensor included in the MySignals Healthcare Toolkit. MySignals is a forum for medical device and e-Health application creation. The MySignals toolkit includes an Arduino Uno board and a variety of sensor ports. The sensors were attached to the MySignals Hardware package (which includes an Arduino) and programmed using the Arduino SDK.

Chapter 4

System Requirements, Benefits, and Applications

4.1 Software Requirements

Sr. No	Particulars	Specification
1.	IDE	Arduino IDE
2.	Coding Language	Python
3.	Operating System	Windows 10/11
4.	Coding IDE	VS Code

Table 4.1: Software Requirements

4.2 Hardware Requirements

Sr. No	Particulars	Specification
1.	Processor	Intel-I3
2.	RAM	4GB
3.	Hard Disk	40GB
4.	Sensor	Galvanic Skin Response(GSR)
5.	Microcontroller	Arduino UNO
5.	Storage	Secure Digital Card(SD)
6.	Module	SD Card Module

Table 4.2: Hardware Requirements

4.3 Advantages

1. This project can help user to track stress of himself/herself.
2. The project gives the output as stress levels so, it is useful for maintaining mental health.
3. It is very easy to use.
4. Mobility, you can take it anywhere you go.
5. Simplicity: It is simple to use, we just need to wear finger grips in two of five fingers and then sensor detect and collect the information and send to micro-controller.
6. Good accuracy: As we use Galvanic Skin Response Sensor to measure skin electricity conductance so, it is approximately 89% accurate.

4.4 Applications

1. **Stress Detection in Students:**
   Stress has become part of students' academic life due to the various internal and external expectations placed upon their shoulders. The age that was considered once most carefree is now under an outsized amount of stress. The effect that exam pressure or recruitments stress has on the scholar which regularly goes unnoticed.

2. **Stress Detection in Teachers:**
   Teachers report elevated levels of stress and psychosomatic illnesses compared to other professions. Teacher stress has far-reaching consequences on their health outcomes.

3. **Hospitals:**
   Hospital workers are known to work long hours in a highly stressful environment. The COVID-19 pandemic has increased this burden multi-fold. Pre-COVID statistics already showed that one in every three nurses reported burnout, thus affecting patient satisfaction and the quality of their provided service. Real-time monitoring of burnout, and other underlying factors, such as stress, could provide feedback not only to the clinical staff, but also to hospital administrators, thus allowing for supportive measures to be taken early.

Chapter 5

Snapshots

5.1 Interfacing Arduino UNO

5.1.1 Interfacing Arduino UNO with GSR Sensor

- Connect the GSR sensor's GND (Ground) pin to any of the GND pins on the Arduino Uno. This establishes the common ground reference between the sensor and the Arduino.
- Connect the GSR sensor's VCC pin to the 5V pin on the Arduino Uno. This provides power to the sensor. Ensure that the sensor is designed to work with 5V, as some sensors may require a different voltage level (e.g., 3.3V).
- Connect the GSR sensor's OUT pin to one of the analog input pins on the Arduino Uno. This allows the Arduino to read the analog signal output by the sensor.

5.1.2 Interfacing Arduino with SD Card Module

- Connect the VCC and GND pins of the microSD card module to the 5V and GND pins of the Arduino, respectively.
- Connect the MISO, MOSI, SCK, and CS pins of the microSD card module to the corresponding SPI pins (MISO, MOSI, SCK, and any digital pin for CS) on the Arduino.
- Insert a formatted microSD card into the module.
- Install the SD library in the Arduino IDE.

