System Level Design: The high-level design includes the three layers of input data collection, classification and application. The below flow diagram indicates the different blocks of stress sensing.
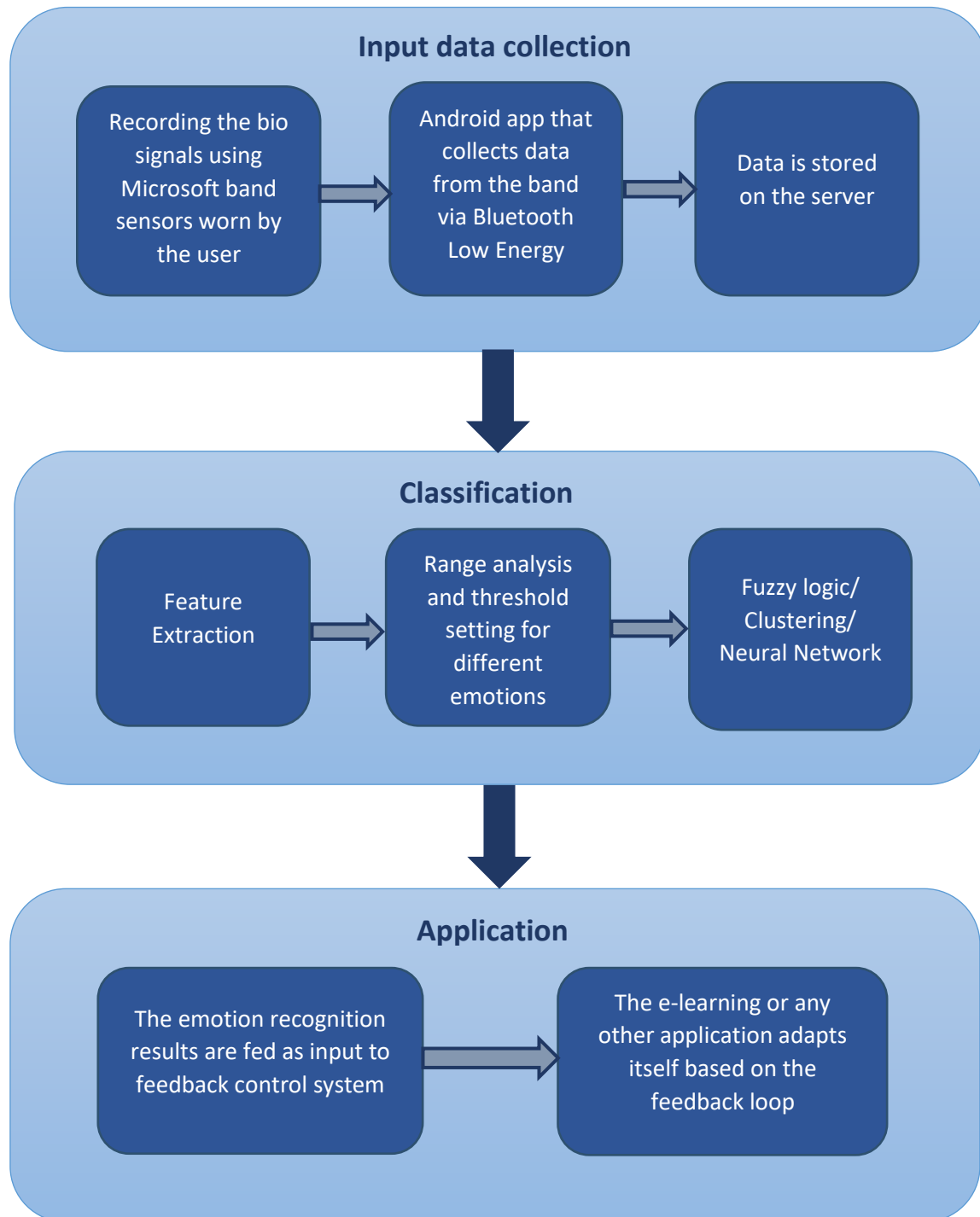

Fig 1: System level design

Design Decisions at Each Level:

1. **Input Data Collection:**

   - The signals such as the heart rate, galvanic skin response and skin temperature are collected from the sensor of the Microsoft band.
   - The data needs to be stored on cloud hence the android application collects the data from the Microsoft band via Bluetooth.

