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Intelligent Approach to Reduce Overstimulation for Multi-Screen Computing Systems

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Abstract – The use of computing systems is expected to significantly increase with the rapid proliferation of high-speed computing networks, and their use in modern internet integrated power systems. The increased adoption of computing entities and systems is accompanied with associated usage-related cognitive concerns. An important concern in this regard is that of cognitive overstimulation. Cognitive overstimulation arises in this case when the eyes execute roaming thereby accessing content from multiple web pages. The execution of eye roaming in this manner results in a visual sensory load. The concerned visual sensory load becomes significant when the concerned user utilizes a multi-screen computing system for enhancing individual productivity. The presented research proposes an intelligent mechanism to enable selective web page minimization, maximization, and migration between screens to reduce the visual sensory load. In addition, the proposed intelligent mechanism executes selective activation and deactivation based on the number of mouse click related activities. Performance evaluation shows that the proposed mechanism reduces the visual sensory load by (44 – 70)% on average.

Keywords – modern power grids ; future networks ; computing systems; cognitive overstimulation ; visual sensory load

I. INTRODUCTION

Computing systems, entities and solutions play a significant role in modern power system monitoring and operation [1–3]. However, the use of more computing entities and devices has been observed to raise challenges with regards to the occurrence of overstimulation.

Sensory overstimulation occurs when the subscriber's sensory organs are subjected to sensory input overload. The occurrence of sensory input overload arises when the subscriber's sensory organs (sense organs) have more information input than that which can be processed at a time. The overload leads to the occurrence of cognitive overstimulation. Cognitive overstimulation has been recognized to be a health challenge as seen in [4–6].

The occurrence of cognitive overstimulation arises due to the increasing use of computing entities and their derivatives. The challenge of cognitive overstimulation is expected to be of increasing significance in future communication networks i.e., sixth generation (6G), and beyond sixth generation (B6G) communication networks.

Multi-screen computing entities and systems have been recognized to be capable of enhancing individual productivity [7–9]. The use of multi-screen computing entities provides additional space for task execution. In this way, the use of multi-screen computing systems enhances human capacity for accelerated productivity. The viewpoint that technology can be used to enhance human capacity is also advocated in [10-12]. However, the use of multi-screen computing entities leads to the occurrence of cognitive visual overstimulation (CVO). CVO occurs when the sensory visual inputs require visual processing from multiple visual display units i.e., screens.

The discussion in [13] recognizes and addresses the challenge of CVO in smartphones used in fifth generation (5G) and beyond fifth generation (B5G) communication networks. However, the case of the modern power system as seen in smart grids with internet control capability. The research presented in [13] proposes a concept of sensory load balancing across the multiple senses. The sensory load balancing in this case is observed to reduce the sensory load per sense organ. The focus on [13] is on a smartphone and not on multi-screen computing systems (MCSs).

The presented research addresses the challenge of reducing the occurrence of CVO and visual sensory overload in MCSs. The MCS is being used in the context of an internet integrated smart grid power system. In this context, a manned human operator entity monitoring the status of multiple systems at different epochs is being considered. A similar context is applicable to the case of a personnel monitoring the states of different sub-systems associated with a space mission on a computing screen. In both cases, the concerned operator accesses repositories to gain an improved understanding of different status indicators. The concerned repositories are accessed online. Besides these applications, the proposed mechanism is applicable in a context and application domain where an individual utilizes computing systems with several interfacing screens. The presented research makes the following contributions:

1. First, the paper proposes an intelligent mechanism to reduce the visual sensory overload arising from the use of MCSs. This is done by recognizing the activity of eye roaming as a cognitive procedure through which a significant amount of content is accessed by the eyes for processing. The proposed intelligent mechanism considers the important parameters of observed screen activity, screen illumination duration, and active screen web interfaces, and active computing load.

These parameters are used for visual sensory overload regulation, and management in the MCS.

2. Second, the research formulates and investigates how the use of the proposed intelligent mechanism influences the visual sensory load (VSL). The VSL metric has been motivated by the consideration in [13]. In addition, the research evaluates the performance benefit of the proposed mechanism via MATLAB simulation of investigating the VSL.

The rest of the research is organized as follows. Section II describes the existing and background work. Section III presents the proposed solution. Section IV formulates the VSL performance metric. Section V evaluates and describes the performance benefit. Section VI concludes the presented research.

