Make Title

James Whiffing
jw204@bath.ac.uk
University of Bath - Department of Computer Science
Bath, England

ACM Reference Format:
James Whiffing. 2022. ***Make Title*** . In *Proceedings of **TODO** (Conference acronym 'XX).* ACM, New York, NY, USA, 5 pages. https://doi.org/XXXXXXX.XXXXXXX

1 INTRODUCTION

[26] Modern mobile device screens getting larger

[21] Review usability of touch-screens of different sizes

[10] Study with 4 phones with increasing screen size, investigating the areas of the screen which are obtainable with each digit (Screen for thumb, phone back for fingers)
As expected, larger screen sizes afforded less coverage for the thumb, in-particular reaching the upper parts of the screen, and in some-cases the side of the screen opposite to the thumb
However this study did not ensure grip was consistent between participants, or that participants keep a constant grip. As such it isn't clear if some observed reachability is due to grip, hand-size, or adjusted grips.

[16] Usability of phone generally, touches on touch screens

[17] Usability with respect to touch-screen

[25] evaluation of touch gestures on screen

[12] gaze is difficult

[26] Modern mobile device screens

described by **?** as "situations, contexts, or environments that negatively affect the abilities of people interacting with technology" (**?**)

[**?**] suggest further defining Severely Constraining Situational Impairments" (SCSI), wherein the the ability to input to the device is restricted.

[**?**] undertook a couple studies to investigate both the support for one-handed use offered by mobile devices, and the scenarios wherein users would operate the device single handedly.
From their field study (23 people) they observed a correlation between one-handed interaction and the user's movement. If the user was mobile or standing, they were much more likely to be using the phone one-handed as compared to when they were sat down.
In their study of 135 people, they found that 66% of participants preferred one-handed use, regardless of whether they were encumbered (e.g. suffering from SIID), resorting to two-handed use only when the interface requires it.

From a sample of 1334 observations (Unclear on number of people), [**?**] observed that 49% of mobile device interaction was one-handed, with 36% being one-handed with the second hand cradling the phone, and the last 15% being two-handed (wherein both thumbs were in use).
They go o0n to discuss the effective touch-screen reach the user can obtain with each method, and how users switch between these different modes based on adapting to completing different tasks (primarily if completing a task requires access to an unreachable part of the phone that they can't access in the current 'stance')

Given how prevalent one0handed use is, Samsung [**?**] (and other platforms?) have a dedicated one-handed mode, which effectively shrinks the screen towards the corner which has the most reach for the user's thumb.
However this has the downside of shrinking the screen content, and reduces the accuracy of the thumb input (as where the thumb interacts with the screen is now effectively increased)

Study with 4 phones with increasing screen size, investigating the areas of the screen which are obtainable with each digit (Screen for thumb, phone back for fingers)
As expected, larger screen sizes afforded less coverage for the thumb, in-particular reaching the upper parts of the screen, and in some-cases the side of the screen opposite to the thumb
However this study did not ensure grip was consistent between participants, or that participants keep a constant grip. As such it isn't clear if some observed reachability is due to grip, hand-size, or adjusted grips.

2 LITERATURE REVIEW

2.1 Head Gestures

[19] usage of an IMU, within a headband on a user's head, to track pitch and roll (nodding up/down and left/right) of the head.
Performed by tracking the changes in linear acceleration (why not angular?) detected by the IMU along the Pitch and Yaw degrees of freedom. These were used to detect nodding left, right, up, and down.
To avoid tracking involuntary / small head movements, a low-pass filter was applied to the IMU output. To improve gesture recognition for specific users, they are able to customise parameters of the model, such as minimum thresholds of movement (for the low-pass filter), maximum displacement (to avoid when user is going beyond range for gesture), time window (how quickly a nod need be performed for the action).
Of the 10 participant, 9 achieved greater than 80% classification

Unpublished working draft. Not for distribution.

Unpublished working draft. Not for distribution.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from permissions@acm.org.

Conference acronym 'XX, N/A, N/A
© 2022 Association for Computing Machinery.
ACM ISBN 978-x-xxxx-xxxx-x/YY/MM…$15.00
https://doi.org/XXXXXXX.XXXXXXX