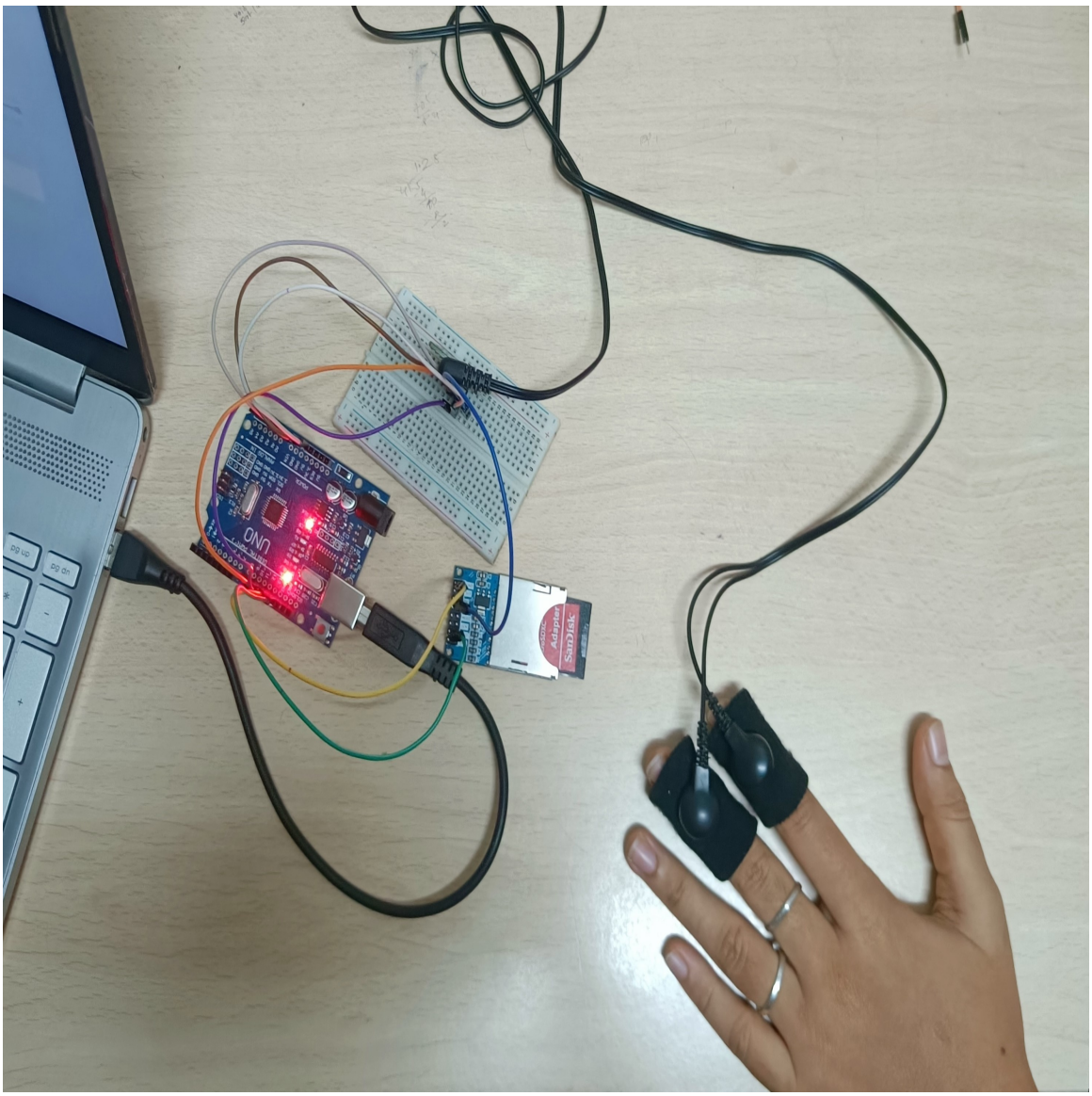

Figure 5.1: Interfacing Arduino UNO With GSR & SD Card Module

5.2 Navigation Pane

The Navigation pane provides the basic navigation between different sections.

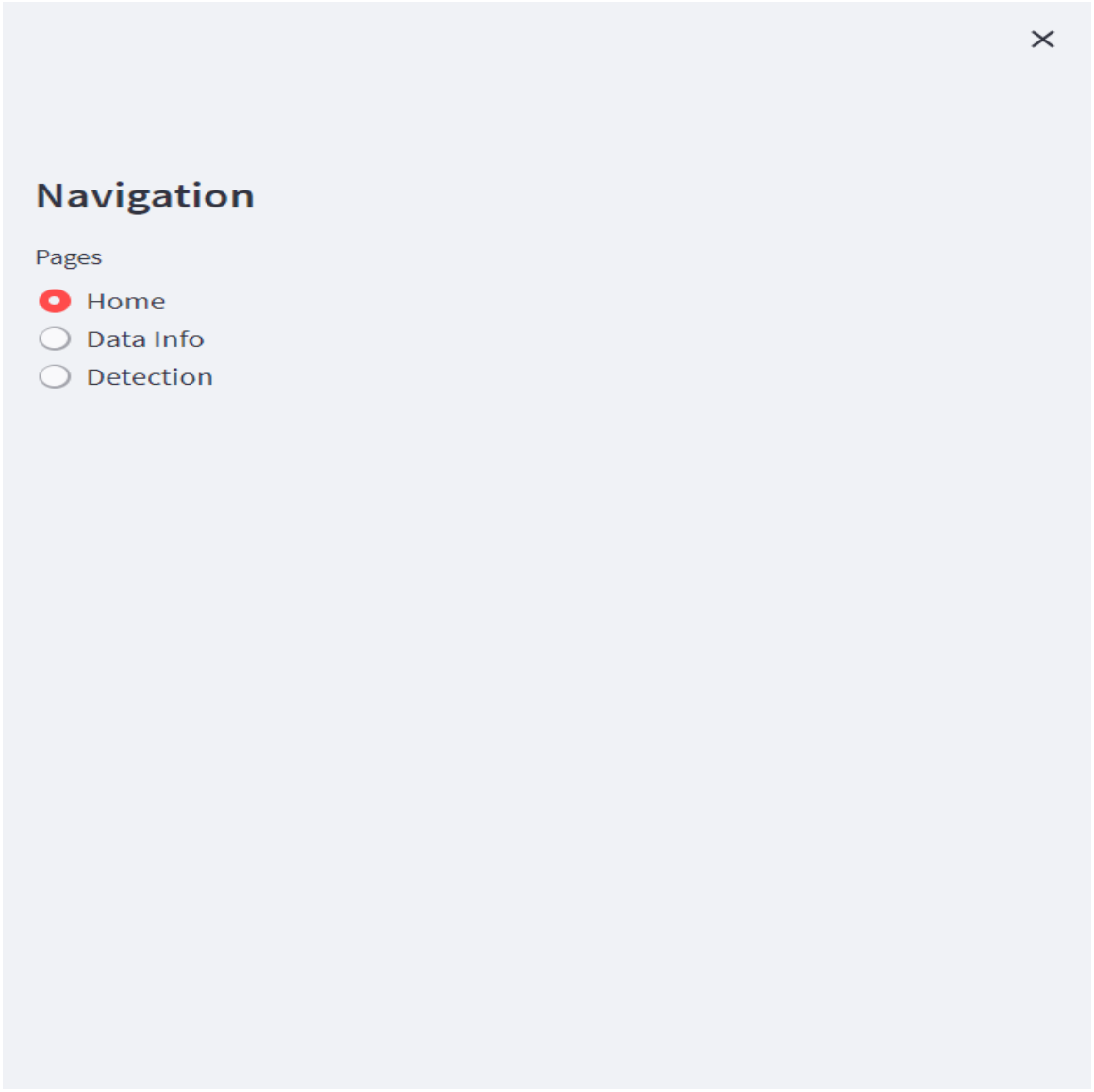

Figure 5.2: Navigation Pane

5.3 Home Page

Home Page provides the basic information about the project. It also provides some information about the concept used in the project.