II. Background Work

The discussion in [1] identifies the notion that ethics is important with relation to the use of computers alongside artificial intelligence. Ethics is considered from the perspective of evaluating the impact of technology on the user. In this regard, the ethical aspects of computing systems are those associated with the use of data, data security and surveillance applications. Furthermore, computer application development is identified to be of ethical importance. In this regard, the effects of computer use, and application development, and its effect on user (human) health has not been considered.

The discussion by Laato *et al.,* [2] extends [1] by examining how the use of computers to enhance human productivity raises use related challenges. In addition, Laato *et al.,* [2] present an ethic–themed theory i.e., the culture lag theory. Laato *et al.* [2] focus on addressing the challenges that arise due to increasing computer usage. It is recognized that there is increasing adoption of computing systems that is propelling software development. The discussion recognizes the emergence of tools and technologies that serve to accelerate human productivity. The concern of ethics receives coverage via the consideration of culture lag theory. Culture lag theory advocates analyzing the implications of a selected path for technology deployment, and adoption. However, an ethical framework or ethical analysis of computing related technology has not been explicitly presented. Moreover, the focus in [2] is on software.

The use of computers and related technology results in the emergence of data. The discussion in [2] has considered how to ethically address the use of computers to enhance human productivity but not in handling the data arising from the use of computing technology. The concern of the ethical handling of data arising from computer use is discussed in Quach *et al.,* [3]. Quach *et al.* [3] address the concern of ethical use of client related data. The consideration of the data use approach assumes that the data has been acquired in an ethical manner. The data is acquired by data harvesters. In the context of [3], the use of computing systems and associated ethical concerns by data harvesters and data experts as not been addressed.

The concern of the ethical handling of data emanating from the use of computing systems is also relevant with relation to the COVID–19 pandemic [4]. The discussion by Xu *et al.* [4] recognizes that the sudden release of significant amount of data causes information overload. The overload in this case is called an infodemic. The occurrence of the infodemic during the COVID–19 pandemic is not unrelated to the large-scale use of computing systems and technologies. However, the aspect of information overload and infodemic arising due to the use of computing systems from the perspective of [4] requires further research consideration.

The use of computing systems involves the exertion of the human senses of touch and sight. This also results in the activation of different aspects of the human brain. The resulting processing of data in this case involves the excitation of the brain. This neural response has not been considered in [1–4] but receives focus in [5–13]. Werkhaven *et al.*, [5] identifies that a computational perspective is beneficial to understanding brain malfunction in mental disorder. The discussion in [5] identifies the role that external stressors play in mental disorder. However, the identify of the concerned external stressors is recognized to require additional research.

The discussion by Ghasemi *et al.*, [6] anxiety constitutes an external stressor to the occurrence of hyperexcitability in the hippocampus region. The discussion in [6] focuses on the sequence of brain responses arising due to the introduction of external fear inducing stressors. The focus in [6] is not on analyzing factors that induce fear overgeneralization. However, the discussion in [5] provides inference that fear overgeneralization stressors and stressors from other sources can arise from systems in the external environment. The focus of the discussion in [7] aims to identify how computing systems used in education constitutes a type of stressor from another sources besides the external fear stressor.

The discussion in [7] recognizes that the use of larger screens is most beneficial for reading and comprehension. The conclusion of the research by Haverkamp *et al.,* [7] is that the use of large screen computing devices is beneficial for use in education. The larger screen is not recognized to induce more visual stimulation thereby considering an external stressor source from the perspective of [6]. A similar perspective with focus on the productivity associated with using large screens and displays is in [8].

The discussion in [7–8] identifies that computer screens constitute an external stressor to the brain. In addition, it is identifies in [8] that larger screens and displays induce more visual stimulation thereby causing more external stress. The discussion by Amir *et al.,* [9] recognizes the use of multi-monitor computing systems. In addition, a negative effect is associated with the use of computig systems with multiple high resolution screens. A solution to address this challenge while retaining multi-screen productivity has not been addressed.

The increased use of computing systems as identified in [7–9] provides a technology base for a transition to post-human technology application. An important application that is recognized in this regard is that of artificial intelligence [10]. Lamola *et al.,* [10] discuss how the increased deployment of artificial intelligence enable the realization of post-humanism perspective in technology application. This receives consideration in the Society 5.0 application i.e., a merge of physical and cyberspace environment. However, the health implications i.e. potential of being another external brain stressor (especially due to the use multi-screen immersive computing ssystems) has not been considered. A consideration of post-humanism (solely from the beneficial perspective) can also be found in [11 – 12].