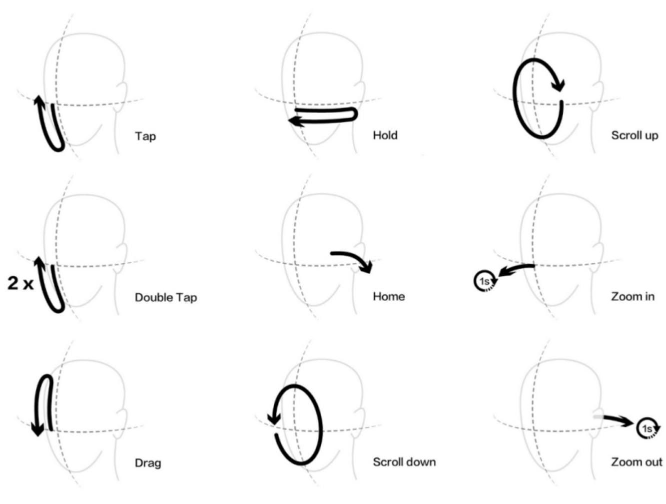

Figure 1: Proposed head gestures and their corresponding actions (p10)[27]

rate using the globally tuned model params, with all being able to achieve equal or better accuracy with individually tuned parameters. Used to perform motions with a robotic arm (e.g. lateral movements in a given plane, or rotations). Plane actions performed on switched via additional input, not gestures.

[7] Also utilises IMU from within a VR head-set. Compares several techniques, Principal Component Analysis (PCA, classification based on identifying the most 'important' feature and classifying on that feature), Dynamic Time Warping (DTW, computing the similarity between observed motion and gesture classes), Neural Networks (NN), and Random Forests. Gesture set was simple, nodding, looking left / right. Extracted gestures not used

[27] Propose several gestures for specific actions using IMU on a hololens to interact with display, seen in Figure 1
gestures segmented via detection of acceleration (20 Degrees per second) and deceleration (4 Degrees per second), not exceeding 2 seconds.
Feature extraction performed with DTW (same approach as evaluated by [7]), followed by an SVM classifier to classify the observed gesture into one of 9 categories, or unintentional movement.
Compared head gestures with hand gestures. Found that head gestures caused more fatigue and generally felt less natural, however were similar / slightly better with regards to learning effort

[5], using a single camera. Feature defined by intensity gradient (e.g. change in lighting/colour, such as corners). Since nose is always closest to the camera, and convex in nature, it should be the 'brightest' feature. The tracked point isn't a specific point on the nose (e.g. the tip), but a point that can move across the surface of the nose, based on what is closest to the camera.
They go on to extend this work with [6] Usage of the user's nose to control a pointer on their screen
Usage of nose to meet requirements for trackable feature that is always visible (presuming the user is facing within 180 degrees towards the camera)
Utilises stereography (e.g. 2 cameras) to perform the tracking, each with resolution as little as 160x120px For accuracy/fidelity the system also requires 2 additional features of the face to track, with relation to the nose.
To click with the 'Nouse' the user blinking twice within short succession. Determined by reviewing the change in the sequence of 3 frames.
Low resolution to permit real-time tracking.
Cursor utilised to play pong, draw, and adjust pose of 3D model.
They make claims about accuracy and enjoyment, but relevant data not provided, just statements made suggesting Nouse was as good / if not better than typical mouse control (claim mouse causes wrist ache, but movement of entire head doesn't present neck ache?)

[22] another nose based control, however uses Haar cascades to perform face-detection, within which they use a similar technique as [5] to extract points for the corners of the nose, or the nostrils.
Segment face region into 3 sections, eyes/eyebrows, nose, and mouth.
To detect eyes, determine user's skin colour by sampling the pixels within the detected face region. They then presume the eyes will be a different colour, and as such filter based on the extracted skin-tone. They then select the features closest to the nose, that are symmetrical.
With the features they use the nose to infer direction and velocity of the cursor. For mouse buttons, a UI is created with the actions as buttons. User moves cursor to the action tye wish to perform, then wink (with either eye) to select it. When they then fixate on part of the screen (move the cursor to a point and keep it stationary), the action will be performed.
Only evaluated for click recognition and accuracy of where the click was performed within a grid of points. However >80% accuracy even for users with no training time, just instructions.
Not compared to usage of a mouse, however was designed for those who could not use a mouse, or might find it difficult.

[20] Usage of optical flow to extract the motion of the user's head.
Background subtraction performed with Gaussian Mixture Models. Effectively classifying pixels based on probability that they belong to user, which can be adjusted ont he fly to adapt to slowly changing light levels and changes to elements of the background.
Optical Flow techniques then used to infer the direction of motion of the user's head (rotational). Can only extract Left, Right, Up, Down.
Doesn't specifically extract user's head, so can also match on user's hand, or any other foreground object.

2.1.1 Mobile Device Head Interaction. [18] Using front faced camera to scroll, using the head angle w/r/t the device as direction of scrolling.

[14] Using front facing camera to track user's head orientation (used to move a cursor), and the distance between the user's eyes to infer distance from the display, which in turn adjusts the coarseness of the cursor locations by effectively zooming in/out.

[23] developed a tool to combine head orientation to move a cursor into a particular section of the screen, from which they can then use relative motion of the thumb to adjust the cursor to the

Unpublished working draft. Not for distribution.

element of interest.