2. **Emotion Recognition and Classification:**

   - For obtaining the threshold values and the benchmark for training, the international affective picture system (IAPS) experiment is conducted for each user. The effective range calculation for each emotion is vital for the system to be robust.
   - Using these values, the system of classification is trained to map the signals to the four different emotions. The range can be further divided to include the neutral zone as shown below:
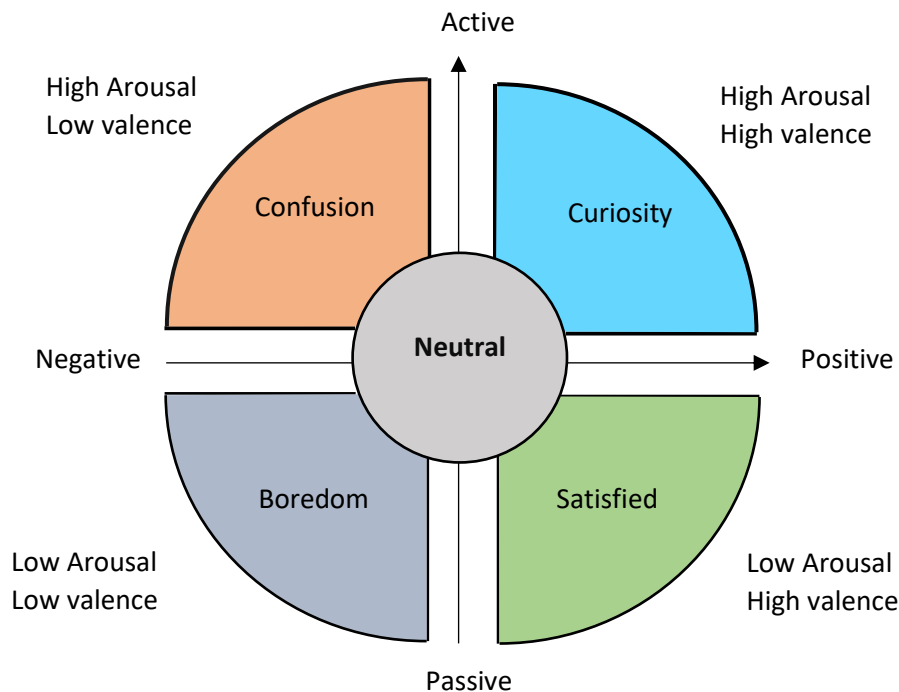
Fig 2: Valence Arousal model for emotion

   - The accuracy of mapping of the signals to the specific emotion depends on what set of rules or algorithm is applied for the input data set.
   - The classification can be done using deep learning or convolutional neural networks if the training data set is very huge and incase the training set is a not very large then to use normal machine learning techniques such as feed forward neural networks or radial basis neural networks require the feature extraction level to be more specific. For example, if the variation in the signal is not very significant then the possibility of using wavelet transforms for better results can be adopted.
   - If the feature set has some overlapping and still be able to cluster into sub domains, then the clustering or fuzzy logic can be used to classify.

- Points to be considered:
  - Does the threshold vary for each user and is the variation considerable?
  - If the clustering is different for each user, then how to merge the data in an efficient manner such that the classification is independent of the user.
  - Does the IAPS training set provide sufficient data for setting the benchmark for classification or do we need an additional verification and validation methodology like emotion recognition using signals and pattern recognition, for more accuracy.

3. **Application:**

- The E-learning system consists of a feedback control block which takes the input from the emotion recognition block and adapts the learning based on the emotions of the user.
  While designing the classification system, we need to consider if the E-learning adaptation is improved if an extra state or emotion is added to the cluster pattern.