Periola *et al.* [13] recognizes that the increased use of computing systems constituting an external stressor to the human brain via the occurrene of cognitive overstimulation. The discussion in [13] addresses the challenge of the occurrence of cognitive overstimulation in mobile smartphones. The occurrence of cognitive overstimulation is addressed by proposed an intelligent mechanism that reduces subscriber's sensory load. This intelligent mechanism achieves the goal of reducing subscriber sensory load by controlling the screen exposure duration. However, the reduction of sensory load in multi-screen computing systems (MCSs) has not been considered and addressed in [13].

An important aspect that arises in the occurrence of cognitive overstimulation that is not addressed in [13] is that of eye roaming. Eye roaming is recognized in [14 – 16] to occur as an individual accesses information from the screen of a computing entity. The execution of eye roaming is recognized to be the kernel task for visual information processing. However, additional research is required to ensure that the occurrence of eye roaming does not result in cognitive overstimulation. This is especially important in the case of MCSs.

III. PROBLEM DESCRIPTION

The context being considered concerns an individual i.e., subscriber utilizing a computing system. The discussion in the rest of the paper section utilizes the mathematical notation presented in Table 1.

TABLE 1: MATHEMATICAL NOTATIONS

Notation	Meaning
α	Set of screens in a multi-screen computing system.
$\alpha_a, \alpha_a \epsilon\ \alpha$	The ath screen in the multi-screen computing system
t_y	The yth epoch in the consideration.
$V_1(\alpha_a,, t_y)$	Number of tasks on the ath screen at the yth epoch
ϑ_{thresh}	Threshold visual sensory load
$\vartheta_1(\alpha_a,, t_y)$	Visual sensory load of the ath screen at the yth epoch
$\alpha_1(S_1, D_y^1)$	The number of mouse clicks over the screen S_1over the duration D_y^1.
$\alpha_2(S_1, D_y^1)$	The number of active web interfaces over the screen S_1over the duration D_y^1.
$\alpha_3(S_1, D_y^1)$	The active computing load over the screen S_1over the duration D_y^1.
θ_1	The computational weight associated with the consideration of $\alpha_1(S_1, D_y^1)$.
θ_2	The computational weight associated with the consideration of $\alpha_2(S_1, D_y^1)$.
θ_3	The computational weight associated with the consideration of $\alpha_3(S_1, D_y^1)$.
ϑ_j	The visual sensory load for the j^{th} screen.
$\alpha_1(S_j, \beta_f, D_y^n)$	The web-based number of mouse clicks for the f^{th} web interface β_f on screen S_j over the duration D_y^n spanning the epochs t_1 and $t_n, t_n \epsilon\ t$
ϑ_{exi}	Visual sensory load for an existing multi-screen computing system.
ϑ_{pro}^1	Visual sensory load in the proposed case for a multi-screen computing system without migration.
ϑ_{pro}^2	Visual sensory load in the proposed case for a multi-screen computing system with migration.
$I_A(S_j, \beta_f, D_y^n)$	Web page activity indicator for the f^{th} web page β_f on the j^{th} screen S_j over the duration given by D_y^n.
$\gamma(S_j, D_y^n)$	Number of active web pages on the screen S_j over the observed duration D_y^n.

The considered computing system comprises multiple screens. Let the set of screens be given as α.

$$\alpha = \{\alpha_1, \alpha_2, \dots, \alpha_A\} \quad (1)$$

The subscriber visual sensory load for the a^{th} screen in the MCS $\alpha_a, \alpha_a \epsilon\ \alpha$ at the epoch $t_y, t_y \epsilon\ t, t = \{t_1, \dots, t_Y\}$ is given as $V_1(\alpha_a,, t_y)$. The number of tasks executed on the concerned screen and associated with the visual load $V_1(\alpha_a,, t_y)$ is given as $\vartheta_1(\alpha_a,, t_y)$. In addition, enhanced user productivity is obtained when $\vartheta_1(\alpha_a,, t_1) < \vartheta_1(\alpha_a,, t_2) < \vartheta_1(\alpha_a,, t_3)$ for different variations of the VSL on the screen α_a across the epochs t_1, t_2, and t_3. The visual sensory load in this case could be either $V_1(\alpha_a,, t_1) \le V_1(\alpha_a,, t_2) \le V_1(\alpha_a,, t_3), V_1(\alpha_a,, t_1) > V_1(\alpha_a,, t_2) > V_1(\alpha_a,, t_3)$ or $V_1(\alpha_a,, t_1) \approx V_1(\alpha_a,, t_2) \approx V_1(\alpha_a,, t_3)$.

