Ambiance Signal Processing:

A Study on Collaborative Affective Computing

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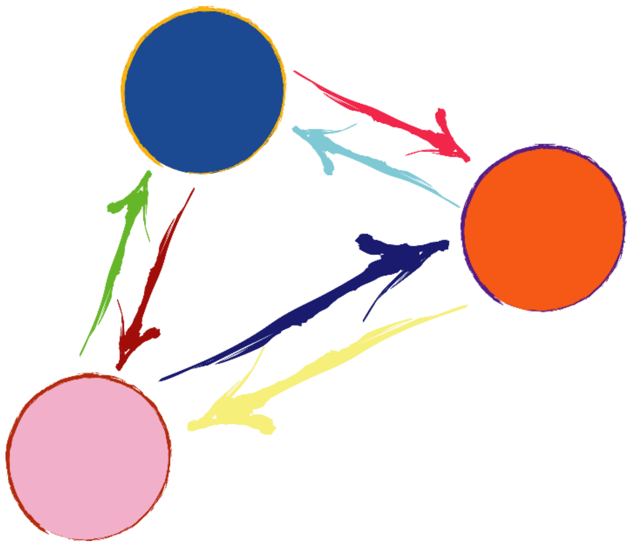
Introduction

- The objects around us make the environment, and their features provide the ambiance.
- The objects have a mutual influence on each other since they contain energy and transmit their energy to other objects nearby.
- In general, there is a mutual relation between the objects of the same or similar clusters.
- recognition of objects' features and characteristics can help to estimate the other objects' characteristics, which are in the same cluster or nearly similar clusters [2].



Problem Statement

For decades, researchers have tried to recognize the object features by using different sensors and employing complex mathematical techniques.

When there is no direct access to the objects, and the system cannot interact with the object (or the user) directly and explicitly.

- **In the absence of direct access, analysis of the environment and the objects nearby can shade away from the out of reach objects [3].**