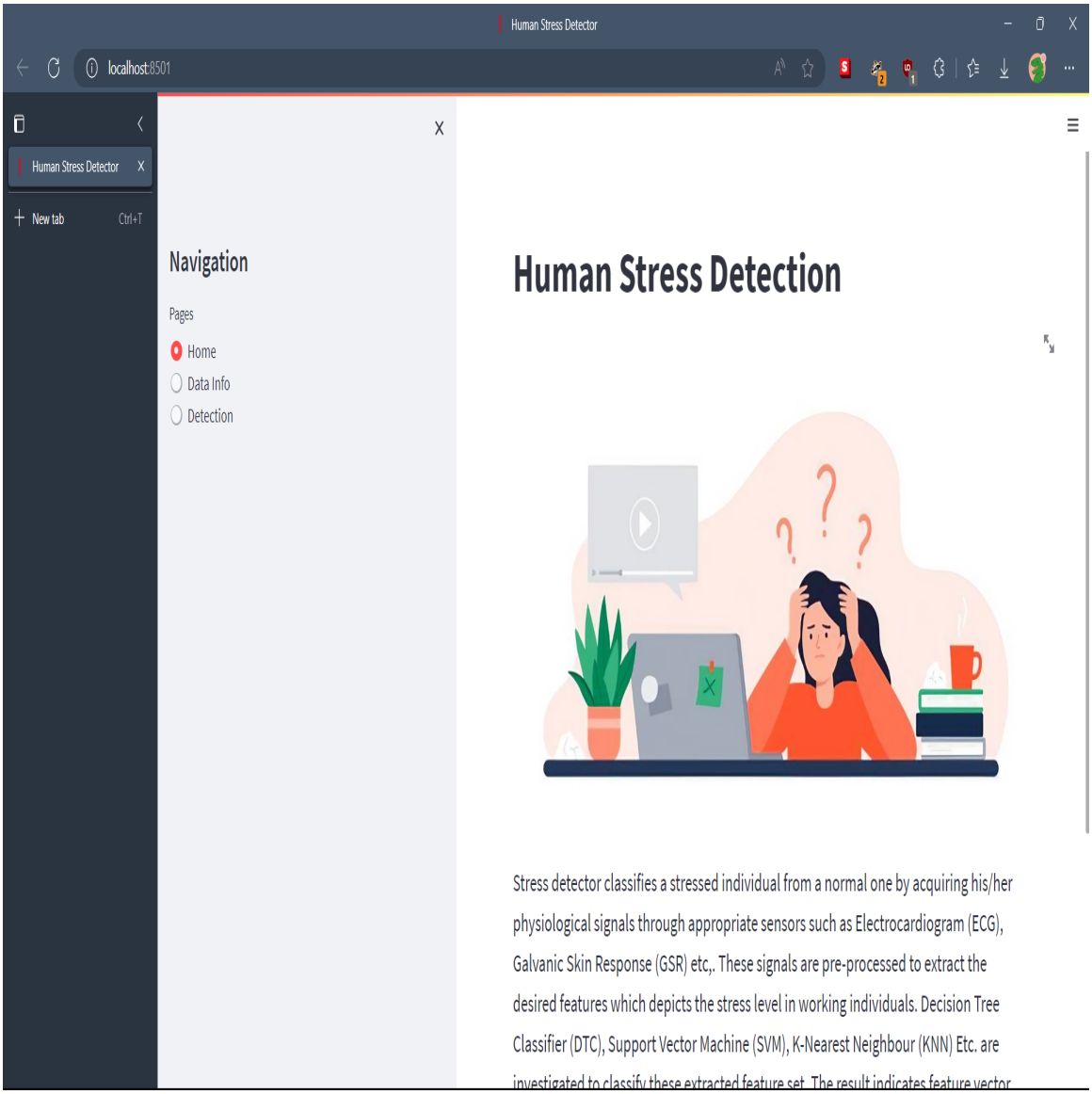

Figure 5.3: Home page of the project's output

5.4 Data Information Page

The data information page provides the data related information such as the dataset used and the column wise description of the dataset.

