Mobile Device Interaction by Eye Tracking Analysis

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Abstract—this paper describes a non-intrusive eyetracking tool for mobile devices by mistreatment pictures no inheritable by the front camera of the iPhone and iPod bit. By following and decoding the user's gaze to the Smartphone's screen coordinates the user will act with the device by employing a lot of natural and spontaneous approach. the appliance uses a Haar classifiers based mostly detection module for distinguishing the eyes within the no inheritable pictures and later the CAMSHIFT algorithmic program to find and track the eyes movement and find the user's gaze. The performance of the planned tool was evaluated by testing the system on sixteen users and also the results shown that in concerning seventy nine of the days it was ready to find properly the users' gaze.

Keywords: - Eye Gaze Tracking, Audio Video Foundation, Camshift

I. INTRODUCTION

The new generation of smart phones has been revolutionized with the introduction of technologies like bit screen, measuring system, gyroscope, photograph camera, etc. These innovations in conjunction with the rise in hardware performance, permits a distinct approach within the use of those devices up user expertise and interaction. Several recent analyses come demonstrate however the interaction with mobile phone technologies improved [1], [2]. As mentioned in [3], the evolution of mobile phones to smart phones opened new horizons for the implementation of innovative styles of mobile applications, like victimization the phone's camera for a lot of specialized sensing activities, like chase the user's eye movement across the phone's show as a way to activate applications. In fact, eye gaze sensing is a very important methodology in human pc interfacing. The attention gaze may be a a lot of natural method to act with a tool than a mouse or keyboard. Eye movement is reflective of psychological feature processes [4] and eye gaze interaction may be a convenient manner for dominant mobile devices.

The strategies for eye chase are often classified into 2 categories: intrusive and non-intrusive. Intrusive strategies need direct interaction with the user. The user has to wear head mounted equipment leading to discomfort and proscribing their movement varies [5]. Non-intrusive strategies, instead, use images captured from a camera to estimate the gaze direction [6] or Associate in nursing infrared based mostly approach to boost the distinction between the pupil and also the iris [7], [8], [9]. In distinction to eye chase systems for computers, mobile devices suffer from many drawbacks like: intensity of sunshine (indoor or outside use), camera resolution, standardization problems (caused by head movements and mobile device movements). Eye chase technology for interaction with mobile phones is not nonetheless offered as a stable and usable application. One reason is the lack of infrared devices for correct eye detection. The data captured type a camera should be sufficient to grasp the gaze movement. This suggests the utilization of complicated and heavy procedure techniques that touch the dearth of process power to handle video streams on these devices in time period.

Various systems are enforced that integrate eye tracking capabilities into a movable. In [10], a system capable of driving mobile applications victimization solely the user's eye movements and actions is represented, whereas in [11], different approaches, specially dwell-time methodology and gaze gestures, are compared so as to research however gaze interaction will be accustomed management applications on movable.

The implementation of an eye fixed trailing system employing a Smartphone and pictures captured from its camera, requires a robust methodology to sight the eyes location. Especially in [12], the authors introduced Haar classifiers to accurately and rapidly sight faces among a picture and might be tailored to accurately sight countenance, like eyes [13].

In this work, we tend to gift a system design for eye tracking victimization associate degree iPhone by process the pictures captured from the device's front camera. the rest of the paper is as follows: in Section II we tend to describe the system's general architecture and every block that composes it. In Section III, the performance of the system square measure mentioned, whereas within the last section, final remarks square measure given.

II.SYSTEM ARCHITECTURE

The design of the enforced framework is predicated on a set of blocks that job asynchronously. every of those blocks performs a specific perform so as to capture the user's gaze. The framework, known as BAEyeTracking, uses the Apple Audio Video Foundation (AVFoundation) Framework to grab the video frames from the device's front camera. each specific operation runs in a very completely different queue exploitation the Central Dispatch Queue Framework. Especially, there are a unit four distinct modules:

• The info acquisition module aims at effort the pictures from the iPhone's front camera and at changing it into raw image information appropriate for the following process steps. Given the tiny quantity of memory, each operation must be as easy as doable, and should robustly release inessential memory.

• For eye detection, a Haar classifiers [13] is employed so as to find the eyes and check if the rectangles of the eyes are stable(i.e. the rectangles didn't move significant for three consecutive frames). Anytime the Haar Detector starts, it checks the quality deviation between the previous rectangles and also the current ones, and uses heuristic conditions to check whether or not the rectangles area unit really representing the eyes or not. Once the Haar Detector find 3 stable samples, it enters in a very stable state and lowers its execution frequency, till the rectangles destabilize exploitation the device measuring instrument, every time the Haar Detector is started, if the device was moved too far from its previous position, the detection are going to be forced to find new rectangles as presently as doable.

