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Biometric Censoring Skin Conductance Response and Pupillary Response Using Touch Pad

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Abstract

In the actual sense, the skin tells us a lot about our emotions, our skin gives out a lot of information about what we feel and responds to stimuli when exposed to emotionally loaded stimuli inform of video content, images, events, and other kinds of stimuli. They give both positive and negative emotions depending on what we are involved in. During stress and nervous or fearful situations, we are automatically psyched up or surprised. The electrical conductivity of the skin subtly changes in reaction to such emotion. One of the most sensitive measures for emotional arousal is the skin conductance response (SCR) and pupil dilation (PD). This paper demonstrates the logical design behind their mechanism and how it can be used to measure the emotional response and physiological responses of a person by expurgating its response measure. The method adopted uses a novel method of design in a custom-based logic scheme that illustrates the logic and its mechanism. Custom intelligent analytics that is mobile inclined is used to visualise and analyse the physiological readings by detecting tonic and phasic changes using Savistki Golay filter. The error in physiological response prediction is computed for each response rate and discussed in the result section.

Keywords: *Skin conductance response, Pupil response measure, Mobile eye-tracking, Smartphone, RGB camera, Savitsky Golay, Computer vision*

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1 INTRODUCTION

The skin conductance response originally originates from the automatic activation of sweat glands on the surface of the skin. The sweating on the hands and the feet are triggered by emotional stimulation *(Harker (2013); van Dooren et al. (2012))*. When there is an emotional inducement from external stimuli the SCR data shows distinctive patterns that are most of the time visible to the ordinary eyes and can also be quantified based on statistical measures *(Eippert et al. (2007); Lanteaume et al. (2007); Ohira et al. (2006); Stephens et al. (2010); Dimberg (1987); Ohman and Wiens (2003); Grewe et al. (2011))* .

To understand the mechanics of the SCR *(Wang et al. (2018); Iffland et al. (2014); Crone et al. (2004))*, we need to understand the physiological characteristics of the skin organ of the body. The skin is one of the major organs of the body and it functions as the principal interface between the organism and the environment.we need to understand the physiological characteristics of the skin organ of the body. The skin is one of the major organs of the body and it functions as the principal interface between the organism and the environment. The skin is a protective barrier, the skin separates the body from the environment and its threats such as mechanical impacts, and variations in temperature and pressure.

How can the skin be a stolen field in line with non-conductivity in a dry state? Given the non-active or low response readings in most physiological responses such as the SCR.

The touch screen is one of the novel methods of detecting a response from the skin to the surface screen due to the problem of lack of conductivity in response detection in some users. The projected capacitance of the touch screens in sensors measuring changes the electric field coupling (Figure 1) from the drive electrode to the sensor or receive electrode and can be used to sense even the driest skin in a person. Another trivial question that should be asked is: Don't the field lines terminate on conductive surfaces with low conductivity? This paper discusses briefly some of these challenges by reflecting on the fact that the changes in capacitance read-out when the finger is brought close to the sensor are based on pico-farad phenomena, considering how the non-conductive of the epidermis layer of the skin changes in large variations ($\sim 100kOhms$). The field lines in some research *(Khadka and Bikson (2020); Zhao et al. (2021); Wake et al. (2016); Abe and Nishizawa (2021))* are known to terminate on conductive layers underneath the skin i.e. epidermis layer. This measures the phasic and tonic changes of the skin in response to stimuli. Another known physiological measuring censoring part of the human body is the Pupillary response (Pupil changes), this part not only tells of changes in light intensity but also a significant response to stimuli *(Nunnally et al. (1967); Granholm et al. (1996); Hakerem and Sutton (1966); Beatty (1982); Stanners et al. (1979))*.

Eye movements have been a central part of understanding attention and visual processing in the mind. The study of how the eyes move and what they fixate on during a specific moment in time when a user is performing certain tasks has been considered to offer a direct way of measuring spatial attention and focus, in some cases, it can provide a window to the brain. Analysing eye movements and pupil response has been one of the major interests of a much broader community with its applications ranging from user behaviour to driving and game interface theory. Recently *(Stephens et al. (2010); Dimberg (1987))*, eye movement reading has now been inclined to using mobile apps that calibrate the eyes and are used in tracking in extensive mode on visual surfaces, it is a reliable and accurate measure. There are several different methods and systems used to track eye gaze for a person. Some of its drawbacks include complexity, invasiveness, and low cost. This can also be of advantage since most research is cutting back on very expensive experimental setup and design procedures.