The case of a loss in individual i.e., subscriber productivity is deemed to occur when there is an increase in the visual sensory load as influenced by the number of tasks executed on the concerned screen. A decline in the user productivity is observed when $\vartheta_1(\alpha_a,, t_1) > \vartheta_1(\alpha_a,, t_2) < \vartheta_1(\alpha_a,, t_3), \vartheta_1(\alpha_a,, t_1) > \vartheta_1(\alpha_a,, t_2) > \vartheta_1(\alpha_a,, t_3)$ or $\vartheta_1(\alpha_a,, t_1) < \vartheta_1(\alpha_a,, t_2) > \vartheta_1(\alpha_a,, t_3)$. An increasing visual sensory load profile in this case could be described by one of the three conditions $V_1(\alpha_a,, t_1) \le V_1(\alpha_a,, t_2) \le V_1(\alpha_a,, t_3), V_1(\alpha_a,, t_1) > V_1(\alpha_a,, t_2) > V_1(\alpha_a,, t_3)$ or $V_1(\alpha_a,, t_1) \approx V_1(\alpha_a,, t_2) \approx V_1(\alpha_a,, t_3)$.

In the case where the visual sensory load profile is given as $V_1(\alpha_a,, t_1) \le V_1(\alpha_a,, t_2) \le V_1(\alpha_a,, t_3), V_1(\alpha_a,, t_1) > V_1(\alpha_a,, t_2) > V_1(\alpha_a,, t_3)$ or $V_1(\alpha_a,, t_1) \approx V_1(\alpha_a,, t_2) \approx V_1(\alpha_a,, t_3)$, it is important to ensure a scenario where the instantaneous visual sensory load is less than or equal to the threshold visual sensory load ϑ_{thresh}. In this case, the visual sensory load meets the conditions: $\vartheta_1(\alpha_a,, t_1) \le \vartheta_{thresh}, \vartheta_1(\alpha_a,, t_2) \le \vartheta_{thresh}, \vartheta_1(\alpha_a,, t_3) \le \vartheta_{thresh}$. Th design of a solution that enables the realization of this condition is the goal of the presented solution.

PROPOSED SOLUTION

The reference computing system has multiple screens, has one subscriber i.e., user and is shown in Figure 1.

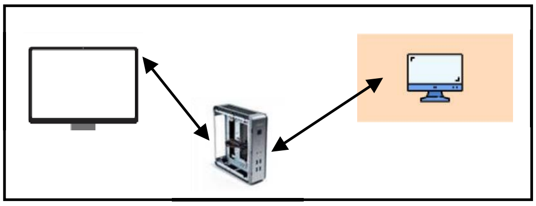

Figure 1: Reference Multi-Screen Computing System.

The end-user is executing jobs requiring having access to the display from multiple screens. In this case, the computing system's use pattern is deemed to be described by the user on-screen activity, screen illumination duration (this determines the number retina processing epochs), active web screen interfaces (which influences eye roaming), and the active computing load.

The parameters are monitored by a screen focused computing client entity (SFCE). The SFCE observes the value of these parameters and uses these values alongside corresponding weights to compute the visual sensory load (VSL). The VSL is computed in the non-cloud variant for a given and an observed screen illumination duration. In this case, the screen illumination duration is the user specified period for screen use in utilizing the multi-screen computing system (MCS).

The number of mouse clicks (describing user on-screen activity), active web interfaces (influencing eye roaming), and active computing load for the screen S_1 over the duration D_y^1 (corresponding to the epochs spanning instants t_1 and t_y , $t_1 \epsilon t$, $t_y \epsilon t, t = \{t_1, \dots, t_1 \epsilon t_Y\}$ are denoted as $\alpha_1(S_1, D_y^1), \alpha_2(S_1, D_y^1)$, and $\alpha_3(S_1, D_y^1)$, respectively. The SFCE acquires the value of the parameters $\alpha_1(S_1, D_y^1), \alpha_2(S_1, D_y^1)$, and $\alpha_3(S_1, D_y^1)$. The weight associated with $\alpha_1(S_1, D_y^1), \alpha_2(S_1, D_y^1)$, and $\alpha_3(S_1, D_y^1)$ are denoted θ_1, θ_2 and θ_3, respectively. The visual sensory load i.e., VSL in this case ϑ_1 is given as:

$$\vartheta_1 = \sum_{m=1}^{3} \sum_{N=1}^{2} \theta_m \, \alpha_m(S_1, D_y^1) \,, y > z \tag{1}$$

For the j^{th} screen, the VSL ϑ_j is given as:

$$\vartheta_j = \sum_{m=1}^{3} \sum_{n=1}^{2} \theta_m \, \alpha_m(S_j, D_y^1) \,, y > z \tag{2}$$

