

## Research Article

# Exploring the Research Landscape of Automated Emotion Recognition System Adoption in Malaysia: A Systematic Literature Review

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## ABSTRACT

Artificial intelligence (AI) has revolutionized the way we interact with technology, and one of its key subcategories is the automated emotion recognition system (ERS). ERS is a technology that enables AI to recognize human emotional states, and it has the potential to transform human-computer interaction (HCI) as we move towards the fifth industrial revolution (IR 5.0). ERS has significant implications for various sectors, including healthcare, education, and the workplace. For example, in healthcare, ERS can be used to identify and treat mental health disorders, while in the workplace, it can be used to monitor employee well-being and improve productivity. However, the adoption of ERS is crucial for its success, and there is a need to understand the factors that affect its adoption. This paper aims to explore the landscape of ERS adoption in Malaysia by conducting a systematic literature review of studies published over the past decade between 2011 and 2022. The review will focus on understanding the current levels of adoption of ERS in Malaysia, identifying the factors that hinder or facilitate its adoption, and discussing the potential benefits and drawbacks of using ERS in different contexts. The findings of this review will provide insights into the current ERS research landscape in Malaysia and inform future research on the adoption and use of ERS in the country.

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## 1. Introduction

Human complex emotions are neurophysical changes involving thoughts, feelings, behavioral responses and degree of pleasures and displeasures [1]. Furthermore, [1] added that human emotion will always play a major role in communication and interpersonal bonding between people. People may perceive their emotions based on their physical attributes of facial expression, speech expression, and body movement [1], [2]. With recent technological advancement and changes experienced globally, technologies have grown to be part of the daily lives of people in helping with tasks, aiding industries and creating opportunities for the future. One of the examples of recent technological advancement is artificial intelligence (AI). AI is an advancement in

computer science that allows a computer or machine to learn and be trained to perform and complete a task or make decisions, replicating how a human being learns from experience [3]. AI development can be seen over the recent years, so much so that the AI recent generation is predicted to reduce the barrier to communication and advanced learning with human brain-like working mechanisms [4].

Over the last decade, researchers have identified the subpart of AI that can be enhanced further using the capabilities of machine learning. One of the main highlights that have been suggested is machines and computers identify or learn human emotions [5] to improve the interaction between human-computer and increase potential future applications for human-computer. Furthermore, in order for machines and computers to learn about human emotions, it needs a

system that enables the required process to learn human emotion [5], [6] and is specified as an emotion recognition system (ERS). ERS enables a system that accepts various modalities of data, learns and allows the machine to recognize the emotion of the human subjects.

Previous researchers specified ERS as originally in the field of Affective Computing (AC), a field that was brought forward by [7]. According to [8], AC is an ability of a computer that relates to, arises from and understands human behavior [7], [8]. With that being said, AC led to further findings of emotion recognition, and it has been suggested by the previous researcher that AI learning can signify for further findings of ERS as embedded technology in various applications [10]. Moreover, ERS has emerged as one of the attractive areas in the field of AC and AI with the promises of what the technology can achieve [11]. Such as, to develop robots that can interact and communicate with humans, equipped with functions for both understanding human emotions and expressing human emotions [10].

Outcomes and expectations from the previous studies show that ERS can be an important technology in the making based on the advantages offered to individuals, society, organizations, businesses and industry via various platforms and applications. For example, ERS in healthcare [12], ERS in driving assistance in the car [13], ERS in the classroom [14] and ERS in smartwatches as the latest addition due to the modalities of smartwatches being the same ERS modalities.

In existing research on ERS, researchers adopted AI algorithms such as convolutional neural network (CNN) and deep neural network (DNN) for emotion recognition based on various data modalities like facial expression, voice intonation, heart signals (electrocardiogram), brain signal (electroencephalogram) and many others. It is important to look into the relationship between ERS and its significance in society and industry specifically in the industrial revolution.

ERS can be seen as embedded technology in various applications that can be used for professional or individual day-to-day use. Based on the modalities for ERS, and the potential applications of ERS to society and the industry, it is important to look into the relationship between ERS and its significance in society and industry specifically in the industrial revolution.

### **1.1 Artificial Intelligence (AI)**

AI has transformed from just a theory to tangibility with recent applications from AI to transform businesses, industries and societies [11]. Inspired by human intelligence, AI aims to learn, reason, make decisions like humans [15]. With years of advancing and refining AI, technologies or smart devices nowadays are equipped with AI minimizing the need for human intervention [11].

