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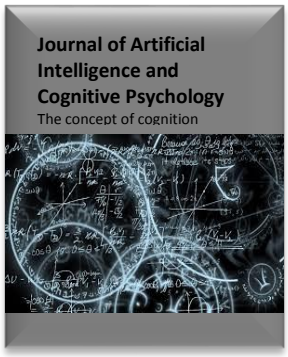

Emerging Cognitive Analytics for Detecting Cognitive Response Based on Pupil Dilation and Skin Conductance Response (SCR)

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Cognitive Analytics for Cognitive Response

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Abstract
Cognitive analytics uses Artificial Intelligence (AI) oriented methods to understand the context and meaning of certain sentences by recognising certain objects in a vivid image given the large amount of information presented as a graphical representation of its concept. AI algorithms and machine learning are used to improve the quality and content over time, by applying its concept and revealing patterns and network connections that have implementation strategies. Recent areas and projects in the development of analytics use cognitive analytics to monitor customer behaviour patterns and current emerging trends. This helps an organisation to predict future outcomes and make strategic plans for common objectives to improve production performance. The method adopted here uses an AI-oriented procedure to capture users' eye movement interaction in synchronous to physiological response. The baseline is set in such a way that the basic measure patterns is to detect event correlates and cognitive response to the visual content. Its major contribution is its ability to detect patterns that correlate to the user cognitive response as measured from their physiological response.

Keywords: *Cognitive psychology, user interface design, eye movement, pupil changes, skin conductance response, cognitive analytics*

1. INTRODUCTION

The concept relating to cognitive analytics and its perception has been improved over the years, it is considered as an intelligent technology that is capable of covering multiple analytical procedures to analyse a big amount of data and give a structured meaning to its unstructured boundaries. The procedure relating to its structured searches through the unstructured data that exists in its knowledge base and to establish a possible solution that contributes to knowledge and make sense for research questions.

The analytics in its cognition uses Artificial Intelligence (AI) that understands the context and meaning of certain sentences by recognising certain objects in a vivid image given the large amount of information presented as a graphical representation of its concept. It uses AI

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algorithms and machines to improve over time, applying its concept and revealing patterns and network connections that have implementation strategies. Recent areas and projects in the development of analytics use cognitive analytics to monitor customer behaviour patterns and current emerging trends. This helps an organisation to predict future outcomes and make strategic plans for common objectives to improve production performance. Other branches of cognitive analytics fall under the category of predictive analytics, which uses data in the business intelligence section to forecast prospects.

In the medical field, cognitive analytics is used to monitor and match patients with the available best treatment. Using computational oriented cognitive analytics one can tap into unstructured data sources like images, video contents, text documents and basic posts. The procedures implemented in its framework is capable of bringing real-time solutions for a huge amount of data and a paradigm shift from traditional analytics to modern-day data-driven solutions.

2. LITERATURE REVIEW

There are millions of bytes of data created that originates from sensors used to gather information from physical occurrence and behavioural phenomena such as physiological metrics [1, 2, 3, 4, 5, 6], climate information, digital pictures, videos, mobile GPS signals and purchase transaction, this is described as the oil of 21st-century digital economy [7, 8 9, 19, 11]. In this perspective data analytics is very important in both cognitively oriented research [12, 13, 14] and also in economic driven areas that encompass processing, transforming and modelling data with the sole purpose of realising very useful information that helps in decision making [15, 16, 17, 19, 20, 21]. The figure shows the stages of data analytics trends that have evolved over the past years from Descriptive to diagnostic, predictive, prescriptive and cognitive analytics which is the next big paradigm shift that will move us towards exploiting the massive advances in high-performance computing (HPC) that combines AI and Machine learning techniques with data analytics approach [22, 23, 24, 25, 26, 27].