There is a high VSL for the MCS with respect to the j^{th} screen when $\alpha_2(S_j, D_y^1) > \alpha_1(S_j, D_y^1)$, and $\alpha_2(S_j, D_y^1) > \alpha_3(S_j, D_y^1)$ over the duration spanning the epochs t_1 and t_y. The rationale for these relations is the mouse clicks are being executed while completing a task without involving eye roaming. Eye roaming is highly visual cognitive because it involves processing visual input stimuli from multiple active web pages. The process of eye roaming is recognized and implied to be highly cognitive (as a trigger of attention) as seen in [14–16]. In addition, the presented research recognizes that computing load execution may not necessarily require active visual attention.

In the case where the relation $\alpha_2(S_j, D_y^1) > \alpha_p(S_j, D_y^1), p \, \epsilon \, \{1,3\}$ holds true, the eye roaming associated with viewing multiple web pages is reduced. This is done by reducing the inactive web pages. Inactive web pages are identified by the client in the SFCE as those having the mean least number of clicks. These web pages are also not executing any computing load. The web-based number of mouse clicks for the f^{th} web interface β_f on screen S_j over the duration D_y^n spanning the epochs t_1 and $t_n, t_n \epsilon \; t$ is denoted as $\alpha_1(S_j, \beta_f, D_y^n)$. The parameter described by $\alpha_1(S_j, \beta_f, D_y^n)$ can also be obtained for other web interfaces.

The SFCE executes a web-based interface ranking procedure. In this ranking procedure, web pages are deemed inactive if their values fall below a user defined threshold. The flowchart showing the execution of this process is presented in Figure 2. The flowchart shown in Figure 2 aims to limit the visual sensory load (VSL) by reducing the number of eye roaming events while using the MCS. However, eye roaming minimization may not necessarily reduce the VSL when active webpages are deemed critical and cannot be deactivated. In this case, the on-screen webpage load can be reduced. The on-screen webpage load (OSWL) reduction can be executed by grouping the on-screen web pages and minimizing the grouped web-pages.

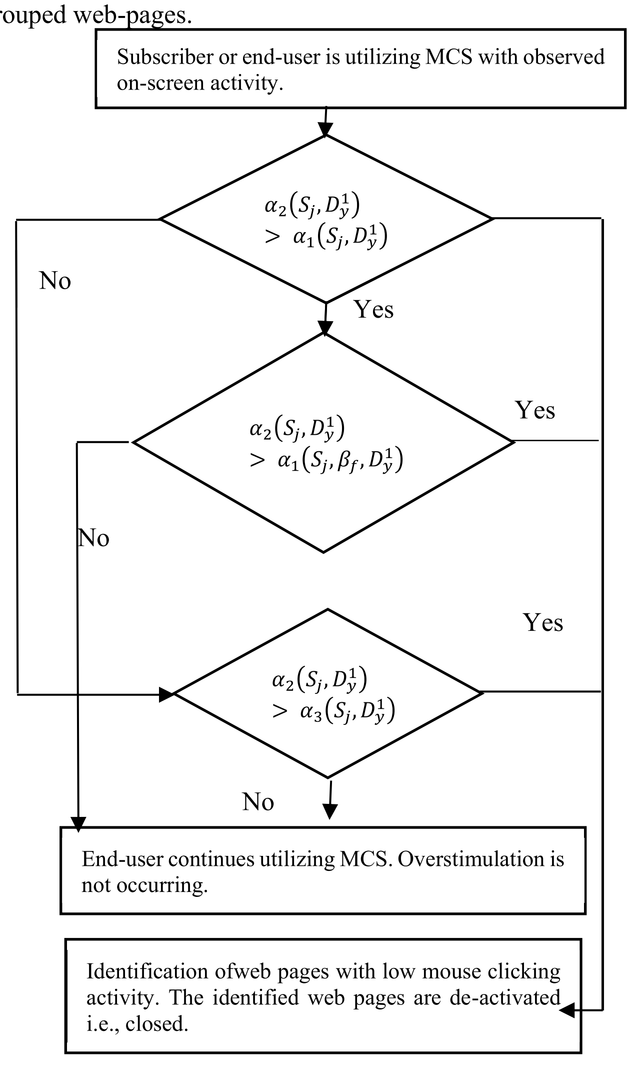

Figure 2: Flowchart showing task execution sequence describing dynamics within a screen in the multi-screen computing system (MCS).