Mobile eye-tracking and pupil response detection have been a central part of understanding visual attention and processing in human cognition. The eyes move and fixate during specific moments and it is considered by some to offer a direct means to measure spatial attention. The

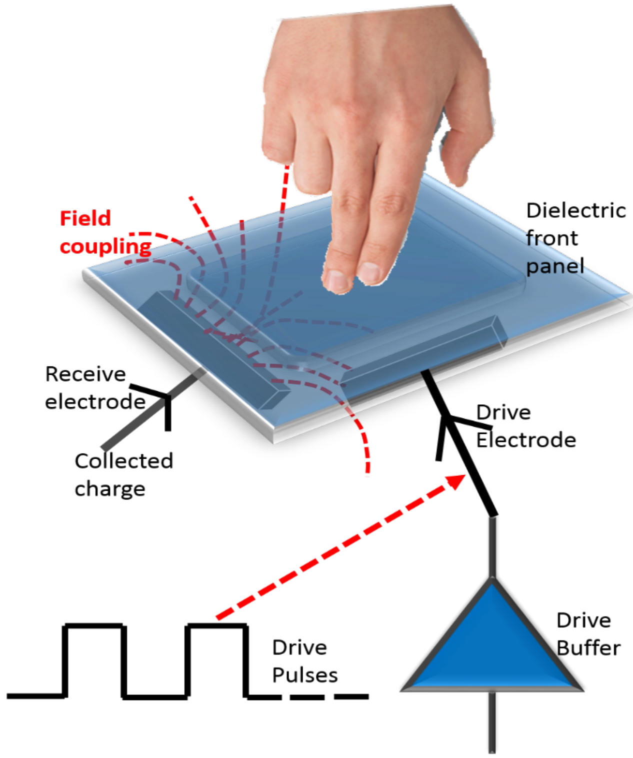


Figure 1: The logic design of the SCR using a touch screen sensor.

main purpose and goal of most research regarding eye movement are to make eye tracking more available and common to both users and evaluators by implementing and evaluating new and promising techniques. One of these promising techniques is using a mobile lens as a means of tracking and measuring users' fixations and changes in pupil size. The mechanism behind this is based on a light sensor that locates an iris position (Figure 2).The method and procedure used in detecting and simultaneously tracking eye fixations and pupil response are discussed in the proceeding section.

2 METHOD

The method adopted here is based on a user-interface setup where participants (5) recruited were to look at a mobile lens camera in real-time and the image of the right eye is captured. The visible skin for the physical contact to the light conversion is used as input images from the mobile lens to the (Figure 3) optical system and an image sensor that registers the captured image in a tablet that hosts the analytical tool is set for images and perception by synchronising other physiological response from the touch screen for more visible information.

In this process, the skin inside the lens is equal to the sensor image outside the lens and response data detected is transferred back to the mobile lens. Both eye and skin mechanisms can be visualised in synch with the

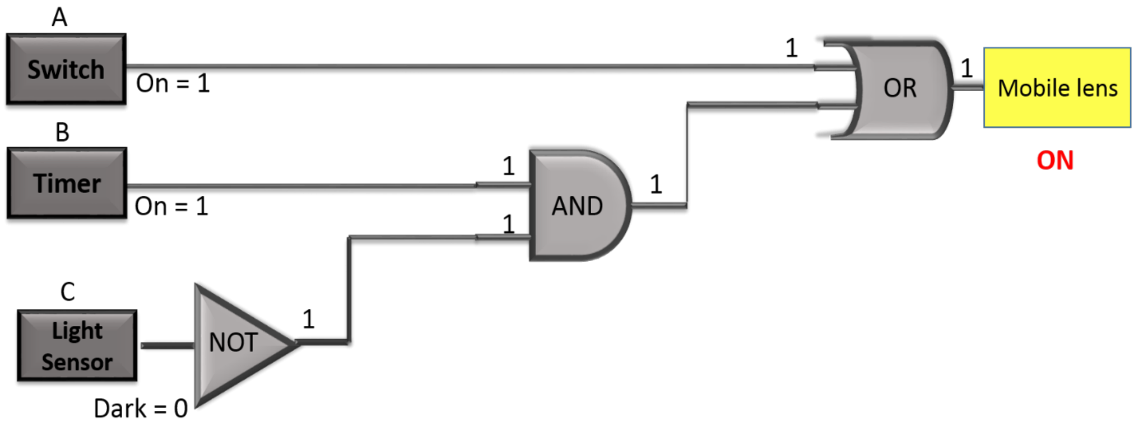


Figure 2: Logic circuit for a mobile inclined sensor for input data recording.