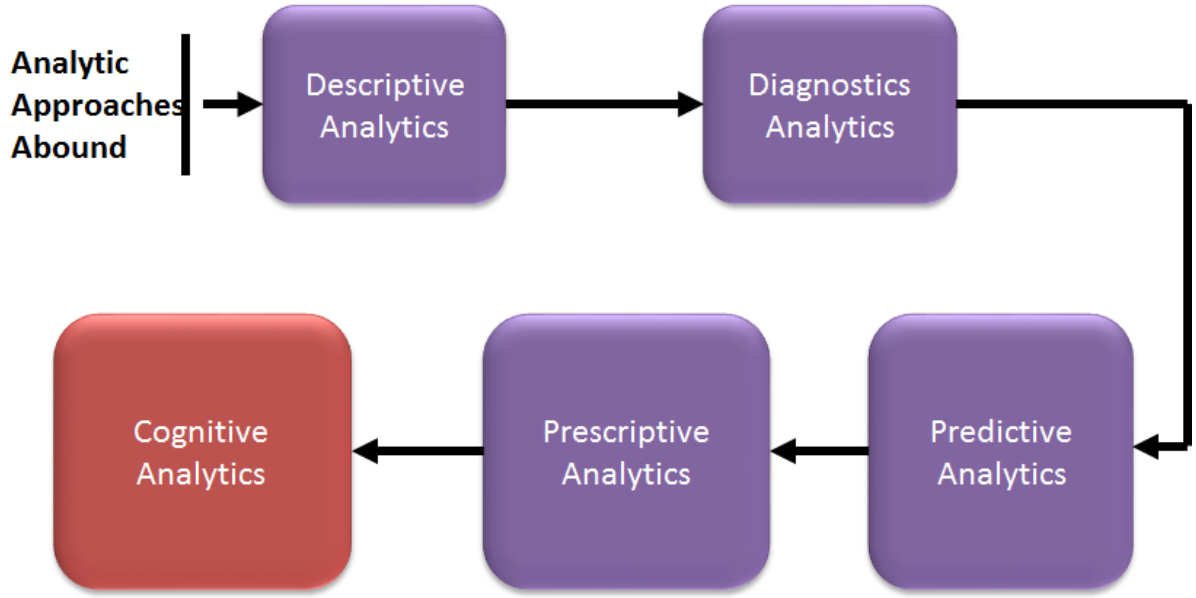

Figure 1: The stages of analytic approaches to data acquisition and processing.

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The entire concept in cognitive analytics applies the mechanism of human intelligence to basic tasks and combines intelligent technologies from semantics to deep learning to get smarter and more effective improvement in the modern technology from its interactions with human aptitude from harnessing the power of cognitive analytics. The process adopted in this paper is aimed to improve methods of analysing encoder or compress media content and its correlates to user physiological response to the visual display [28, 29, 30, 31]. The following sections outline the procedure for the cognitive analytical tool.