The minimized web-page groups are maximized after a given duration. Groups of minimized web pages form an array that are selectively viewed after informing the user. The execution of selectively viewed maximized web pages is done given the availability of sufficient computing resources. In the case where sufficient computing resources is not available, the SFCE checks to see if a screen with integrated computing resources is available. The availability of computing resources on an integrated screen enables the migration of web page group arrays for future selective maximization. The flowchart shows the sequence of tasks when OSWL is incorporated as shown in Figure 3.

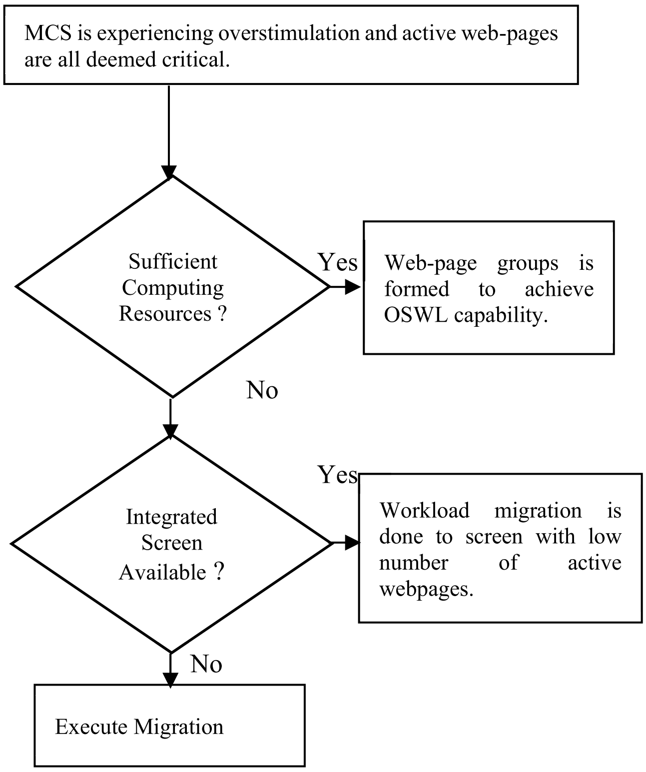

Figure 3: On-Screen Workload Reduction via Migration.

IV. PERFORMANCE FORMULATION

The performance metric being examined and formulated is the visual sensory load (VSL). The VSL is formulated recognizing the cognitive load associated with the execution of eye roaming. Eye roaming between different web pages opened on a screen in the MCS is recognized to have a high cognitive load. This is because it requires analyzing multiple input content in a short duration. The VSL is formulated for three scenarios i.e., Scenario 1, Scenario 2, and Scenario 3. Scenario 1 describes the existing case. Scenario 2 and Scenario 3 focuses on the proposed case (without migration) and proposed case (with migration), respectively.

The VSL in the existing case for the j^{th} screen is denoted as ϑ_j and is presented in (2). The VSL $j\vartheta_j$ is formulated for an MCS comprising multiple screens is denoted ϑ_{exi} and given as:

$$\vartheta_{exi} = \sum_{j=1}^{J}\sum_{m=1}^{3}\sum_{y=1}^{z} \theta_m \, \alpha_m\left(S_j, D_y^n\right), n > z \quad (3)$$

The VSL in the proposed case (without migration) is denoted ϑ_{pro}^1 and given as:

$$\vartheta_{pro}^1 = \sum_{j=1}^{J}\sum_{m=1}^{3}\sum_{n=1}^{z}\sum_{f=1}^{F} \theta_m \, \alpha_m\left(S_j, D_y^n\right)\left(1 - \frac{A(j,n,f,y)}{B(j,n,f,y)}\right) \quad (4)$$

$$A(j,n,f,y) = \left|I_A\left(S_j, \beta_f, D_y^n\right) = 1\right| \quad (5)$$

$$B(j,n,f,y) = A(j,n,f,y) + \left|I_A\left(S_j, \beta_f, D_y^n\right) = 0\right| \quad (6)$$

$I_A\left(S_j, \beta_f, D_y^n\right) \epsilon \{0,1\}$ is the web page activity indicator for the f^{th} web page β_f on the j^{th} screen S_j over the duration given by D_y^n. The web page β_f is active and inactive on the j^{th} screen S_j over the duration described by D_y^n when $I_A\left(S_j, \beta_f, D_y^n\right) = 1$, and $I_A\left(S_j, \beta_f, D_y^n\right) = 0$, respectively. The active status implies a high number of mouse clicks while an inactive status implies a low number of mouse clicks related events. The VSL in the proposed case (with migration) is denoted ϑ_{pro}^2 and given as:

$$\vartheta_{pro}^2 = \sum_{j=1}^{J}\sum_{m=1}^{3}\sum_{y=1}^{z}\sum_{f=1}^{F} \frac{\theta_m \, \alpha_m\left(S_j, D_y^n\right)}{\gamma\left(S_j, D_y^n\right)}\left(1 - \frac{A(j,n,f,y)}{B(j,n,f,y)}\right) \quad (7)$$

$\gamma\left(S_j, D_y^n\right)$ is the number of active web pages on the screen S_j over the observed duration D_y^n.

