

Assessing the use of Emotion Recognition Technology (ERT) for consumer sentiment analysis

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Abstract— In this paper we discuss the ethical considerations necessary for an emotion recognition system used for dynamic ad placement to exist. By conducting an Ethical Impact Assessment using the Value Sensitive Design framework, we offer recommendations to ensure the system’s implementation is minimally biased and reduces potential harm to stakeholder groups.

1. INTRODUCTION

The first impression a consumer forms upon encountering an advertisement (ad) plays a pivotal role in determining its success in engaging their interest [1], [2]. By understanding how consumers emotionally connect with advertisements, brands can make informed decisions to improve the effectiveness of their marketing. This underscores the importance of analysing consumer sentiment.

The proposed solution is a machine-learning model capable of classifying facial expressions into distinct labels. The model will consist of 3 key mechanisms:

1. *Object detection & classification* - Identifying and distinguishing human faces within a visual input
2. *Gaze detection* - Detecting which people are currently looking at the advertisement
3. *Emotion classification* - Classifying the facial expression

The model will be trained, validated, and tested using a large, diverse range of human faces each labeled with an emotion. For an in-depth discussion of dataset choice and recommendations for implementation see Section 7.2.

The primary output of the model is an emotion distribution, indicating the model’s confidence level in each emotion, similar to that depicted in Figure 1 below.

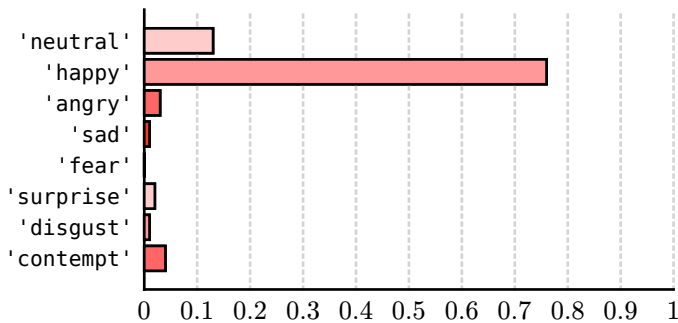


Figure 1: Sample model output distribution [3]

2. APPLICATIONS OF THE SYSTEM

While this system has a variety of potential uses in marketing, for example:

- *Market Research* - Analysing consumer sentiment in a product’s development phase, to make small adjustments to the product.
- *A/B testing* - Presenting two versions of a product to a candidate, and measuring which one they react more positively to. This is particularly applicable to websites where most have roughly 5 seconds to make a lasting impression [2].

, we will focus on *Dynamic ad placement*.

In particular, consider high-traffic pedestrian areas such as bus shelters, train stations, or public squares which are littered with advertising screens.



Figure 2: Example of an advertisement at a bus shelter [4]

By leveraging emotion recognition and continuously surveying the general public through video feeds, advertising agencies can:

- Identify which ads are most well-received and in which areas
- Switch the displayed ad for a passerby if it detects a negative response to the currently displayed ad
- Sell the collected consumer sentiment data back to brands

3. VALUE SENSITIVE DESIGN (VSD)

VSD is an approach to system design that systematically integrates human values into the design of technology [5]. It relies on an “*iterative, tripartite methodology consisting of conceptual, empirical, and technical investigations*” [5], [6].

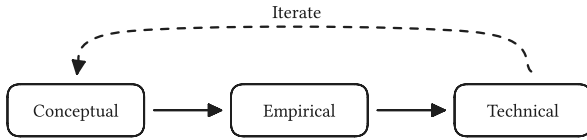


Figure 3: Diagram of the iterative nature of VSD

It consists of 3 integral investigations:

1. **Conceptual** - Identifying and analysing various stakeholder groups affected by the technology along with their values, rights, and principles to understand which values are important.
2. **Empirical** - Engaging with qualitative and quantitative research methods to gather insights from actual users and stakeholders.
3. **Technical** - Focusing on the design and development of the technology itself and exploring how values identified in the conceptual and informed in the empirical can be embedded in the technology’s design.

More broadly, it is a methodology that seeks to identify stakeholders’ root values [7], how the values of these stakeholder groups may conflict, and offer compromises or ways to resolve those conflicts in an unbiased way.

Two key benefits of this approach are:

- Human values are deeply rooted within the technology’s design from the beginning which helps prevent negative consequences for users and society
- By considering the broader societal and ethical implications of a technology, VSD helps develop solutions that are resilient to changing societal norms. The approach not only addresses pre-existing biases, but also proactively guards against the development of emergent bias [8].