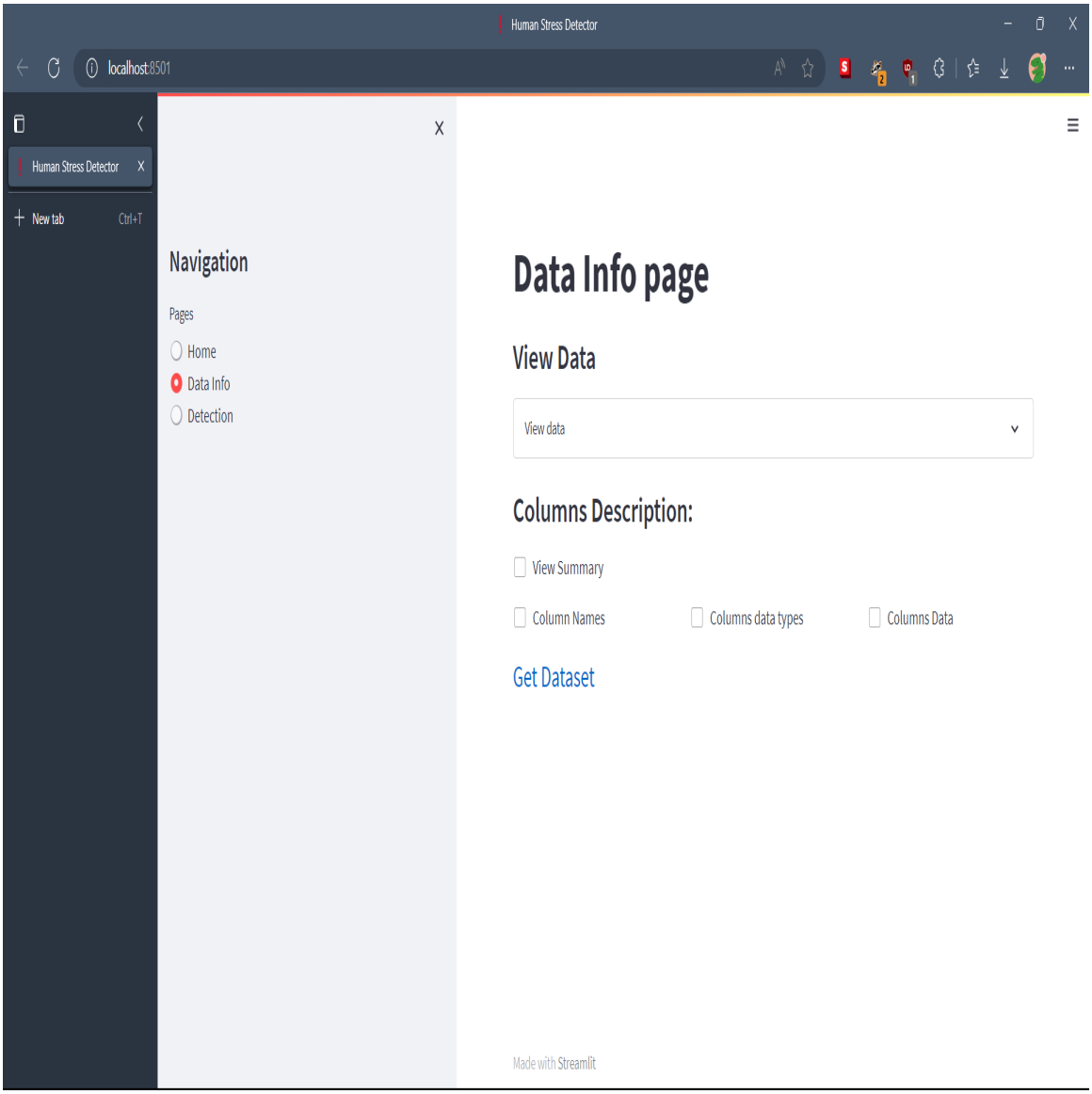

Figure 5.4: Data Information Page

5.4.1 Dataset

The dataset section is the dataset used in the project.

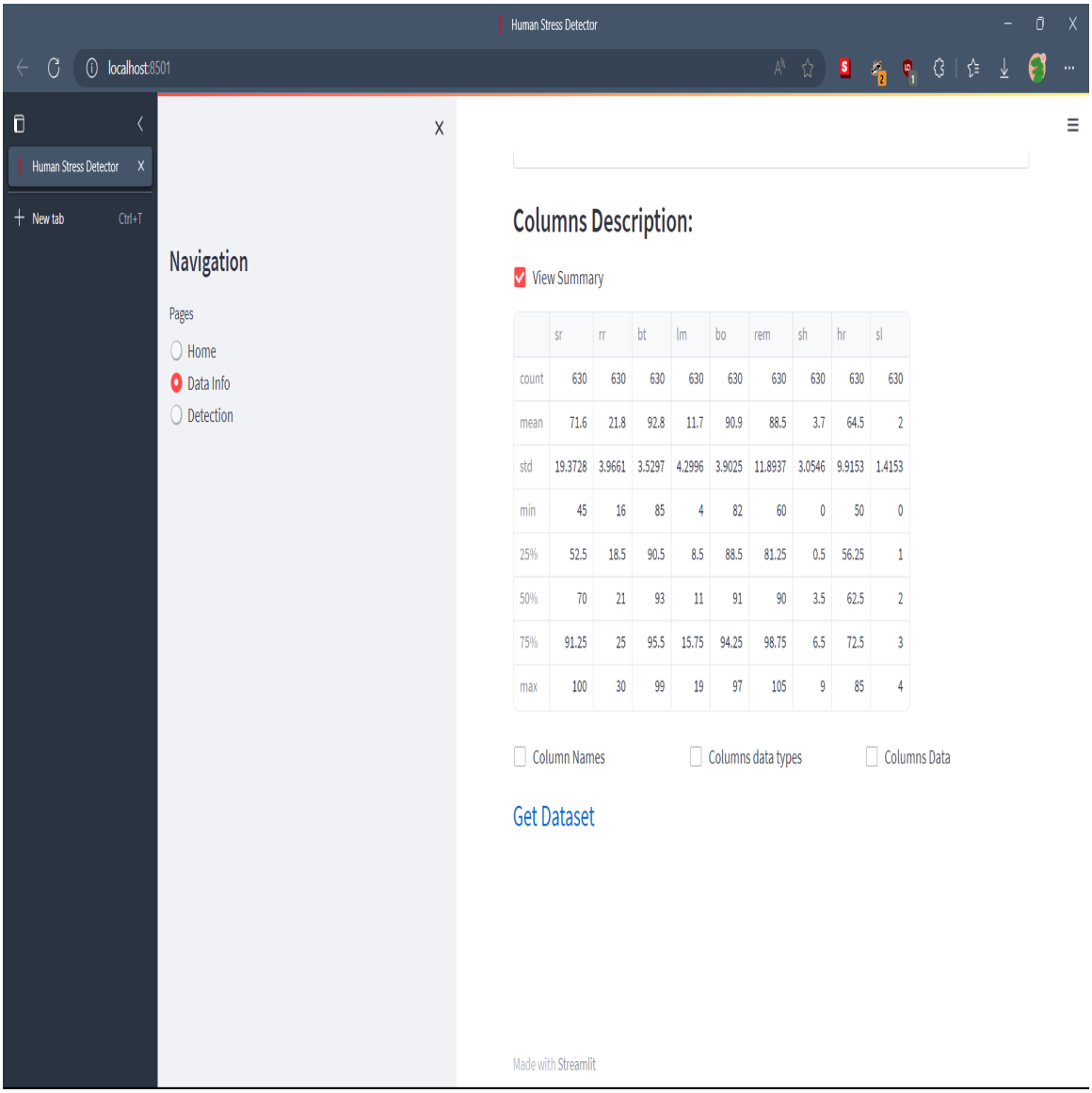

Figure 5.5: Dataset

5.4.2 Column wise description

This section provides the column wise description of the used dataset.