VI. PERFORMANCE EVALUATION

The performance evaluation is done via MATLAB simulations using the parameters in Table 1. In addition, the computer screens in the MCS are deemed to spend equal duration proportion in the active state and the inactive state.

The simulation parameters in Table 2 have been selected considering a brief glance at the screen by the user. In this case, the user i.e., subscriber is executing multiple tasks. The execution of these multiple tasks requires that the user acquires input from up to ten screens. These screens are associated with the computing entities. In the simulation procedure, the user spends a maximum of 1 second acquiring data from and glancing at a screen. In the considered simulation scenario, the activity ratio and inactivity ratio are independent for a given screen. Furthermore, each screen has independent activity ratio and inactivity ratio relative to each other. The user is considered to view a varying number of web pages on each screen. However, the maximum number of viewed web pages on a screen is 10.

TABLE 2: PARAMETERS USED IN THE SIMULATION PROCEDURE

S/N	PARAMETER	VALUE
1	Total Number of Screens	10
2	Maximum Screen Duration [Screen 1 Screen 2 Screen 3]	[0.964, 0.998, 0.995] seconds
3	Minimum Screen Duration [Screen 1 Screen 2 Screen 3]	[0.02, 0.09,0.06] seconds
4	Mean Screen Duration [Screen 1 Screen 2 Screen 3]	[0.54,0.57,0.40] seconds
5	Maximum Screen Duration [Screen 4 Screen 5 Screen 6]	[0.989,0.980, 0.833] seconds
6	Minimum Screen Duration [Screen 4 Screen 5 Screen 6]	[0.07 0.09, 0.06] seconds
7	Mean Screen Duration [Screen 4 Screen 5 Screen 6]	[0.493,0.473,0.471] seconds

8	Maximum Screen Duration [Screen 7 Screen 8 Screen 9]	[0.841, 0.941,0.954] seconds
9	Minimum Screen Duration [Screen 7 Screen 8 Screen 9]	[0.40, 200.6,199.2] ms.
10	Mean Screen Duration [Screen 7 Screen 8 Screen 9]	[0.445,0.619,0.702] seconds
11	Maximum Screen Duration [Screen 10]	0.988 seconds
12	Minimum Screen Duration [Screen 10]	0.082 seconds
13	Mean Screen Duration [Screen 10]	0.628 seconds
14	Maximum Active Ratio [Screen 1 Screen 2 Screen 3]	[87.2% 60.9%, 70%]
15	Minimum Active Ratio [Screen 1 Screen 2 Screen 3]	[1.2%, 3.8% 18.6%]
16	Mean Active Ratio [Screen 1 Screen 2 Screen 3]	[47.3%,30.8%,40%]
17	Maximum Active Ratio [Screen 4 Screen 5 Screen 6]	[82.1% 82.3%,85.2%]
18	Minimum Active Ratio [Screen 4 Screen 5 Screen 6]	[3.2%,3.4%,9.6%]
19	Mean Active Ratio [Screen 4 Screen 5 Screen 6]	[54.2%,44.7%,48.1%]
20	Maximum Active Ratio [Screen 7 Screen 8 Screen 9]	[93% ,80.8%,95.6%]
21	Minimum Active Ratio [Screen 7 Screen 8 Screen 9]	[19.5%,0.47%,27.4%]
22	Mean Active Ratio [Screen 7 Screen 8 Screen 9]	[58%,45.3%,67.3%]
23	Maximum Active Ratio [Screen 10]	87.7%
24	Minimum Active Ratio [Screen 10]	2.15%
25	Mean Active Ratio [Screen 10]	49.7%
26	Maximum Inactive Ratio [Screen 1 Screen 2 Screen 3]	[64.5% 51% 60%]
27	Minimum Inctive Ratio [Screen 1 Screen 2 Screen 3]	[0.11 %, 0.50%,0.005%]
28	Mean Inctive Ratio [Screen 1 Screen 2 Screen 3]	[28.7%, 22.2%, 17.7%]
29	Maximum Inctive Ratio [Screen 4 Screen 5 Screen 6]	[53.5% 56.2% 38.7%]
30	Minimum Inactive Ratio [Screen 4 Screen 5 Screen 6]	[0.005%,2.5%,1.8%]
31	Mean Inactive Ratio [Screen 4 Screen 5 Screen 6]	[12.4%,24.5%, 18.3%]
32	Maximum Inactive Ratio [Screen 7 Screen 8 Screen 9]	[48.9% 58.6% 82.4%]
33	Minimum Inactive Ratio [Screen 7 Screen 8 Screen 9]	[1%,0.002%,0.70%]
34	Mean Inactive Ratio [Screen 7 Screen 8 Screen 9]	[14.2%, 15.3%,26%]
35	Maximum Inactive Ratio [Screen 10]	44.9%
36	Minimum Inactive Ratio [Screen 10]	5.18%
37	Mean Inactive Ratio [Screen 10]	21.6%
Mean Number of Web Pages		
38	[Screen 1 Screen 2 Screen 3 Screen 4]	[0.47 4.41, 7.81 9.92]
39	[Screen 5 Screen 6 Screen 7 Screen 8]	[8.49 0.6 7.67 7.25]
40	[Screen 9 Screen 10]	[7.55 2.01]