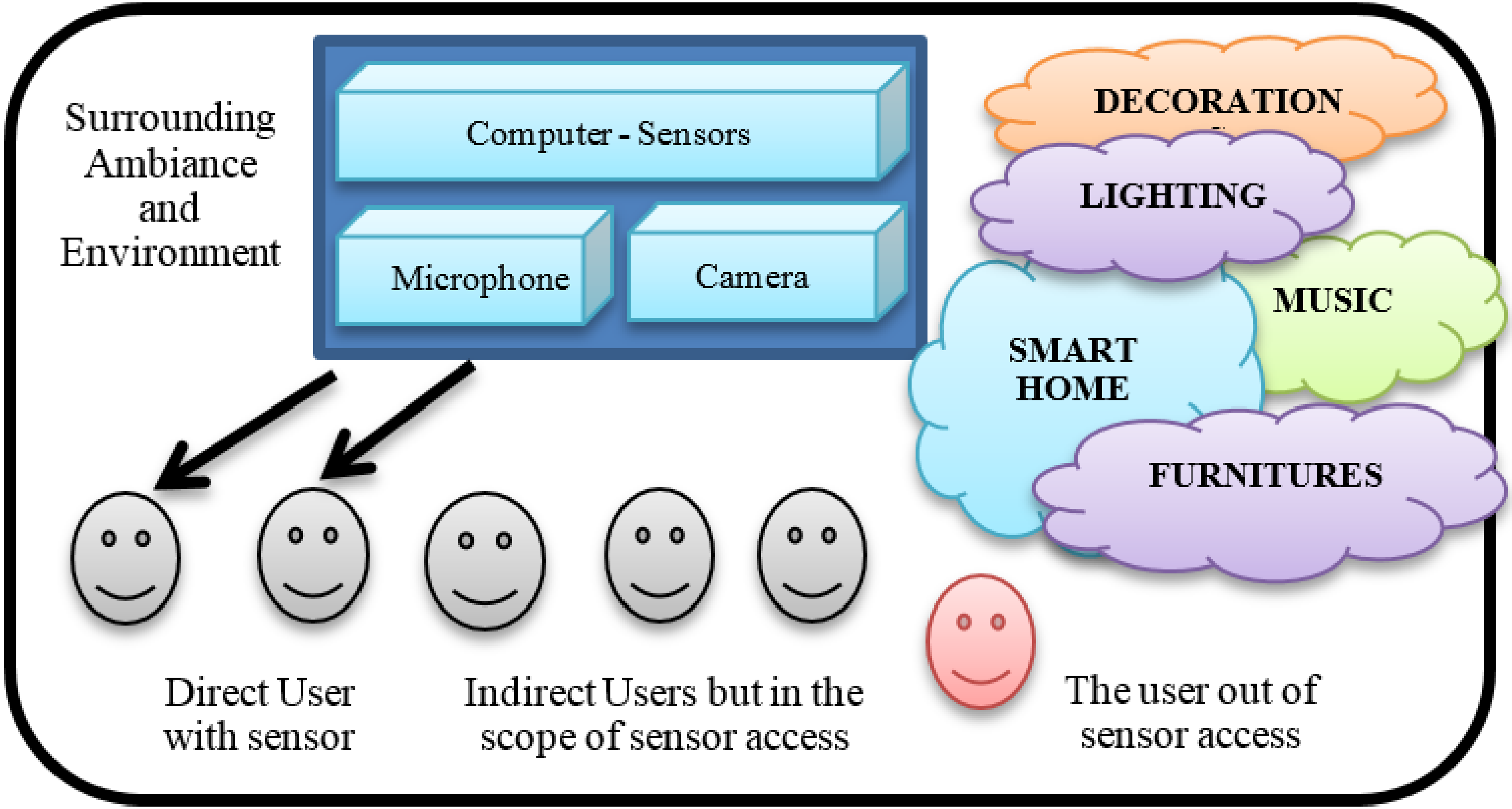
Background

- Previously, the similar estimation for feature recognition was possible based on the statistical models (e.g. k-NN algorithm),

but….

- the result was a generalized outcome about a group of objects based on the other objects of the same class with a similar type, similar features. Therefore, extracting a feature of a specific object was not simply possible by statistical models, especially when there was no data space of the objects of the same class.

Ambiance Signal Processing (AmSiP)

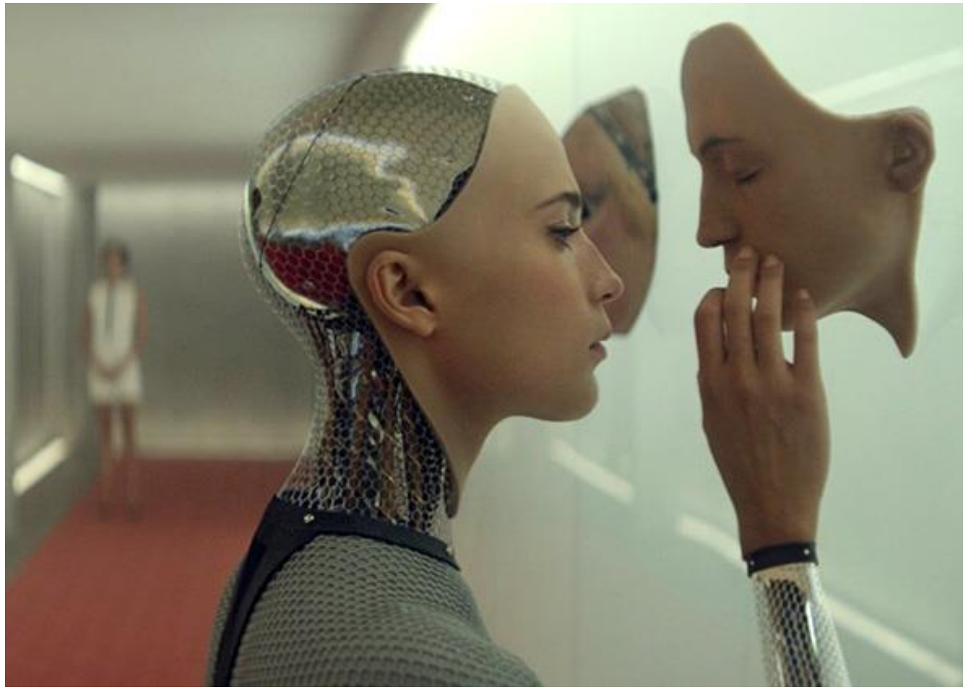


Affective Computing (AC)

Definition:

- Affective Computing (AC) is the study of recognizing, interpreting, processing, and simulating human emotions.