By utilising the VSD framework, we conduct an Ethical Impact Assessment (EIA). This crucial step ensures that the implemented AI system aligns with values and principles that prioritise human rights, fairness, and transparency [9].

This proactive approach promotes trust in AI systems by identifying and mitigating potential biases and their potential harms.

4. IMMEDIATE ETHICAL ISSUES

- Highlight any apparent ethical issues to be considered ahead of development

Two immediately apparent ethical issues are:

1. **Informed consent** [5]
2. **Environmental sustainability**

5. ETHICAL IMPACT ASSESSMENT

Stakeholder	Values	Potential risks / harms
Advertising Agency (Direct) Serves as the project initiator and aims to collect data on individuals' first impressions of advertisements and leverage machine learning algorithms to optimise the location, timing, and content of ad placements.	<ul style="list-style-type: none"> • Accuracy Ensuring the data collected on people's immediate reactions to advertisements is accurate is vital to understanding the true impact of the ads. • Accountability The agency must be held partially or fully accountable for the technology's use, and potential misuse and consequences. • Innovation Advertising is a highly competitive and constantly evolving landscape. By developing new technologies, the agency can uncover insights that competitors cannot, giving it a competitive edge in the market. • Consumer Engagement Engaging consumers effectively is crucial for the success of every advertisement [10]. Higher consumer engagement leads to a boost in consumer loyalty, higher consumer retention [10], and ultimately higher conversion rates [11]. 	<ul style="list-style-type: none"> • Innaccurate data In recent years, Data-Driven Decision Making (DDDM) has seen increased adoption to help organisations reduce risk and take advantage of opportunities [12]. It does however have its downfalls where faulty data can lead to disaster. This was the case with some companies during the 2008 financial crisis where many data-driven models had hard-coded incorrect data [12] and hence extrapolated incorrectly. • Inadequate security measures The agency is responsible for storing consumer sentiment data "including protection against unauthorised or unlawful processing and against accidental loss, destruction or damage" [13]. Failure to adequately protect this data may result in prosecution, civil lawsuits, and irreversible damage to the advertising agency's reputation.
Brands (Direct) Companies who approach the advertising agency with a product to advertise to the general public.	<ul style="list-style-type: none"> • Consumer Trust The trust consumers have in a particular brand is directly related to their likelihood of purchasing products from that brand [14]. Moreover, given that the likelihood of converting an existing customer ranges from 60-70%, compared to only 5-20% for new customers [15], it is clear brands will ensure consumers stay loyal. 	<ul style="list-style-type: none"> • Reputation If the technology disproportionately impacts/targets certain demographics, brands could face backlash by being associated with this marketing strategy, leading to a loss of consumer trust and reputation. • Financial Loss Bad-quality data gathered by the model can lead to incorrect insights, which can be detrimental to the brand's image and customer engagement. Both of these can impact the brand's market share and lead to financial loss.
Developers (Direct) Employed by the advertising agency and tasked with creating the technology.	<ul style="list-style-type: none"> • Universal Usability Developers are likely to prioritise usability by ensuring the technology is accessible to the widest possible audience, including individuals with disabilities, and people from a diverse range of backgrounds. • Freedom from bias 	<ul style="list-style-type: none"> • Scapegoating If the technology is misused by the agency, the developers may be used as scapegoats leading to most of the public backlash being targeted at the developers.