In recent technological advancements, AI established trustworthiness enabling the AI systems in the aspect of beneficence, non-maleficence, autonomy, justice and explicability [11], [16]. The uniqueness of AI is characterized by the integration of AI capabilities with human capabilities [11], [17]. AI systems are designed to operate with varying levels as well as defined objectives, predictions and recommendations influenced by real or virtual environments.

AI technologies offer benefits for businesses and industries such as the automation of repetitive and time-consuming tasks that allow humans to focus on higher-value of work [11]. For example, massive restructured data that was once required by human expertise to further analysis, such example, data from written reports, analyzing documents, photos, images and videos can be assisted by AI, with AI considered much faster and more efficient working in completing tasks in a shorter time [11]. Moreover, AI can integrate thousands of computers [11] and other resources to resolve complex problems.

Therefore, AI capabilities are leveraging the need for technological advancement to automate the process further. AI can provide innovative solutions based on the previous example in previous studies towards societies, individuals and industries. With the addition of ERS as an emerging technology, it can enhance technology further by understanding human emotions and behavioral responses [11].

### **1.2 The Industrial Revolution**

The history of the industrial revolution began in the 18<sup>th</sup> century with the mechanization known as the First Industrial Revolution (IR 1.0) which was based on machines powered by water and steam. Today, we are living in the era of the Fourth Industrial Revolution (IR 4.0) where its main characteristics are digitalisation and integration of computers in co-operating with humans. IR 4.0 reshapes individuals' lives and works with digital transformation and emerging technologies that grow the industry further [18].

In IR 4.0, technologies such as artificial intelligence (AI), the internet of things (IoT) and big data services achieve sustainability and productivity [18]. IR 4.0 concept was mainly focused on the manufacturing industry to smart manufacturing but has evolved in the last decade with the involvement of digital transformation. The results create the entire industry, delivery channels become digitization [18], [19]. IR 4.0 is a big part of an individual's daily life and industry. However, innovations keep being introduced, soon there will be Fifth Industrial Revolution (IR 5.0) [20].

The main characteristic of I.R 5.0 that differentiates it from I.R 4.0 is specialization where machines and computers are equipped with the ability to understand

human and act accordingly [21], [22]. As suggested by [22], the industry will enable humans and machines to work together by bringing humans back into the workforce, therefore, IR 5.0 will be seen to unlock the potential of human-computer interaction (HCI). To signify human-computer interaction, communication between human-computer needs to be enabled. For example in [10], [22], the computer system must have the ability to communicate with humans in some forms.

Since the used cases of IR 5.0 are still in their formative years, manufacturers must actively organize their way to incorporate humans and machines to maximise the opportunity that can be gained in IR 5.0. Technology enablers such as ERS may enhance robots and machines to understand human emotions with the proposition of collaborative robots (Cobots), hence, [10] suggestions in the study can help achieve a better understanding of human-computer interaction.

### 1.3 Real-World Applications of ERS

Although in recent years developing systems to recognize human emotions and potential applications of automated emotion recognition functions have been suggested by previous researchers, there are still limited examples of actual real-world applications. Nevertheless, the continuing industrial revolution and its technological advancements create more opportunities and possibilities for ERS to be applied.

One of the main highlights that benefit from ERS is in healthcare industries. [23], [24], [25] developed the modalities of ERS and suggested their applications in healthcare. Recently [26] highlights ERS in the diagnosis of autism by allowing medical experts to investigate patients' emotions. Specifically, the researchers use facial recognition combined with electrocardiogram (ECG) to identify the six basic emotions. One of the main reasons is autism patients specifically amongst children are difficult to observe and accurately recognize their emotions. Thus, ERS helps the medical team to analyse and understand better the emotions of their patients. Furthermore, ERS has been suggested to provide better health services quality assurance by facilitating decision making throughout the Covid-19 pandemic by allowing safe monitoring and higher emotion awareness among the practitioners [27], [28].

Moreover, [27] suggested more real-world applications start to benefit from ERS modalities during the Covid-19 outbreak in 2020. For example, online learning classes using online platform were enhanced with emotion recognition technology and led to more effective planning of the lessons content [27], [14]. Furthermore, according to [27], social robots have risen to facilitate limitations due to covid restrictions. Social robots work and interact with humans, therefore, features

of emotion recognition technology might enhance the interaction between social robots and humans.

In marketing perspective from retail industries, ERS helps in advertising products. One of the main examples is through text sentiment analysis. [29] suggested that text mining provides useful data in identifying emotions awareness through text. Text mining is a learning-based algorithm to describe characteristics of text, such as word expression based on human sentiments and emotions [29]. Combining with multimodalities such as facial recognition and body movement, [27] suggested that retailers will be able to identify their customers emotions from advertisement and leverage the information to improve product experience [27].