• To perpetually keep track of the eyes position, an eye tracking module supported the CAMSHIFT algorithmic program was implemented. Whereas being strong in static conditions, the Camshaft algorithmic program should be configured accurately to be able to handle not solely completely different lighting conditions however also differing types of eyes.

• So as to interpret the no inheritable image in eye gaze location, a Gaze Detection module was used. Every module is intended to figure asynchronously within the background, and dispatches solely the borderline quantity of operations and information once required on the most thread.

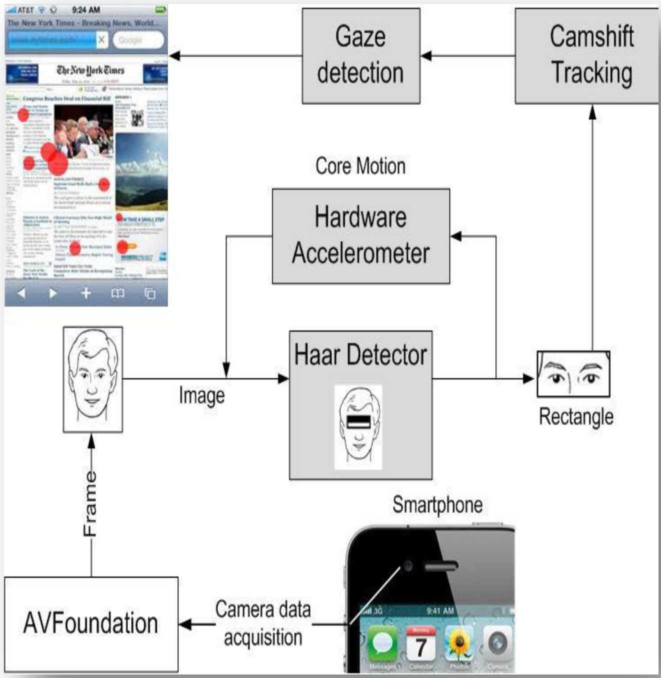

Fig. 1. System architecture.

A. Haar-Like Eyes Detection module

In order to find the eyes parallelogram into the frame and to track any significant changes within the scene when the first recognition, a Haar classifiers supported Haar-like options that are delineate by adjacent rectangular regions (fig.2) at a specific location in an exceedingly detection window, is used. To accomplish that, for every parallelogram the add of the picture element intensities is

performed and its distinction with the adjacent parallelogram is calculated. This distinction is then accustomed classify subsections of a picture (eyes, nose etc...).
During the detection section, a window of the target size is overplayed and affected over the input image (fig. 3) and for every subsection of the image the Haar-like options area unit calculated.
The distinction between the 2 rectangles is then compared to a threshold that permits to tell apart associate object from another one.
Normally, the Haar Detector find quite one eye in the scene, though they're not gift, then it's necessary to filter these false positives out. to realize that, from the set of the attention regions found, the 2 eye regions, which centroids have the minimum coordinate axis distinction, area unit elite.

With this straightforward heuristic condition all the rectangles that do not stand on constant axis, area unit removed. Afterwards, the standard deviation between the present parallelogram found and therefore the previous one, so as to examine whether or not the world has modified, is calculated. If it's bigger than a threshold, the frame is classified as not stable and therefore the formula starts once more from the beginning, otherwise the frame is classified as stable and therefore the Number of stable samples found is incremented. If the amount of the consecutive stable samples is bigger than a price, the detection module puts itself within the stable state, within which its execution frequency is reduced (1 per 2 seconds rather than2 per second) till its state changes.

Fig. 2. Example of common Haar-like features.

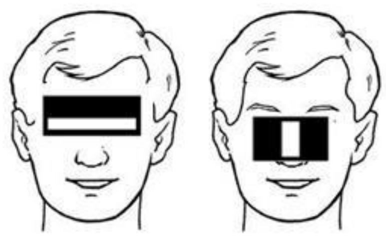

Fig. 3. Example of features overlay.

B. Hardware Accelerometer module

One of the most important issues in implementing eye trailing on a mobile device is that the device (and its camera) is not adequately still and image arrangement happens as a result of the phone's movement. sadly, unless employing a dock or position the phone on stable ground (e.g. a table), this movements cannot be removed, and also the downside should be dealed with different accessible detector knowledge. Especially, to face this downside, the Core Motion Framework was wont to acquire gyroscope and measuring device knowledge. on every occasion the detection procedure is named, gyro and measuring device knowledge is sampled and compared to the previous values. If the distinction is too high, it implies that the device was affected from its previous position and, later on, the eyes won't get on the same position. During this case, the Haar Detector module switches To the non-stable state and initiates the attention detection procedure instantly.