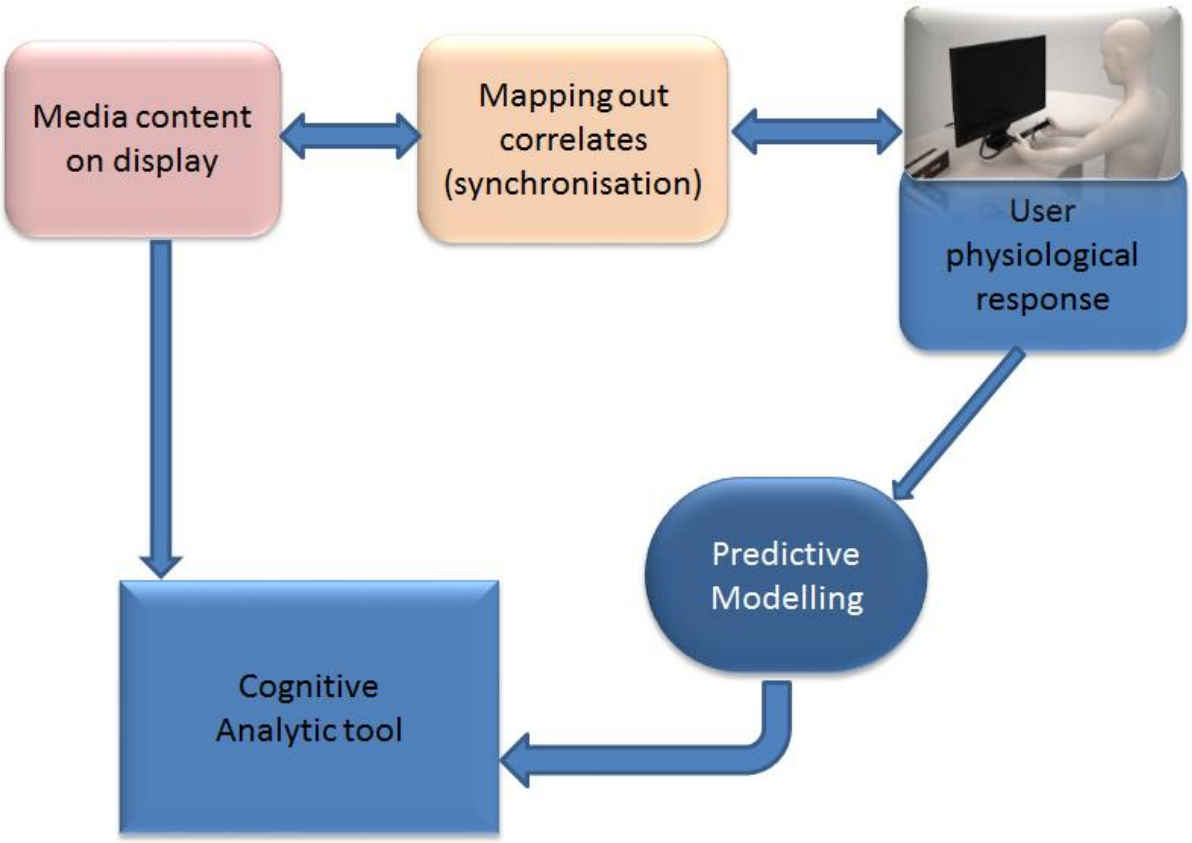

Figure 2: Framework on Cognitive analytics development and implementation.

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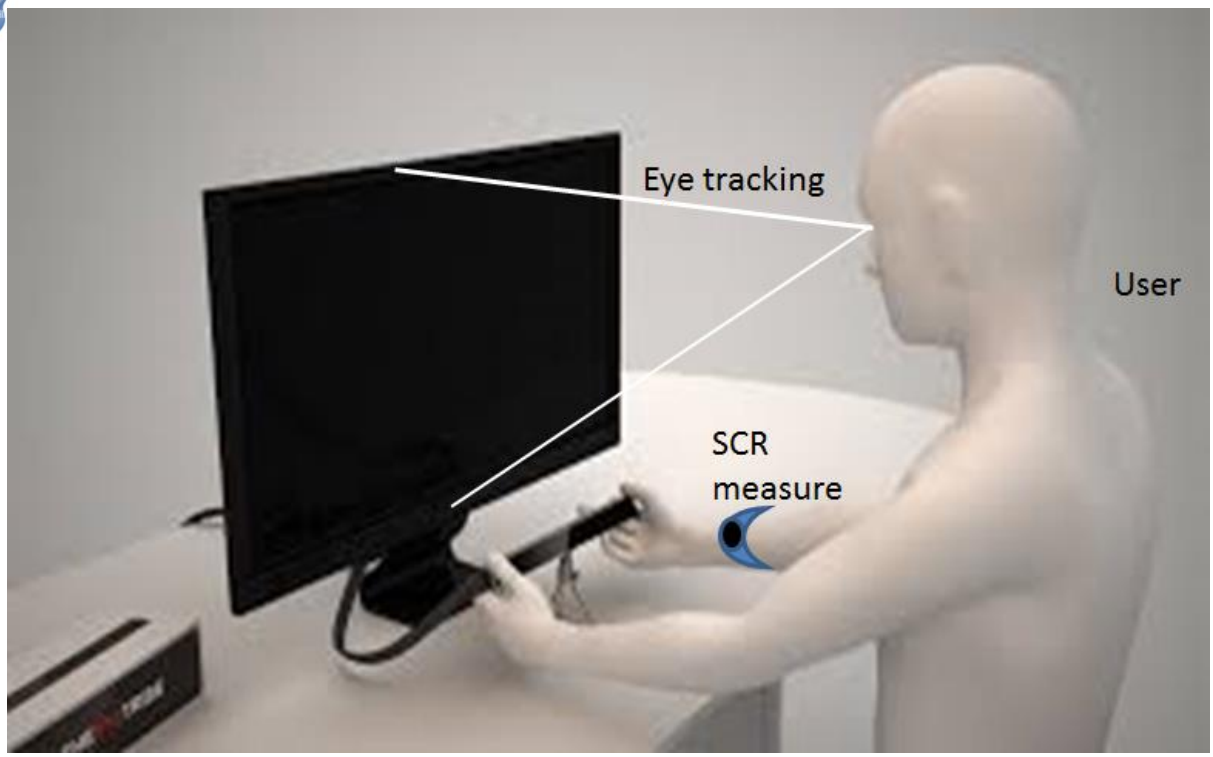

Figure 3: Experimental setup that involves two users.

3. METHOD

The method follows the concept from the application of predictive models (Recurrent Neural Network (RNN)) that uses the decoder data obtained from both image and video contents to detect physiological response and affect the state of the users during a UX session, the function is embedded as an inference engine to learn patterns in UX recorded datasets. The media content is synchronised at the same time as the physiological response of users is recorded RNN helps to map out and predict the correlates of their response to the different visual content displayed on the interface. Two users (Figure 3) were used for the pilot test of the analytical tool with their decoded and encoded data recorded in synch with the physiological response. Matlab was used as the platform to implement the model because of its capability to store a large number of datasets for both media and text content. Video content was recorded in frames while picture content is in pixel as the matrix (X_m). Figure 2 shows the framework of the process where the user physiological response is synchronised with the visual interface and event correlates are displayed on the data fields by simulation of the entire experimental setup for each time session entered.