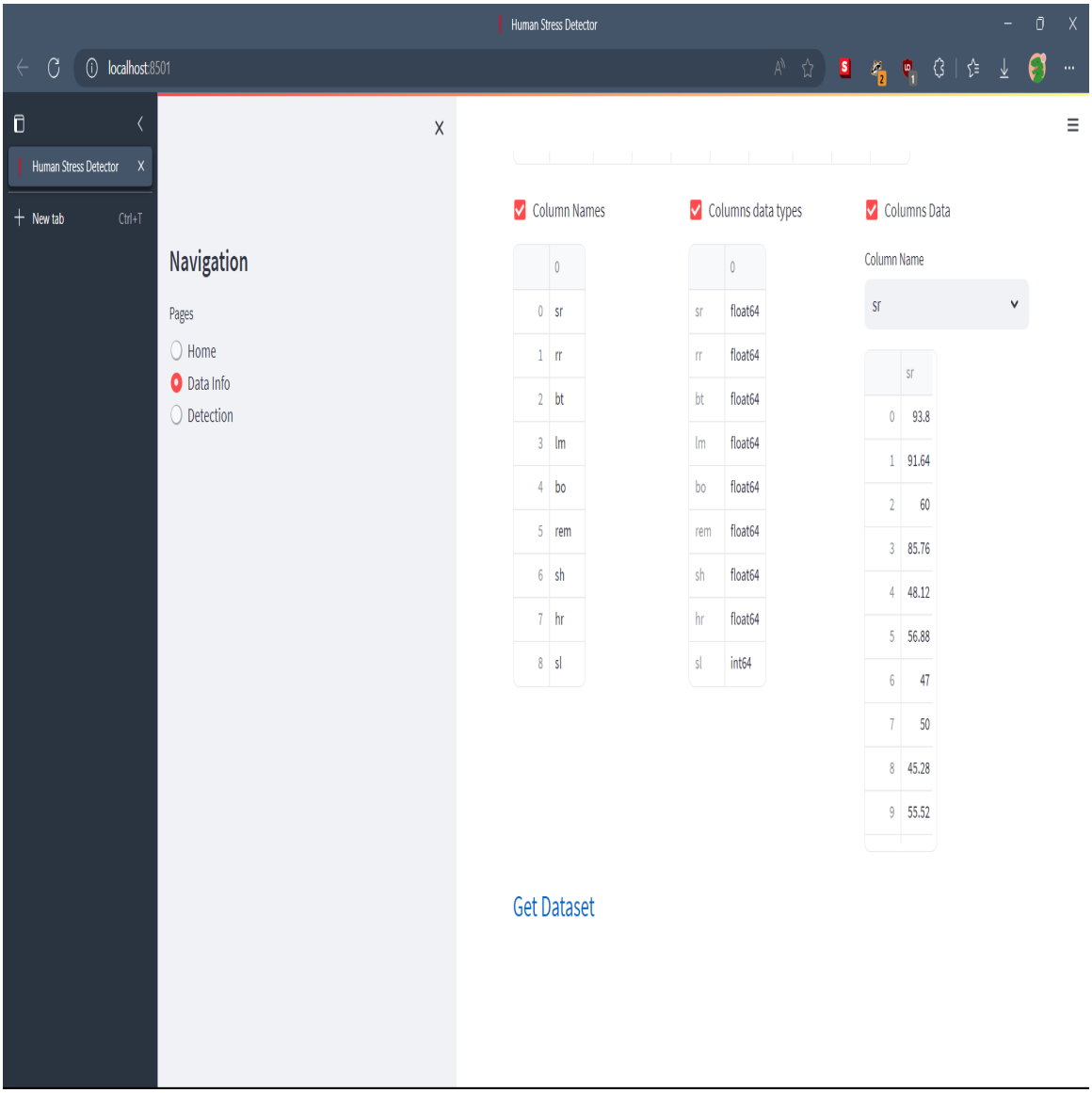

Figure 5.6: Column wise description

5.5 Detection Page

The Detection page provides the final output of the project using various different parameters such as GSR Data, Respiration Rate, Body Temperature, Limb Movement, Blood Oxygen, Rapid Eye Movement, Sleeping Hour, Heart Rate.