Stakeholder	Values	Potential risks / harms
	<p>Valuing freedom from bias directly influences the integrity and fairness of the technology. This responsibility is particularly significant given the increasing regulation around data ethics and AI fairness [16].</p> <ul style="list-style-type: none"> • Quality product The value placed on delivering a quality product/solution is closely linked to a developer's professional pride and technical reputation. Additionally, for developers, it is clear that if the implemented system matches or goes beyond expectations their career prospects can improve significantly. 	
<p>Consumers / Data Subjects (Indirect)</p> <p>Members of the general public who interact with the advertisements.</p>	<ul style="list-style-type: none"> • Autonomy Within consumer choice contexts, autonomy is viewed as “(the) ability to make and enact decisions on (your) own, free from external influences” [17]. By allowing consumers to make independent choices that align with their personal preferences, needs, and values, they may experience higher levels of satisfaction. • Relevant / Personalised ads Enables ads to cater to specific interests making the shopping experience more efficient and enjoyable. Reduces the amount of irrelevant advertising noise and makes the experience feel tailored to the consumer. 	<ul style="list-style-type: none"> • Data Leakage Personal consumer sentiment data stored in databases could be hacked and leaked. This data may contain sensitive or biometric data which poses a security concern as malefactors could use it for identity crimes. • Data misuse There is a risk of the agency misusing the data for its own benefit, such as by selling it to third parties, which is a direct violation of many data protection laws such as GDPR. • Harmful advertisements If the model is particularly biased, the ads it suggests may be harmful. Given the unique demographic composition of each location, the model may unintentionally internalise this information leading to harmful, biased model outputs.
<p>Privacy advocates (Indirect)</p> <p>Organisations or activist groups advocating for the general public's privacy rights.</p>	<ul style="list-style-type: none"> • Privacy These organisations consider privacy as a cornerstone of individual freedoms and societal well-being, consequently, they actively confront the development of technologies that encroach upon human privacy [18]. 	<ul style="list-style-type: none"> • Legal and Political Pressure These groups may feel pressure from the agencies that want to make this technology a reality regardless of ethical considerations. This is a potentially very powerful technology that could be used for national surveillance if not regulated appropriately. • Loss of trust If the model is deemed to produce biased, harmful outputs and disregard the public's privacy rights then these groups

Stakeholder	Values	Potential risks / harms
		may be blamed for not protecting the public regardless of whether they made any attempts.
Government, Regulatory bodies, and policy-makers (Indirect) Organisations regulating the development and usage of AI and facial analysis systems	<ul style="list-style-type: none"> Human Welfare Governments have an ethical duty to ensure the well-being of their citizens, promoting policies that protect the vulnerable and support society as a whole. By prioritising welfare, it ensures social stability, avoiding social unrest. This is most commonly achieved by heavily regulating new technologies [19] and discussing pressing issues with a level of transparency [16]. Courtesy Governments should be courteous in public discourse to promote a cooperative, respectful environment essential for democratic processes and effective implementation of policies. Environmental sustainability Governments have an ethical and moral obligation to ensure companies act in an environmentally sustainable way such that inter-generational equity is not affected. 	<ul style="list-style-type: none"> Public backlash Governments may experience public backlash if the technology is used in invasive ways beyond what was originally specified, or for not interfering and regulating the technology early enough. Furthermore, the proposed technology employs machine learning and is intended to be installed across cities, which is likely to consume significant amounts of energy. This raises environmental concerns which the government may be held accountable for if the technology is not adequately regulated. This is regardless of whether the government is aiding in creation of this technology
General Public (Indirect)	<ul style="list-style-type: none"> Informed consent Companies should not record, store, or analyse the general public's data without explicit informed consent. Failure to obtain such consent constitutes a breach of trust between the agency and the public. Privacy Although there is reduced privacy in public settings compared to personal homes, the general public still retains the right to a certain degree of privacy while in public spaces. 	<ul style="list-style-type: none"> Invasion of Privacy The public may feel like they are constantly being recorded. This may feel like a dystopian society and is likely to affect the general public's welfare. Additionally, a large portion of the general public consists of young people and more specifically children who may be unaware of the risks associated with this sort of technology. This may make it difficult to acquire informed consent.

Table 1: Ethical Impact Assessment using VSD

6. VALUE CONFLICT ANALYSIS

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7. RECOMMENDATIONS

- Guidance on data collection and preparation, task design, or task deployment
 - ▶ Technical and Non-technical Recommendations
 - Utilise existing AI ethics frameworks and bias mitigation toolkits
1. Motivation for recommendations
 2. Choice of Dataset
 - Where is the documentation
 - Who is included? How is it sampled? Does the distribution align with the population the algorithm is applied to?
 - ▶ If the advertising solution is outsourced to other countries or locations then the target demographic may not be the same as the one that trained the ML
 - What data is collected
 3. Risk and bias mitigation measures
 4. Critical Assessment and Limitations

While VSD is well-tested, it is a theoretically grounded [5] approach which does not provide a clear way of embedding values into the design [7].