## 2. Methodology

This study adopted the systematic literature review (SLR) methodology consistent with prior works [30], [31], [32], [33], [34]. This method is ideal when a complete, summary of prevalent knowledge is needed [35]. SLR allows the researchers to identify and synthesise all relevant research in building up to the research gap, that led to the research question and research objectives respectively [34].

In 2009, an international group of systematic reviewers, methodologists and journal editors publish the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and a guideline designed to help authors prepare a complete report for SLR [36]. PRISMA consists of three stages, first one is identification. In this section, keywords or search strings, criteria and database used will be identified. For this study, the search strings were Emotion Recognition System, Youth, Malaysia, Readiness, and Acceptance. The criteria were the OR and AND Boolean operatives [30]. The term Emotion recognition system expanded with synonyms of Emotion Recognition Technology and Emotion Recognition Applications. The search was done using the Lens.org platform. The benefits of using this platform are increasingly recognized by researchers [30], [37]. First launched by Cambia in 2000 as Patent Lens, an Australia-based non-profit organization. In 2013 it became The Lens and has since become more than just a patent search platform.

Initially, the search for the Emotion Recognition System, in general, showed a result of 1,050 publications found based on The Lens filter. This study limited the date range from 2011 to 2022 and the document types are journal articles, conference proceedings articles and dissertations. In the first identification stage, we removed any duplicated publications before moving further into the next stage. Based on the total results, 2 identified publications were removed before the next stage as shown in Fig.1.

The next stage is screening, before narrowing it down to retrieval and eligibility. In this stage, we screened the 1,048 publications by language (selecting papers written in the English language only) and relevance (selecting papers on ERS in Malaysia only). Therefore 2 papers have been excluded because not in the English language. Secondly, since the collection also included technical papers on ERS from the perspective of computer science and informatics, we further filter the papers based on the details of the title and abstract. Those found not focusing on ERS were excluded. Hence, 267 publications were excluded. Thus, the total records that were sought for retrieval such as in Fig.1, were narrowed down to 779.

Then, in the retrieval stage, we need to ensure the records are accessible. A total of 156 papers were identified as not accessible due to subscription restrictions. Due to budget restrictions, it was not possible to purchase subscriptions or individual papers. The remaining records were confirmed to be accessible either under the existing institutional subscriptions or via open access. Ultimately, 623 papers remained for retrieval and were included in the final eligibility screening.

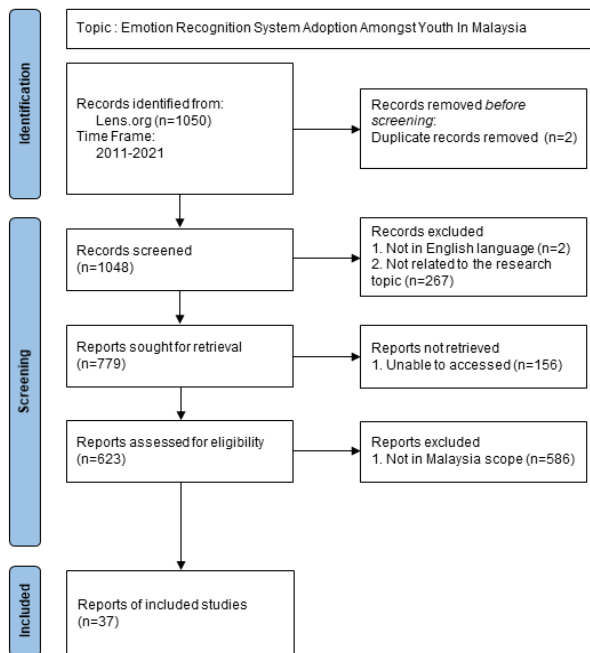


Fig.1.Prisma Flow Diagram

The final screening stage is eligibility according to the scope of the SLR. Here only works reporting from the Malaysian context are the records of interest. A total of 586 records were identified to be out of scope and thus not eligible for inclusion in this study. The final number

of records confirmed to be included in this SLR is 37. The following section reports the results and analysis of the final set.

### 3. Results and Analysis

This section reports the descriptive analysis results of the included 37 records, focusing on the document type, year of publications, subject area, keywords related to the studies and most cited.

#### 3.1 Document Type

The collected data has been classified based on three categories journal article, conference proceedings article and dissertation. These types of research works are selected for the quality control process normally in place before publication. Specifically, the works go through a stringent review process by subject matter experts to verify the quality of the work. Moreover, the journal article and conference proceedings article are chosen due to journal has a better structure while the conference is short and precise that has been used in the conference [38].