Affective Computing (AC)…



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- Many computer games, applications, and security issues can be healed and tailed with human emotions to improve Human-Computer Interactions (HCI) [3,7,8]
- There are many techniques and methods available to recognize the human emotions explicitly such as facial expression recognition, audio/speech signal processing, NLP, Electroencephalography (EEG), heart rate, skin conductance, etc.

Experiment Setup

- Total participants: 50 users (25 Female); Average age: 23
- # of sessions: 2
- Session duration: 2 Hours
- # of participants for each session: 25 (Random selection)

Session/Group 1:
New Age Music with relaxation theme

Session/Group 2:
Jazz & Rock Music

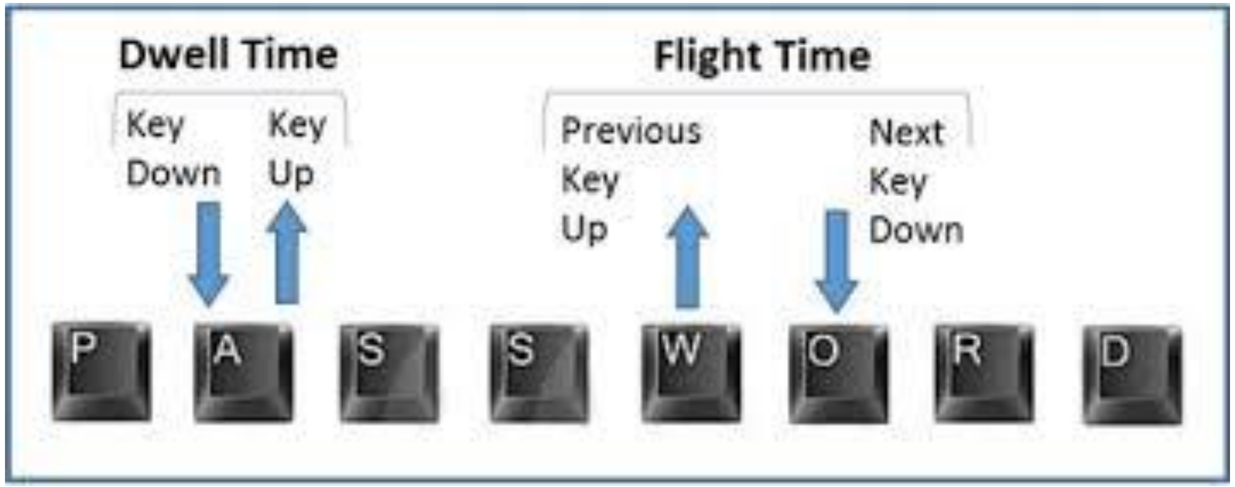
Logger Software:
Developed in C#.NET

Logged Features:
Keyboard Keystroke Dynamics
Mouse Movements/Interactions

Keyboard Keystroke Dynamics

Keystroke dynamics are a habitual rhythmic pattern of typing which is usually used for user identification for many years. There are three major features in keystroke dynamics as below [18]:

- Key down-to-down
- Key down-to-up
- Key up-to-down



Besides the above three main features, 15 sub-features can be extracted.