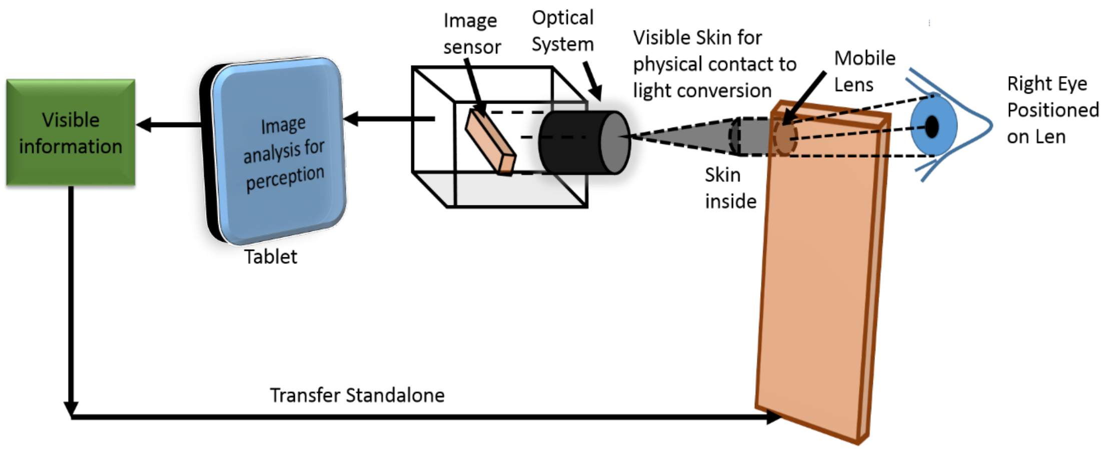


Figure 3: The eye captured mechanism for image sensoring and image analysis and perception.

other physiological measuring sensor. The participants recruited were simply asked to look into the camera of the mobile phone while they interacted with dynamic webpage contents. This is based on a pilot study to test the level of responsiveness and sensitivity to the visual content and at the same demonstrate the logical simulation of the concept described in this paper. The method of data analysis is strictly based on system testing and modifications. The result and image output from both sensors are discussed in the result section.

3 RESULT

The input and output image is both detected using the analytical tool (Figure 6). This is used to visualise and analyse the response detected for each input image from the measuring sensors. Figure 4a and 4b show the input image and the output image of the fingerprint capture and the physiological response (SCR) detected from the image sensor module from the touch screen. The iris in the region of the eye is based on centroid detection and changes in centroid both in area and diameter as the eyes move along the visual interfaces are tracked and recorded via the link to the lens port and its mechanics are simulated by the inference engine designed module. Matlab was the best program to implement the software, due to its large library and blocks for simulation of motor and sensory dynamics. The SCR is detected based on the amount of moisture content on the finger surface induced by visual stimuli. HOG features are first detected and the moisture content is recorded continuously with time. The use of short-term intervals was used in this case since the program is at its pilot stage and model modification.

The eye positions for iris detection are first captured at the initial stage (Figure 5), and the pupil is then detected and tracked with time. The changes in pupil size (Constriction and dilation) are used as one of the physiological metrics and also a way of determining the cognitive state of the user based on pupil constriction and dilation in response to visual stimuli. The fixations are eye locations recorded on the visual field which is made possible by eye calibration. Each coordinate made by the eye movement is tracked and recorded. The resul-

(a) Input finger image capture from the inside lens.

(b) Output moisture content detects on fingerprint image outside the lens.

Figure 4: Input and output image of fingerprint capture for response detection

tant physiological response and user activity are visual and analysed by the tool in Figure 6.

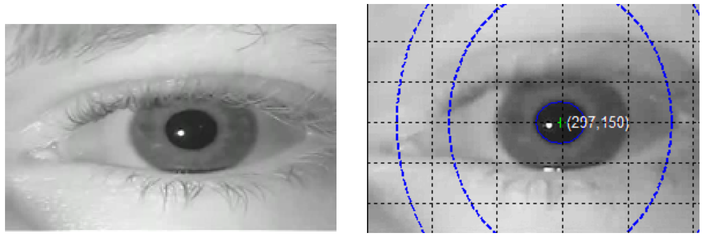
Figure 6 shows the analysis that integrates physiological response from both sensors used in measuring eye movement, pupil changes, and SCR. The touch screen can also record the skin temperature at any point in time by simply indicating how hot or cold the skin is based on the record from fingerprint detection. The application is only limited to detecting and computing the tonic and phasic changes based on the response detected. The baseline estimate indicates and represents the local minima for a specific length of time depending on the latency rate. The latency in this pilot stage is not significant due to the lack of conductance in some cases. Stimulus onset is initialised by a simple hand-clap mechanism. The process is induced, even in cases with low conductivity.