This was then extended upon [9] to use the same tracking technology to instead perform gestures.
Gestures were made simple based on the direction the user looked away, with actions effectively being placed within a disk, with each action getting an equally sized segment.
Performing a gesture requires a user to remember the direction associated with the action they wish to perform.

[27] also developed a system for performing gestures with the user's head, however they utilised more complicated gestures. Made for hands-free, rather than extending touch input.
They determined the gesture movements via a study, resulting in 9 gestures/actions.
Each action was to be a substitute for an existing gesture that could be performed with touch, such as tapping, scrolling, and zooming.
Tracking was performed with hololens (not from phone).
Was evaluated against Air-Tap, hololens extracting hand gestures.

[8] Tool to use front-facing camera to track phone movement relative to user's face. They then use this input to evaluate 3 applications (image viewer, Bluetooth connections, pong).
They highlight that there is an issue with moving device vs tilting, camera FOV can reduce action-space, and that accessibility issues with moving the phone, making it harder to read.

2.1.2 Types of Gestures. [1] Types of gesture

2.2 Adaptive Interfaces

2.2.1 3D Interfaces. An alternative to tabs/pages in applications, have application interface in 3D, and only expose based on perspective Perspective based on phone vs user Examples of AR/VR, display adapts

[13] reviewing data visibility / interpretability through displaying as 3D graphs, which can be viewed from different perspectives by moving the phone

[2] Uses phone movement to adjust 3D content, primarily for data visualisation.

[4] developed a system to adjust 3d content on the screen based on the user's perspective / orientation w/r/t the phone screen/front facing camera.

2.2.2 Context Aware UI. [24] Describes the types of adaptive UI (e.g. what contexts the UI is aware of)

[15] develop an adaptive UI that adjusts display and presented information based on user's gaze.

[3] adapts presented video based on gesture recognition

[29] & [28], evaluate 2 similar applications that react to various user environment states, and previously learned information about the user.

Rather than having depth to the interface, [11] created a virtual display that is in the shape of a concave box, from which the visible part of the box is based on the user's perspective.

Unpublished working draft.
Not for distribution.

REFERENCES

[1] Roland Aigner, Daniel Wigdor, Hrvoje Benko, Michael Haller, David Lindbauer, Alexandra Ion, Shengdong Zhao, and JTKV Koh. 2012. Understanding mid-air hand gestures: A study of human preferences in usage of gesture types for hci. *Microsoft Research TechReport MSR-TR-2012-111* 2 (2012), 30.

[2] Wolfgang Büschel, Patrick Reipschläger, Ricardo Langner, and Raimund Dachselt. 2017. Investigating the use of spatial interaction for 3D data visualization on mobile devices. In *Proceedings of the 2017 ACM International Conference on Interactive Surfaces and Spaces*. 62–71.

[3] Christopher Clarke, Doga Cavdir, Patrick Chiu, Laurent Denoue, and Don Kimber. 2020. Reactive Video: Adaptive Video Playback Based on User Motion for Supporting Physical Activity. In *Proceedings of the 33rd Annual ACM Symposium on User Interface Software and Technology*. 196–208.

[4] Jérémie Francone and Laurence Nigay. 2011. Using the user's point of view for interaction on mobile devices. In *Proceedings of the 23rd Conference on l'Interaction Homme-Machine*. 1–8.

[5] Dmitry O Gorodnichy. 2002. On importance of nose for face tracking. In *Proceedings of Fifth IEEE International Conference on Automatic Face Gesture Recognition*. IEEE, 188–193.

[6] Dmitry O Gorodnichy and Gerhard Roth. 2004. Nouse 'use your nose as a mouse' perceptual vision technology for hands-free games and interfaces. *Image and Vision Computing* 22, 12 (2004), 931–942.

[7] Tomasz Hachaj and Marcin Piekarczyk. 2019. Evaluation of pattern recognition methods for head gesture-based interface of a virtual reality helmet equipped with a single IMU sensor. *Sensors* 19, 24 (2019), 5408.

[8] Thomas Riisgaard Hansen, Eva Eriksson, and Andreas Lykke-Olesen. 2006. Use your head: exploring face tracking for mobile interaction. In *CHI'06 Extended Abstracts on Human Factors in Computing Systems*. 845–850.

[9] Sebastian Hueber, Christian Cherek, Philipp Wacker, Jan Borchers, and Simon Voelker. 2020. Headbang: Using head gestures to trigger discrete actions on mobile devices. In *22nd International Conference on Human-Computer Interaction with Mobile Devices and Services*. 1–10.

[10] Huy Viet Le, Sven Mayer, Patrick Bader, and Niels Henze. 2018. Fingers' Range and Comfortable Area for One-Handed Smartphone Interaction Beyond the Touchscreen. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. 1–12.