Mouse Interactions

- The length of the mouse racing line
- The zero crossings
- The maximum deviation of the values
- Average of the racing line values
- The standard deviation of the racing line
- The variance of the racing line
- Correction function of the curve

Results: Group 1

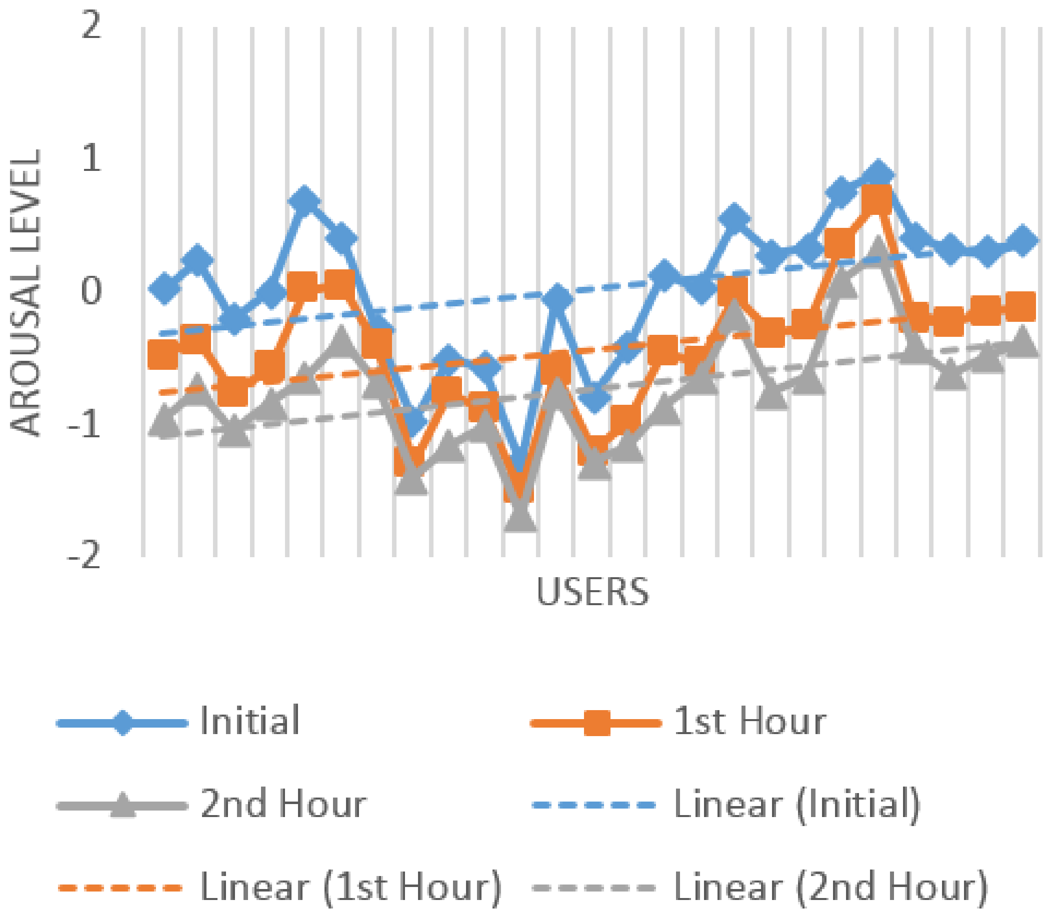


Fig. 2. HV levels of Group 1 with relaxation music

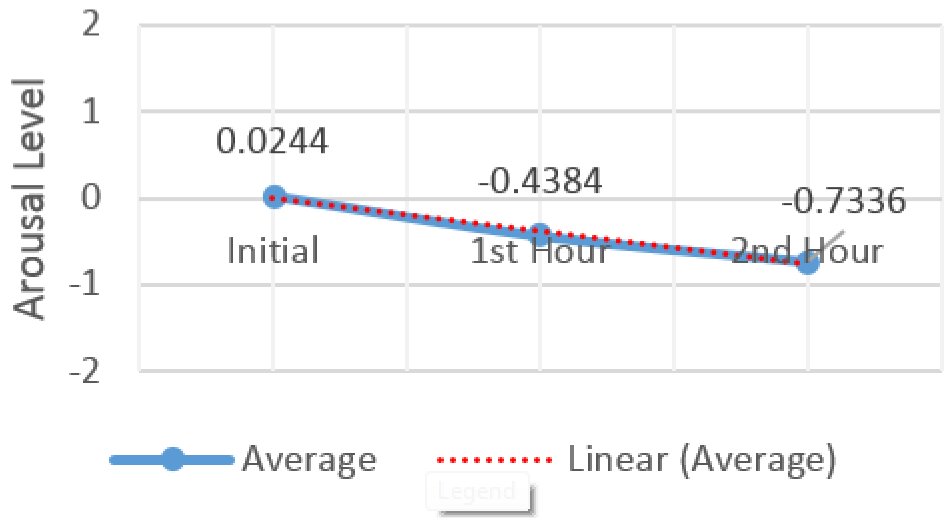


Fig. 3. Average of LA levels change in Group 1 with relaxation music