BIBLIOGRAPHY

- [1] AIContentfy, “The impact of first impressions in Customer Acquisition,” *AIContentfy*, Feb. 2023, [Online]. Available: <https://aicontentfy.com/en/blog/impact-of-first-impressions-in-customer-acquisition>
- [2] A. Kołakowska, A. Landowska, M. Szwoch, W. Szwoch, and M. Wróbel, “Emotion Recognition and Its Applications,” *Advances in Intelligent Systems and Computing*, vol. 300, pp. 51–62, 2014, doi: 10.1007/978-3-319-08491-6_5.
- [3] “AffectNet Dataset.” [Online]. Available: <https://paperswithcode.com/dataset/affectnet>
- [4] [Online]. Available: <https://www.outdooradvertisingltd.co.uk/advertising-services/bus-stop-advertising/>
- [5] B. Friedman, P. Kahn, A. Borning, P. Zhang, and D. Galletta, “Value Sensitive Design and Information Systems,” 2006, p. . doi: 10.1007/978-94-007-7844-3_4.
- [6] B. Friedman, D. G. Hendry, and A. Borning, “A Survey of Value Sensitive Design Methods,” *Foundations and Trends® in Human–Computer Interaction*, vol. 11, no. 2, pp. 63–125, 2017, doi: 10.1561/11000000015.
- [7] S. Umbrello, “Beneficial Artificial Intelligence Coordination by Means of a Value Sensitive Design Approach,” *Big Data and Cognitive Computing*, vol. 3, no. 1, 2019, doi: 10.3390/bdcc3010005.
- [8] B. Friedman and H. Nissenbaum, “Bias in Computer Systems,” 2017, pp. 215–232. doi: 10.4324/9781315259697-23.
- [9] Unesco, “Ethical impact assessment: A tool of the recommendation on the ethics of Artificial Intelligence.” [Online]. Available: <https://www.unesco.org/en/articles/ethical-impact-assessment-tool-recommendation-ethics-artificial-intelligence>
- [10] “What is customer engagement? definition, benefits, and strategies for...” [Online]. Available: <https://www.outreach.io/resources/blog/what-is-customer-engagement>
- [11] N. Sharma, “Why is customer engagement important: What are the benefits?” [Online]. Available: <https://vwo.com/customer-engagement/why-is-customer-engagement-important/>
- [12] K. Heires, “Flaws in the data: In an ERA of data-driven decision-making, businesses must avoid the faulty models and algorithms that can poison their results,” *Risk Management*, vol. 64, no. 3, p. 38–39, Apr. 2017.
- [13] [Online]. Available: <https://ico.org.uk/for-organisations/uk-gdpr-guidance-and-resources/data-protection-principles/a-guide-to-the-data-protection-principles/>
- [14] J. Dublino, “Returning customers spend 67 percent more than new customers.” [Online]. Available: <https://www.business.com/articles/returning-customers-spend-67-more-than-new-customers-keep-your-customers-coming-back-with-a-recurring-revenue-sales-model/>
- [15] B. May, “Council post: New vs. repeat customers: Where should you focus your marketing?” [Online]. Available: <https://www.forbes.com/sites/forbesagencycouncil/2022/07/08/new-vs-repeat-customers-where-should-you-focus-your-marketing/>
- [16] [Online]. Available: <https://www.gov.uk/government/publications/cdei-publishes-briefing-paper-on-facial-recognition-technology/snapshot-paper-facial-recognition-technology>
- [17] K. Wertenbroch *et al.*, “Autonomy in consumer choice,” *PubMed Central*, Jun. 2020, [Online]. Available: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7278769/>
- [18] C. J. Bennett, *The Privacy Advocates: Resisting the Spread of Surveillance*. The MIT Press, 2008. Accessed: Mar. 20,

2024. [Online]. Available: <http://www.jstor.org/stable/j.ctt5hhfb6>

- [19] ICO, Oct. 2022, [Online]. Available: <https://ico.org.uk/about-the-ico/media-centre/news-and-blogs/2022/10/immature-biometric-technologies-could-be-discriminating-against-people-says-ico-in-warning-to-organisations/>
- [20] B. Friedman, "Value-sensitive design," *Interactions*, vol. 3, no. 6, pp. 16–23, Dec. 1996, doi: 10.1145/242485.242493.
- [21] A. Borning and M. Muller, "Next steps for value sensitive design," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, in CHI '12. Austin, Texas, USA: Association for Computing Machinery, 2012, pp. 1125–1134. doi: 10.1145/2207676.2208560.
- [22] [Online]. Available: <https://www.salesforce.com/news/stories/customer-engagement-research/>