I. Pupil Changes

Most recent work on pupil dilation and constriction refers to pupil dilation and constriction as a measure of changes in light intensity, depending on whether a person is in a dark or bright environment. It could also mean response to arousal and response to stimuli. The changes in pupil size do not only refer to changes in light intensity but can also reflect an underlying response to intentionally induced stimuli depending on the nature of an experimental study. It can also be used as a physiological measure to understand user effect or cognitive response to

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the displayed content. The method used here adopts pupil changes by measuring the eye movement of the user during interaction. As the eyes move like an object detector on the visual field, the pupil response is also recorded by a simple calculation of the pupil diameter and radius (Equation 1). The baseline metric is to determine whether the user is in stress or relaxed state.

$$P_{change} = D_{ex} - 2(D_{in});$$

$$D_{ex} = 2(Iris_{size});$$

$$D_{in} = \frac{2}{Iris_{size}}$$

Where D_{ex} is the external diameter and D_{in} is the internal diameter of the pupil in response to tracking of visual object this is measured in *cd* m^{-2}. The baseline is given has:

$$BaselineP = \min[index(P_{change})];$$

$$relax_{state} = BaselineP < Peaks_p;$$

$$stress_{state} = BaselineP > Peaks_p;$$

$$Neutral = BaselineP \quad \ldots 2$$

A relaxed, stress and neutral mood depend on whether the resp
the baseline response as the minimum index of the pupil response (Figure 3).

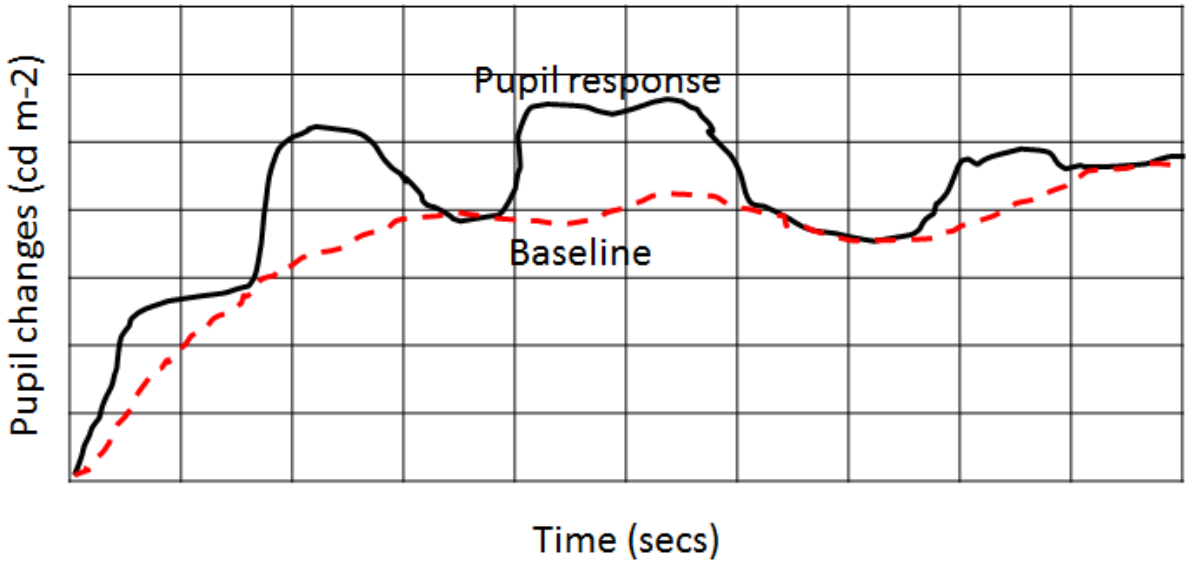

Figure 4: Difference between changes in pupil size and baseline of pupil response.

Video contents are analysed by decoding the frames with a compressor and correlating each frame to the eye movement recordings and Skin conductance (SC) measures.