Based on Table 1, the majority of the publications are journal articles (20; 54.05%) and the remaining are conference proceedings articles (17; 45.95%). There was none for the dissertation category suggesting there is potential for postgraduate research in this area.

Table 1. Document Type

Document Type	Number of publications	% (N=37)
Journal Article	20	54.05%
Conference Proceedings Article	17	45.95%
Dissertation	0	0%
<b>TOTAL</b>	<b>37</b>	<b>100</b>

#### 3.2 Year of Publication

This study reviewed a decade worth of works from the year 2011 to 2022, and the returned publications for each year are different. There is no definitive trend according to the number of publications over the decade (see Fig.2). It can be said that there had been a steady

number of conference papers each year, but a relatively increasing trend can be seen for journal articles.

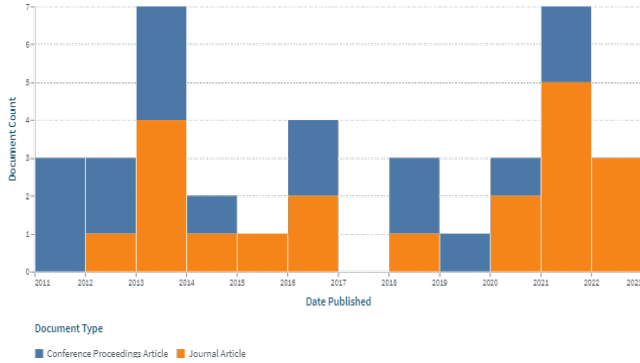


Fig.2. Year of publications

From Fig.2, we see that in the range of 2011 towards 2014 the field of affective computing, artificial intelligence and machine learning was attracting the interest of the researcher to find solutions in creating ERS, however, from 2015 to 2019, the number of publications was not constant, however, 2019 to 2022, the number of publications was increasing again. The upswing in the past 3 years can be due to the technological advancements that enable researchers to test ERS based on the modalities in the real world.

### 3.3. Field of Research

Next, the collected records were analyzed according to their field of research or subject matter (see Table 2). The highest ranking area of study is computer science with a total of 9 articles or 24.32%. Secondly, is engineering with 7 articles or 18.92%.

The majority of the discussions focused on the potential applications, benefits, implementation or deployment, safety, and risk of ERS. However, out of the 37 articles, there is only one research truly within the field of social science; from [39] regarding the awareness and readiness of Malaysian University students for ERS. Arguably, the implications of the study can be extended from the context of Malaysian University students to Malaysian youths in general.

Table 2. Subject Matter

Field	Frequency	%(n=37)
Computer Science	9	24.32%
Engineering	7	18.92%

Artificial Intelligence	4	10.81%
Information Systems	4	10.81%
Biotechnology	3	8.11%
Computational computers	3	8.11%
Environmental Science	2	5.41%
Social Science	1	2.70%
Human-Computer Interaction	1	2.70%
Material Science	1	2.70%
Software Analytics	1	2.70%
<b>TOTAL</b>	<b>37</b>	<b>100</b>

### 3.4. Most Cited

Next, the retrieved records that were included in the studies were analyzed in terms of citation. According to the analytics from Lens.org, the 37 publications collectively garnered 510 scholarly citations. Table 3 shows the top 10 most cited works in the collection. Ranked 1<sup>st</sup>, the paper by [40] is also one of the earliest publications in the retrieved records, thus it is expected to have a high citation. Furthermore, [40] mostly discussed the modalities that can be used for ERS. Such example, the electrocardiogram (ECG) is one of the modalities for ERS. Since the paper is a review, it provides a useful compilation of related works, and this also contributes towards a higher citation number.

Table 3. Top 10 most cited

Authors	Title	Year	Cites
Jerritta et al.	Physiological signals based human emotion recognition: A Review	2011	223
Murugappan & Murugappan	Human emotion classification using wavelet transform and KNN	2011	52
Seng et al.	A combine rule based and machine learning audio-visual emotion recognition approach	2018	43
Rashid et al.	Human emotion recognition from videos using spatio temporal and audio features	2012	37
Jerritta et al.,	Electrocardiogram based emotion recognition system using empirical mode decomposition and discrete fourier transform	2013	32
Bakhtiyari & Husain	Fuzzy model of dominance emotions in affective computing	2014	22
Wani et al.	A comprehensive review	2021	21

	of speech emotion recognition systems		
Chew et al.	Audio emotion recognition system using parallel classifiers and audio feature analyzer	2011	13
Jerritta et al.	Emotion detection from QRS Complex of ECG signals using hurst exponent from different age groups	2013	10
Hasnul et al.	Electrocardiogram based emotion recognition applications in healthcare : A Review	2021	9

From Table 3, it can be observed that the earlier works tend to focus on the technical development of ERS; from developing modalities to establishing the system. More recent works such as [12], classified the applications that can benefit ERS such as the ECG-based ERS for healthcare applications. Meanwhile, [41] reviewed works on speech-based ERS.