C. CAMSHIFT tracking module

In order to trace the attention gaze, once the eyes' position has been identifies, the CAMSHIFT formula [14] was used because it offers an excellent exchange between performance and efficiency. The CAMSHIFT formula tracks objects by matching the likelihood density functions of 2 consecutive frames. As in our case, a likelihood density operates, generally, the hue plane bar chart of the frames is chosen. After the Haar Detector module goes into the stable state, the eye following module is employed to watch the attentions' movements and report their positions to the Gaze Detection module.

D. Gaze Detection module

IBy victimization the calculated information of the attention hunter module, the Gaze Detection module is employed to translate the attention positions into the corresponding screen positions. Whereas there are a unit several algorithms which will be used for this stage (for example the Starburst algorithmic program [15]), it absolutely was most popular to use an easier method for not overloading the device's processor and protective energy.

The method consists in taking the eyes rectangles and calculating their centroids, so as to look for a correlation between these values and therefore the user's gaze. As a result of the device and the eye aren't continually during a fixed relative position, when each eyes area unit caterpillar-tracked, the eyes' rectangles area unit unified and pictured during a totally different system. Using this method, the eyes rectangles area unit calculated continually from the same purpose of origin if the subsequent conditions hold true:

- The parallelogram is calculated for each frame and should be as precise as potential.
- The eyes should continue identical y axis.

Once the centroids area unit calculated, the Gaze Detection module stores the no inheritable information into a csv file.

III. Experiment Result

In order to assess the performance of the system and also the effectiveness of the enforced modules, the applying was tested on sixteen subjects. The sole criteria for a theme to be suitable to participate within the analysis method were to own a visual acuity of 20/20 and to not have any disorder that

Affected their vision. For this reason, an entire ophthalmologic examination was performed on all subjects before the test's execution. The analysis method was performed whereas the iPhone was seated on a dock station and also the subject's position was well adjusted so as to realize a distance of about thirty cm between the subject's eyes and also the iPhone's screen. Moreover, the applying was tested once the iPhone was control by the topic at a similar distance so as to evaluate the performance beneath traditional conditions of the Eye hunter and Haar Detector modules. All of the topics underwent the subsequent routine:

- Application activity to calculate CAMSHIFT's parameters.
- IPhone seated: For five minutes the topic was asked to visit an internet page on the iPhone and to return loud the object (image, text etc.) she was presently gazing.
- One minute pause
- IPhone existing: for 2 minutes the topic was asked to visit a similar web content on the iPhone and to report out loud the thing (image, text etc..) he was presently looking at.
- The rumored locations were registered in conjunction with the elapsed time from the experiment's offset.
- At the tip of the session, the made csv file was compared to the registered notes.

The obtained performance, for all the sixteen users, is rumored in Table I. True positives (TP) represent the quantity of correctly detected fixation whereas false positives (FP) and false negative (FN) represent the quantity of incorrectly detected fixation and also the range of undiscovered fixation, severally. RF and DF are the quantity of the user rumored fixation and the range of the detected fixation, severally. The accuracy of the planned system reached concerning seventy nine once the iPhone was docked and fifty three once the user controls the iPhone on hand.

TABLE I

OBTAINED RESULTS.

Mode	**RF**	**DF**	**TP**	**FP**	**FN**	**Accuracy (%)**
Docked	741	624	603	21	138	79.1
On hand	373	268	224	44	149	55.5

IV. Conclusion

In this paper, we tend to given an answer for desegregation eye tracking capabilities on AN iPhone. Especially, by exploitation the phone's camera and therefore the acceptable image process techniques, our system is ready to observe and track the eyes position in period and interpret it in screen coordinates. While the obtained results, particularly once the iPhone is docked, look promising, a lot of subtle and sophisticated algorithms ought to be employed in order to realize higher performance in world normal conditions. this suggests that a lot of process power is needed so as to not overload the phone's processor, and to the present finish, we tend to aim at desegregation a Cloud computing which can offer, starting from biometric applications like [17process resources on demand, such as the one in [16]. Finally, given the process power of the currently on the market smart phones suffice for image process applications, alternative sorts of image process application will be developed likewise] to media retrieval applications [18], to object detection, tracking and classification applications [19], [20], [21], to medical image analysis tools [22], [23], [24], [25] and tospecific image process strategies [26].

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