The performance simulation result showing the mean visual sensory load (VSL) obtained using the parameters presented in Table 1 is shown in Figure 4. The presented simulation results on the VSL consider a case where each of the screen has a varying value of the active ratio, and inactive ratio. The results presented shows that there is a momentary drop in the VSL. This is because of a momentary reduction in the mean number of accessed web across these screens i.e., Screen 3, Screen 4, Screen 5, Screen 6, and Screen 7.

The results presented in Figure 4 show that the use of the proposed mechanism with the incorporation of workload migration results in a reduced mean visual sensory load (VSL). Analysis of the presented simulation results shows that the use of the proposed mechanism (with workload migration) and proposed mechanism (without workload migration) instead of the existing approach reduces the VSL by an average of 70%, and 50%, respectively. Furthermore, the incorporation of the capability of workload migration reduces the VSL by an average of 44%.

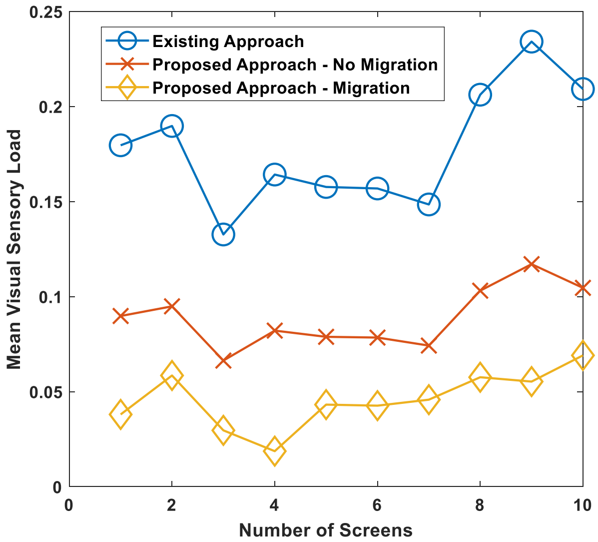

Figure 4: Simulation Results of the Mean Visual Sensory Load.

The simulation results presented in Figure 4 show that the use of the proposed approach with the incorporation of migration results in a reduced visual sensory load. The implication of the presented results is that the incorporation of the proposed solution in a manner that monitors the visual sensory load and with migratory support reduces visual sensory load. The visual sensory load reduction is applicable to the individual working in a context where they make use of multi-screen computing system.

VII. CONCLUSION

The presented research addresses the concern of health issues that may arise with the increased use of computing systems. The increased use of computing systems is recognized to arise with the increasing adoption of the sixth generation and beyond sixth generation communication networks. The use of computing systems in these networks involves accessing web-based content. The research recognizes that eye roaming (leading to high visual sensory load) is important for information access across multiple web pages. The research aims to reduce the occurrence of cognitive overstimulation by lowering the visual sensory load. This is done by limitng the number of web pages across multiple screens via the selective activation and deactivation of web pages and screens in a multi-screen computing system. The multi-screen computing system has been because of it computing system in enhancing its ability to enhance human productivity. The use of the proposed mechanism in a multi-screen computing system reduces the visual sensory load by an average of (44–70)%. Future work will focus on re-examining the visual sensory load by examining computing entity use patterns in a multi-screen computing intensive environment ; and also conducting validating studies prior to development in identified and select computing environments.

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