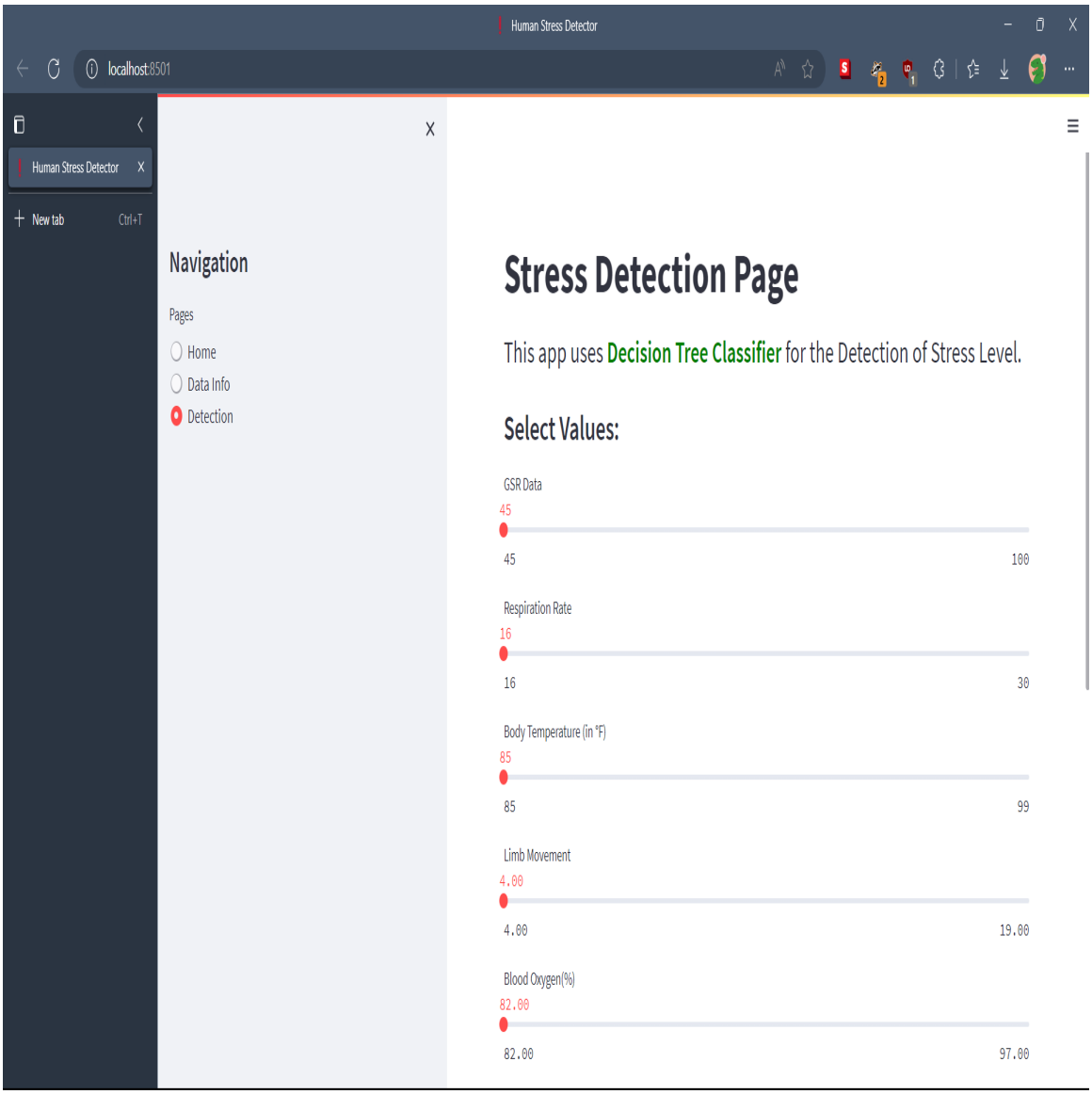

Figure 5.7: Detection Page

5.5.1 Stress Free and Calm

When a person has normal values/parameters, the person is stress free and calm.

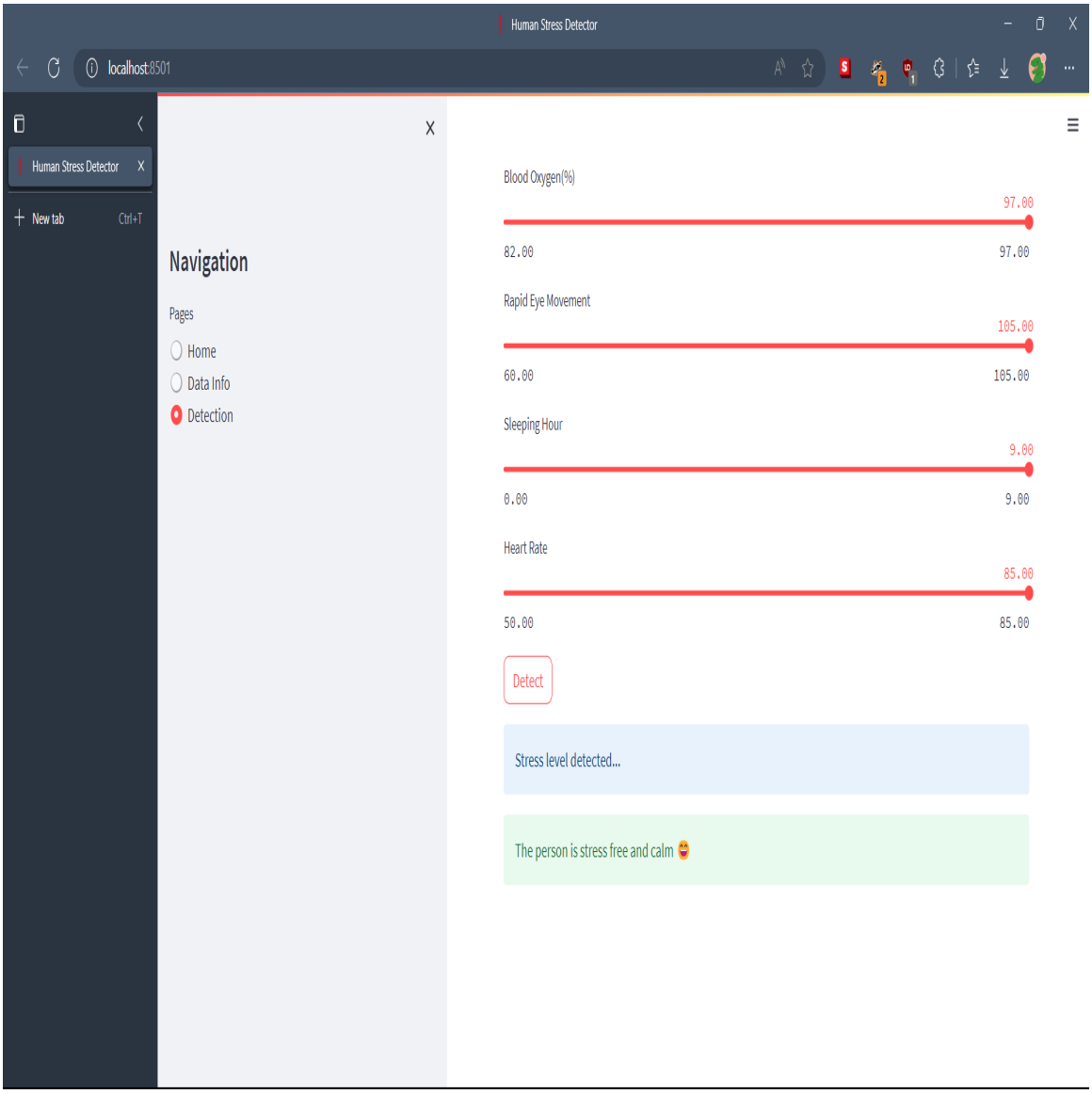

Figure 5.8: The person is stress free and calm

5.5.2 Low Stress

When a person has slightly increased values/parameters, the person has low stress.