[11] Miguel Bordallo López, Jari Hannuksela, Olli Silvén, and Lixin Fan. 2012. Head-tracking virtual 3-D display for mobile devices. In *2012 IEEE Computer Society Conference on Computer Vision and Pattern Recognition Workshops*. IEEE, 27–34.

[12] I Scott MacKenzie. 2010. An eye on input: research challenges in using the eye for computer input control. In *Proceedings of the 2010 Symposium on Eye-Tracking Research & Applications*. 11–12.

[13] Masashi Miyazaki and Takashi Komuro. 2021. AR Peephole Interface: Extending the workspace of a mobile device using real-space information. *Pervasive and Mobile Computing* 78 (2021), 101489.

[14] Yoshikazu Onuki and Itsuo Kumazawa. 2016. Combined use of rear touch gestures and facial feature detection to achieve single-handed navigation of mobile devices. *IEEE Transactions on Human-Machine Systems* 46, 5 (2016), 684–693.

[15] Ken Pfeuffer, Yasmeen Abdrabou, Augusto Esteves, Radiah Rivu, Yomna Abdelrahman, Stefanie Meitner, Amr Saadi, and Florian Alt. 2021. ARtention: A design space for gaze-adaptive user interfaces in augmented reality. *Computers & Graphics* 95 (2021), 1–12.

[16] Lumpapun Punchoojit and Nuttanont Hongwarittorrn. 2017. Usability studies on mobile user interface design patterns: a systematic literature review. *Advances in Human-Computer Interaction* 2017 (2017).

[17] Dimitrios Raptis, Nikolaos Tselios, Jesper Kjeldskov, and Mikael B Skov. 2013. Does size matter? investigating the impact of mobile phone screen size on users' perceived usability, effectiveness and efficiency.. In *Proceedings of the 15th international conference on Human-computer interaction with mobile devices and services*. 127–136.

[18] Maria Francesca Roig-Maimó, Javier Varona Gómez, and Cristina Manresa-Yee. 2015. Face Me! Head-tracker interface evaluation on mobile devices. In *Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems*. 1573–1578.

[19] Nina Rudigkeit, Marion Gebhard, and Axel Graser. 2015. An analytical approach for head gesture recognition with motion sensors. In *2015 9th International Conference on Sensing Technology (ICST)*. IEEE, 1–6.

[20] Parimita Saikia and Karen Das. 2013. Head gesture recognition using optical flow based classification with reinforcement of GMM based background subtraction. *arXiv preprint arXiv:1308.0890* (2013).

[21] Tsai-Hsuan Tsai, Kevin C Tseng, and Yung-Sheng Chang. 2017. Testing the usability of smartphone surface gestures on different sizes of smartphones by different age groups of users. *Computers in Human Behavior* 75 (2017), 103–116.

[22] Javier Varona, Cristina Manresa-Yee, and Francisco J Perales. 2008. Hands-free vision-based interface for computer accessibility. *Journal of Network and Computer Applications* 31, 4 (2008), 357–374.

[23] Simon Voelker, Sebastian Hueber, Christian Corsten, and Christian Remy. 2020. HeadReach: Using Head Tracking to Increase Reachability on Mobile Touch Devices. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. 1–12.

[24] Janet L Wesson, Akash Singh, and Bradley van Tonder. 2010. Can adaptive interfaces improve the usability of mobile applications?. In *IFIP Human-Computer Interaction Symposium*. Springer, 187–198.

[25] Julie R Williamson, Andrew Crossan, and Stephen Brewster. 2011. Multimodal mobile interactions: usability studies in real world settings. In *Proceedings of the 13th international conference on multimodal interfaces*. 361–368.

[26] Pei Xuesheng and Wang Yang. 2018. Research on the Development Law of Smart Phone Screen based on User Experience. In *MATEC Web of Conferences*, Vol. 176. EDP Sciences, 04006.

[27] Yukang Yan, Chun Yu, Xin Yi, and Yuanchun Shi. 2018. Headgesture: hands-free input approach leveraging head movements for hmd devices. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 2, 4 (2018), 1–23.

[28] Enes Yigitbas, André Hottung, Sebastian Mansfield Rojas, Anthony Anjorin, Stefan Sauer, and Gregor Engels. 2019. Context-and data-driven satisfaction analysis of user interface adaptations based on instant user feedback. *Proceedings of the ACM on Human-Computer Interaction* 3, EICS (2019), 1–20.

[29] Enes Yigitbas, Klementina Josifovska, Ivan Jovanovikj, Ferhat Kalinci, Anthony Anjorin, and Gregor Engels. 2019. Component-based development of adaptive user interfaces. In *Proceedings of the ACM SIGCHI Symposium on Engineering Interactive Computing Systems*. 1–7.

Unpublished working draft.
Not for distribution.

A PROJECT PLAN

A.1 Research and Development

A.2 Studies

Unpublished working draft.
Not for distribution.