Results: Group 2

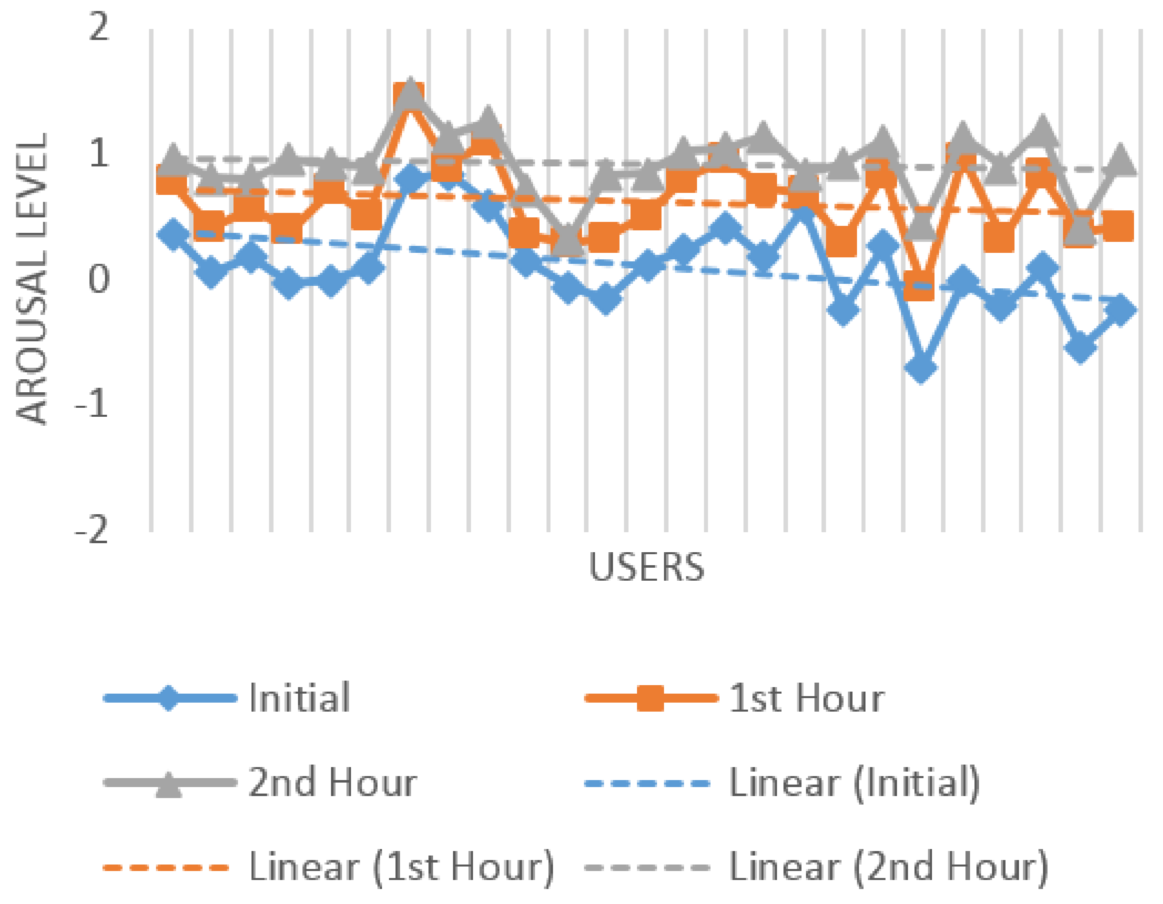


Fig. 4. HV levels of Group 2 with Rock and Jazz music

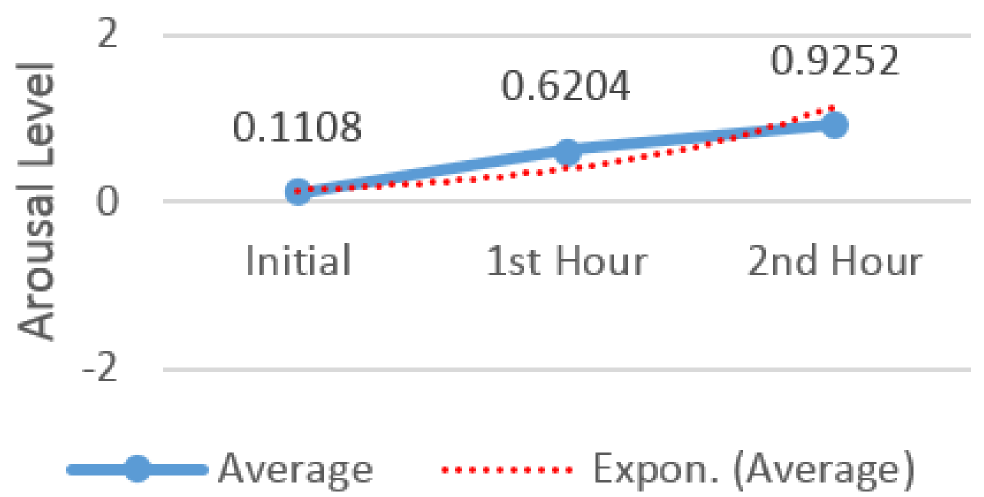
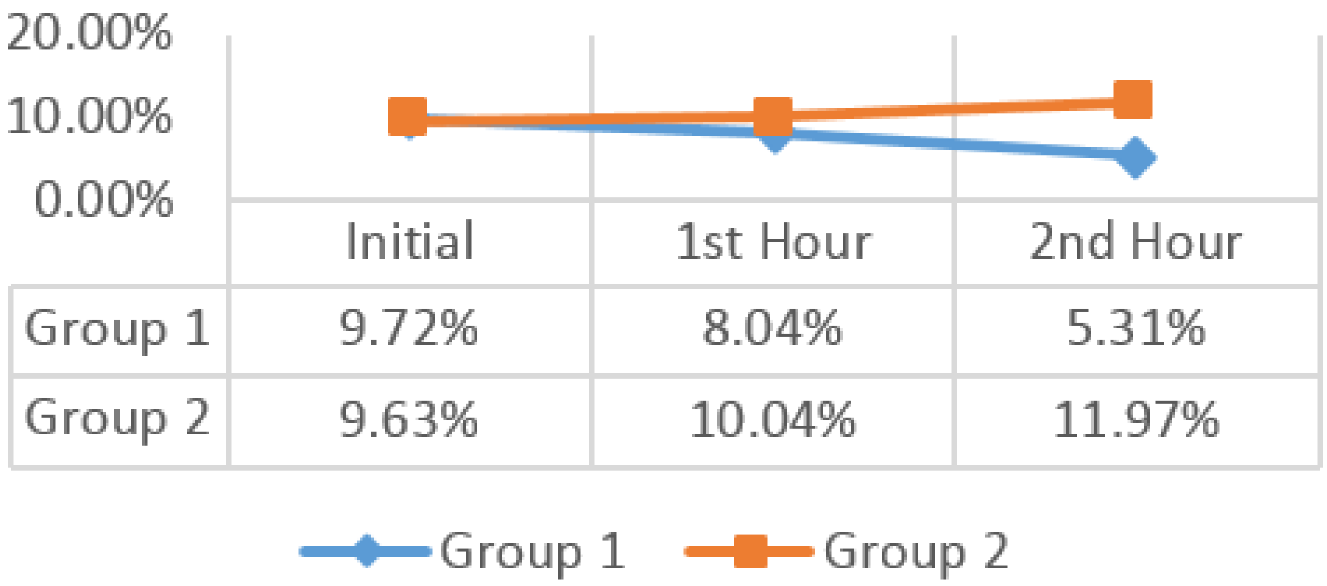