Error in fixation detection on the visual interface for mapped fixations X-coordinate with timestamp is determined for both eyes, and the level of cognition is measured based on pupil dilation (stress) and constriction (relaxed). The standard of measure is not determined based on the current procedure but as a form of customisation for natural occurrences in detecting an error in pupil calculations as the standard deviation for fixations on the X-coordinate on the visual screen, and in this case (Figure 7) the margin is less than the estimated error response rate of 0.01% at constriction level. Short-term time intervals are used given time constraints and simulation speed is considered.

The error in EDA predictions based on standard deviation from the mean response shows that EDA at the tonic phase has a low error rate of 0.3% compared to the phasic response. The skin conductance response, also known as the tonic phase is where no response is detected and this is usually characteristic of dry skin with low conductivity. In normal cases, this form of output is usually considered an outlier and removed; a similar experiment is conducted for that instance and replaces the latter. The average response is usually considered feasible since we detect a phasic change and the intense presence of moisture on the skin surface in response and reaction to stimulus. The stimulus is both mild and inductive and can be triggered by the hand-clap signal. Most response induction is usually triggered by an alarm embedded in the host system, but such a procedure is sometimes expensive and difficult to implement. The basic and most conducive method is to implement the process within an integrated platform.

4 CONCLUSION

This paper attempts to investigate the logical design of a biometric censoring of skin conductance response and pupillary response, by demonstrating the logic behind their mechanism and how it can be used to measure the emotional response and physiological response of a person by expurgating its response measure in an analytical tool. The method adopted, uses a novel method of design in a custom-based logic scheme that illustrates the logic and its mechanism. The custom intelligent analytics which is mobile inclined is used to visualise and analyse the physiological readings by detecting tonic and phasic changes based SavitzkyGolay filter. The error in physiological response prediction is computed for each response rate and discussed in the result section. The error rate for tonic changes exceeds the maximum expected value for both sensors and a reduction of error



(a) Input image of the eye captured from the mobile lens.

(b) Pupil detection and response record of eye movement from analysis.

Figure 5: Input and output image of the eye captured for eye-tracking and pupil response detection.

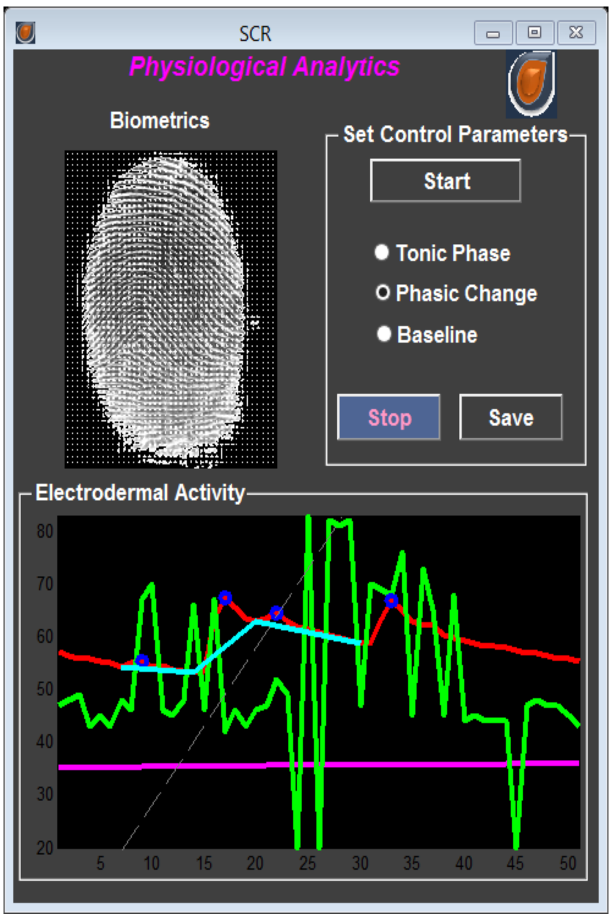


Figure 6: Biometric analytical tool for multimodal analysis of response to simple stimuli.

in standard deviation based on average response is less for the phasic changes in SCR. The future approach is to adopt a more complex means of detecting based on a deep approach, the auto-coders will be used for image detection and pattern tracing, and this will also be compared to other standard methods.