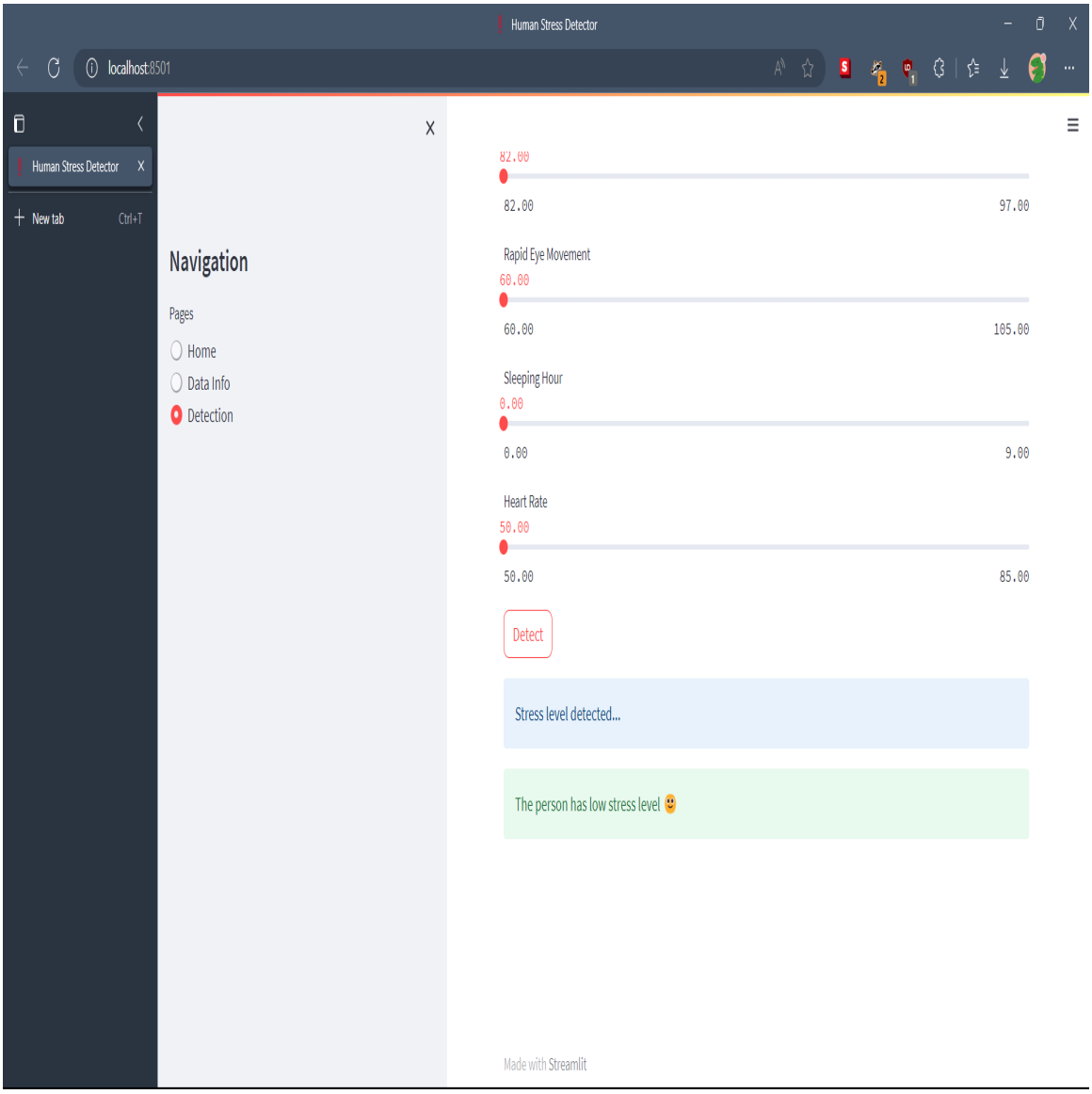

Figure 5.9: The person has low stress level

5.5.3 Medium Stress

When a person has increased body temperature or other values such as Heart Rate with normal sleep, the person has medium stress.

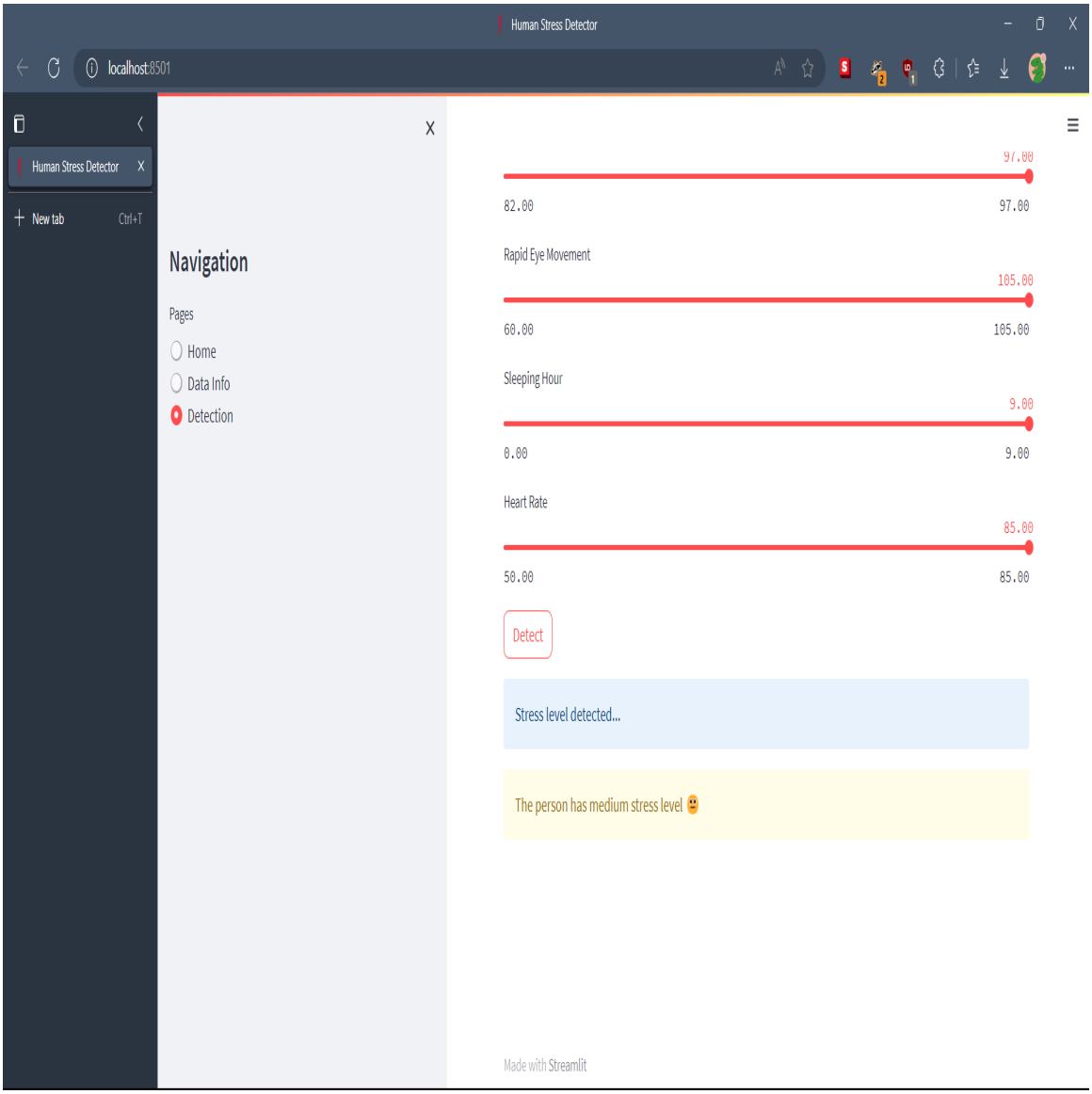

Figure 5.10: The person has medium stress level

5.5.4 High Stress

When a person has highly increased body temperature or other values such as Heart Rate with lower sleep hours (2-3 hrs.), the person has high stress.