II. Skin conductance Response

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This is the measure of the electrical changes of the skin in response to displayed visual content. Its user attributes is determine baseline on the increase and decrease above or below the baseline of the response state, this is also correlated to the changes in pupil size e.g. a stress state is detected if the baseline estimate of both physiological responses on maximum response peak or minimum response relates to a particular (Equation 3) on the visual field i.e.

$$EventP = Baseline_P \equiv Baseline_{SCR}$$

4. RESULT

... 3

Figure 5 below shows a captured scene of interaction with video content as stimuli. The eye movement shows the fixation points on the video content concentrated on the current study of a boy playing chess with the two kids. The task is to access the behaviour of the children as they play and pick out the kid with the most strategic moves, the expression and mood of the observer are captured in synch with the eye movement. The eye movement patterns on the figure show the fixation points on the boy at the left side of the video frame. The events around that point correspond to the peak points marked as concentration (20) and relax mood (21), the numbers match the coordinate of fixation points on the video frame. The baseline estimate for both response measures corresponds to the minimum index for both pupil response and the SCR. The system is designed in such a way as to use other physiological measures attached to the host computer.

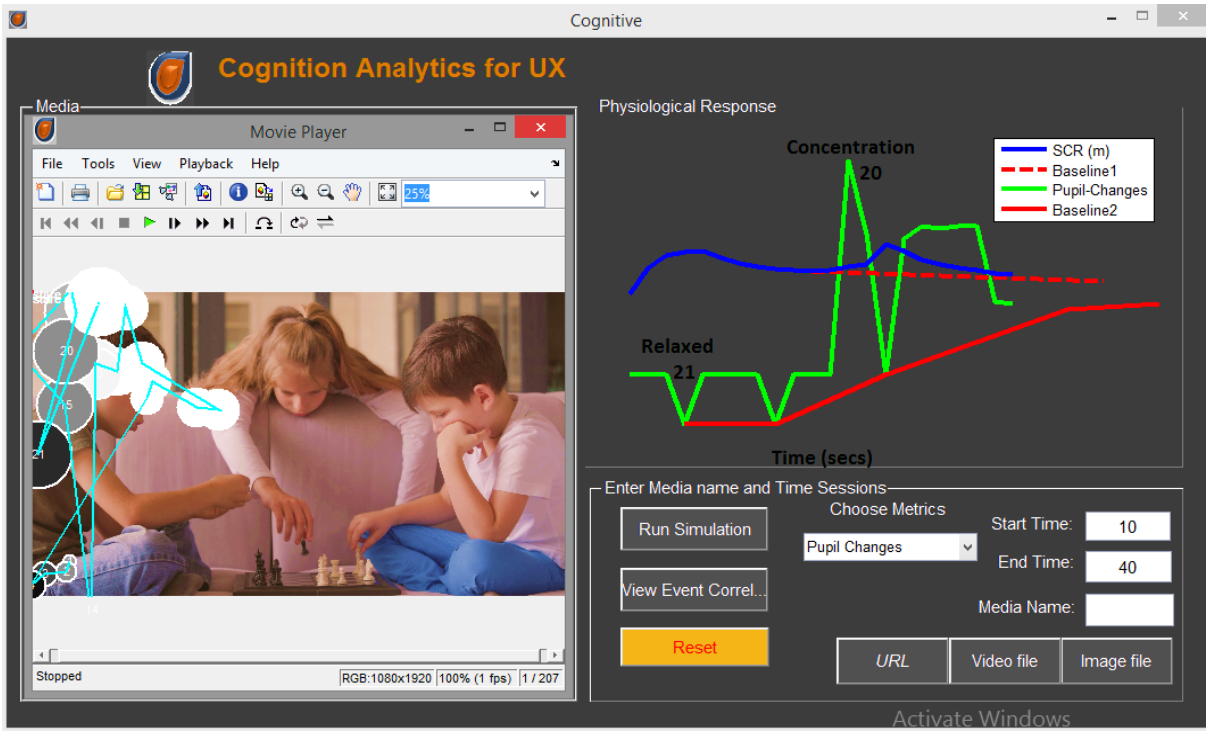

Figure 5: Captured interface showing video media interaction with eye movement in synch with the physiological response.

5. CONCLUSION

The paper tries to demonstrate the method applied in an emerging cognitive analytics tool for detecting cognitive response based on pupil dilation and skin conductance response. The

emergence of intelligent cognitive analytical tools for the cognitive response of users has been a part and branch of AI-oriented research. One of its novel contributions is its ability to accurately synchronise events for a particular session and detect the event correlates with response peak below or above the baseline of physiological response. The system is also generalized in such a way that you can use other physiological measures for analysis and synch with media content such as website, picture and video content. The future direction is to use it as a standalone and embedded analytical tool for UX experimental study and analysis.

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