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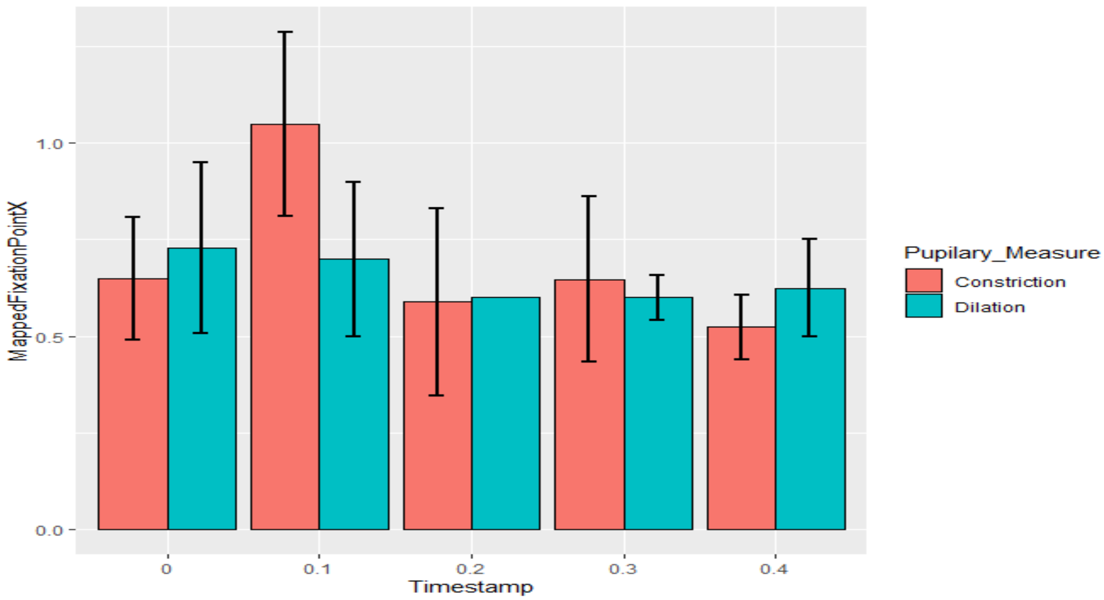

Figure 7: Error in fixation detection on the visual interface for mapped fixations X-coordinate with a timestamp.

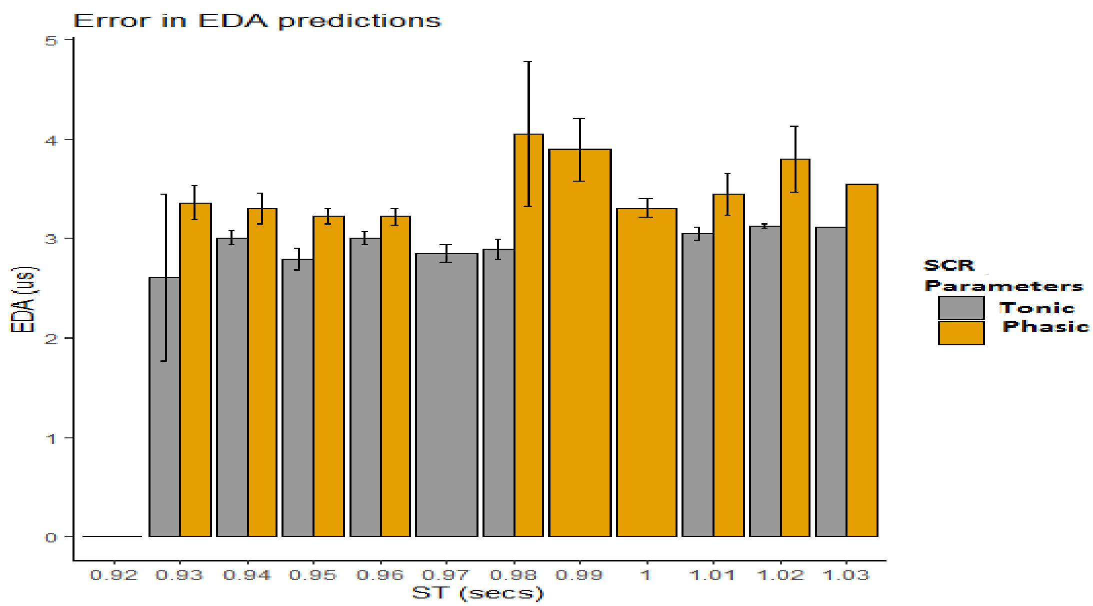

Figure 8: Error in EDA predictions based on standard deviation from the mean response.

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