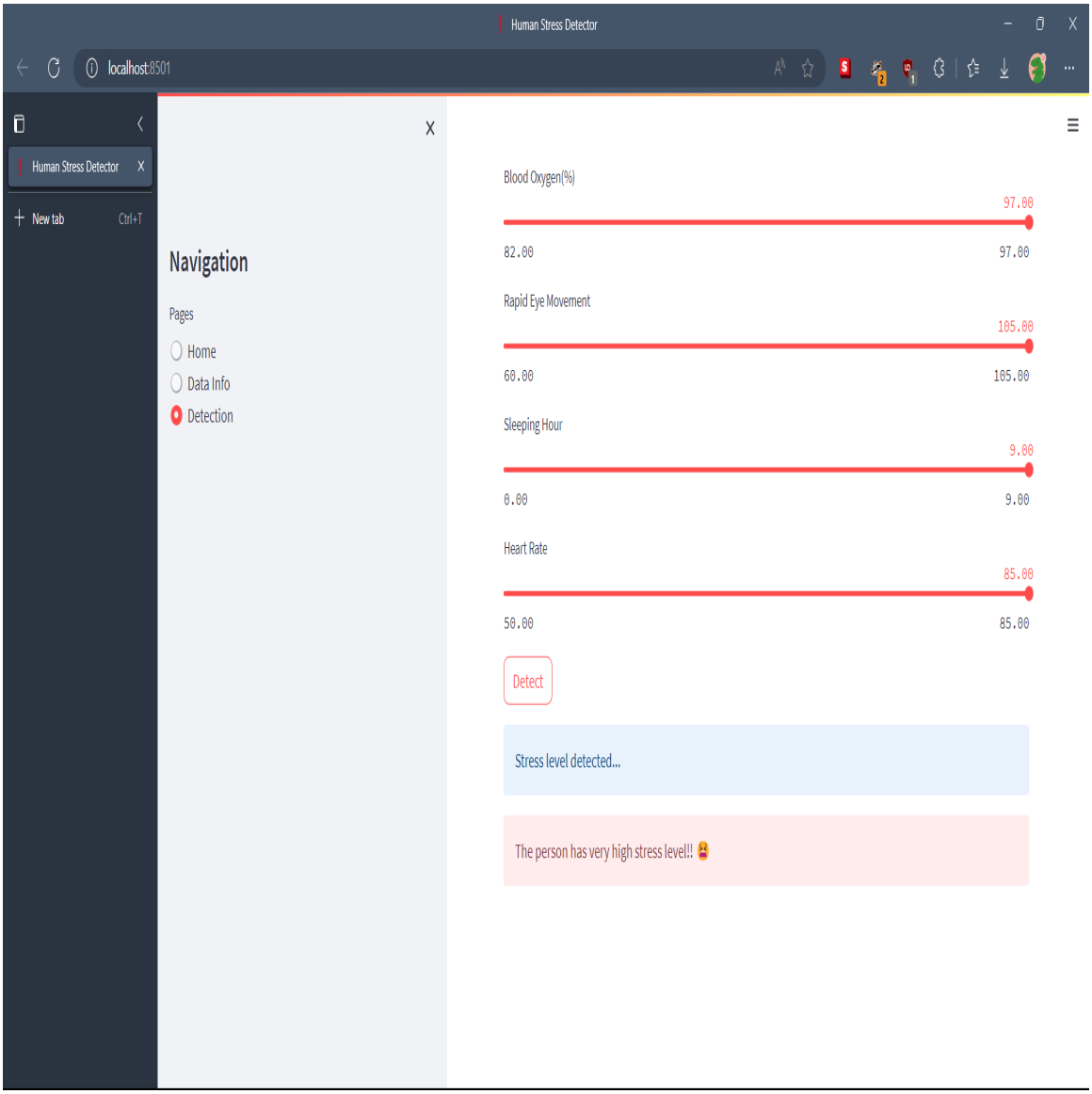

Figure 5.11: The person has high stress level

Chapter 6

Future Work

For future work, it would be interesting to enhance this work into the development of a stress detection model by the addition of other physiological parameters, including an activity recognition system and application of machine learning techniques.
Future research work should concentrate are as following:

- Identifying some specific stressors that have the capacity to determine well-being which can help better in the detection of stress.
- Developing a user-friendly, flexible, and most importantly a sturdy multi-modal device comprising of sensors (Heart Rate) that can be used for consistent and reliable data collection.
- Developing a model compatible to detect stress in students, teachers, and office employees.
- Increasing the efficiency and accuracy of stress detection by using deep learning.

Conclusion

The Galvanic Skin Response (GSR) device detects whether there has been an effort or a different situation from being relaxed with a success rate of 90.97%. It has been observed that participants who had done some trials before obtained the highest difference; so the average could be higher if the user is familiarized with the device. The next stage is to design an algorithm in order to establish the threshold between different emotional situations because this first algorithm does not distinguish between being stressed or making an effort.

Physical activity acts as a de-stress agent on human stress. Therefore, by increasing the amount of physical activity in daily life, one can reduce his/her stress levels. Sleep shortage and insomnia are common signs of stress. Our study shows the time in bed is a significant and positive indicator of stress. Changes in heart rate and an increase in BMI increase the stress levels of individuals.

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