Fig. 5. Average of HV change in Group 2 with Rock and Jazz music

Results: Typo Errors



	Initial	1st Hour	2nd Hour
Group 1	9.72%	8.04%	5.31%
Group 2	9.63%	10.04%	11.97%

Fig. 6. Typo errors recorded by two groups in different stages

Results: Paired t-Test

TABLE 1. Paired t-Test among various states for low and high arousal

	Neutral State - Initial State	**Initial State - 1st Hour**	**1st Hour - 2nd Hour**
	Low Arousal (LA)		
T-Test	0.2219	14.9458	10.3763
P	0.8262	< 0.0001	< 0.0001
d	0.1100	0.031	0.028
95% CI	(-0.251,0.202)	(0.398,0.526)	(0.236,0.353)
	High Arousal (HA)		
T-Test	1.5071	11.8721	8.5651
P	0.1448	< 0.0001	< 0.0001
d	0.074	0.043	0.036
95% CI	(-0.262 , 0.040)	(-0.598,-0.421)	(-0.378,-0.231)

Results: Prediction Accuracy

TABLE 2. Accuracy report with 0.1/4 (2.5%) of MAE threshold for True Positives

	After 1 Hour						
	Relaxation Music				Rock – Jazz Music		
	Detected	Actual	Precision		Detected	Actual	Precision
LA	38	47	80.85%	**HA**	36	46	76.59%
Neutral	1	2	50%	**LA**	1	2	50%
LA-	0	1	0%	**Neutral**	2	2	100%
FP	11	-	22%	**FP**	11	-	22%
	After 2 Hours						
	Relaxation Music				Rock – Jazz Music		
	Detected	Actual	Precision		Detected	Actual	Precision
LA	45	48	93.75%	**HA**	43	47	91.49%
Neutral	0	0	Null	**Neutral**	1	1	100%
LA-	1	2	50%	**HA+**	1	2	50%
FP	4	-	8%	**FP**	5	-	10%

Discussion & Conclusion

- The calculated implicit estimation was quite reliable but with 15% – 20% less accuracy (and higher MAE) than the explicit (concentrated) methodologies.
- AmSiP is a new model of processing the objects to retrieve the information.
- In AmSiP, it is important to identify the most relevant objects, and their features and affects, and to cluster them into various surroundings.
- AmSiP is not a technique, but it is a new concept of looking at the surroundings to obtain the required information implicitly.

Last Word

This solution works with a concept which says:

"the more objects you have, the more information you may get."

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Q&A

Backup: Keyboard Keystroke Dynamics

- *KF1:* The duration between 1st and 2nd down keys of the digraphs.
- *KF2:* The duration of the 1st key of the digraphs.
- *KF3:* Duration between 1st key up and next key down of the digraphs.
- *KF4:* The duration of the 2nd key of the digraphs.
- *KF5:* The duration of the digraphs from 1st key down to last key up.
- *KF6:* The number of key events that were part of the graph.
- *KF7:* The duration between 1st and 2nd down keys of the trigraphs.
- *KF8:* The duration of the 1st key of the trigraphs.
- *KF9:* Duration between 1st key up and next key down of trigraphs.
- *KF10:* The duration between 2nd and 3rd down keys of the trigraphs.
- *KF11:* The duration of the 2nd key of the trigraphs.
- *KF12:* Duration between 2nd key up and next key down of trigraphs.
- *KF13:* The duration of the third key of the trigraphs.
- *KF14:* The duration of the trigraphs from 1st key down to last key up.
- *KF15:* The number of key events that were part of the graph.