#### 4. Discussion

The trend for ERS has been increasing, although there is a gap between time and studies based on Fig.2. However, the momentum of the publications returned has risen from 2019 to 2022. ERS is not seen as a new technology, instead, the previous researcher suggested ERS is seen as an embedded technology through existing devices and technologies [42]. Given the advantages and continued advancement of AI, machine learning as well as deep learning, ERS has the potential to be the enabler of new features in various applications that utilize recognition of human emotions [43].

The following sections discuss the key insights derived from the retrieved 37 publications. Specifically, the discussion focused on modalities, applications of ERS, research gaps identified, limitations, and future directions for research in ERS.

##### 4.1. Modalities

ERS can be identified through various input data modalities, such example, physiological modalities, psychological modalities and data mining modalities. These modalities have been majorly developed in the field of computer science, engineering, artificial intelligence, information systems, biotechnology and computational computers.

###### 4.1.1 Physiological Modalities

In physiological modalities, it is consisting of

electroencephalography (EEG), electrocardiography (ECG) and photoplethysmography (PPG). EEG is frequently used in neuroscience, neural engineering, and biomedical engineering to measure human brain signals through the electromagnetic behaviour of specific components [43], [44], [45]. EEG is most likely the favourite for obtaining high-accuracy data for automated emotions recognitions because EEG processes use the same concept as AI systems that used convolutional neural networks for machine learning and deep machine learning [46], [40]. ECG is commonly used by previous researchers in the field of AC due to its potential adoption using a wearable device. In a previous study by [12], ECG was used to detect stress and the benefit of monitoring a patient's emotional stress condition to ensure that a negative tendency is not triggered. Next for EEG, is photoplethysmography (PPG). PPG has been said to be more practical and suitable in real-life use compared to EEG, in combination with ECG as multimodal, it can be implemented as a "wearable device that can collect signals from a person without compromising comfort and privacy" [46], [47]. For instance, current technology devices such as a smartwatch have a built-in ECG to detect stress levels and blood pressure, consequently identifying temporal emotional states.

###### 4.1.2 Physical Modalities

For physical modalities, the modalities that have been widely used are facial recognition and speech recognition. Facial recognition has gained popularity amongst ERS practitioners due to diverse applications that can be applied in the real world such as marketing purposes, security supervision, online class and gaming experience [48]. Facial expression can determine the six basic emotions, namely, sad, anger, happiness, fear and surprise. Additionally, facial expressions can be used to detect disgust, normality, and drowsiness [49]. Speech recognition as modalities of ERS is capable of detecting human speech and interpreting conditions and emotions for real-life applications [45], [50]. According to [51], speech recognition is defined based on someone's voice, the computer can learn what condition they are in, therefore concluding what is the emotion of that person. In [41], a review of the speech emotion recognition system shows that speech recognition detects and classify emotion recognition system, only the inability to handle the real-time problem and different scenario that

affect human emotions as human speech is vary based on culture.

#### 4.2. Applications

Based on the conducted SLR, some papers presented the potential applications that can be achieved through individuals, society and industries. Firstly, the education system can be improved with the adoption of ERS [53]. Emotion has a significant influence on the relationship with a performance from the perspective of a learner and instructor as described by [14], and students with positive emotions led to increasing student interest, and student performance and “have higher chances at success”. [14] their study suggested a webcam inside a computer laboratory and using a facial recognition modality to identify students’ moods and the results show significant differences in the student’s moods.

From an individual perspective, emotions can affect driving [13]. This is due to emotions’ relationship with focus. For example, anger can lead to poor focus. A poor focus led to an increasing number of accidents, therefore, it is significant for ERS to be embedded in cars for driving safety [13]. Furthermore, [13] used a driving simulation, where a virtual driving experiment was conducted to test ECG-based ERS in identifying human emotions while driving.

In [12], ERS was implemented using ECG in the healthcare industry to “reduce stress and promote relaxation”. The ECG-based ERS helps a person with mental stress to identify negative and positive emotions. Furthermore, ERS can be suggested as a supporting aid for people with certain disorders such as down syndrome, autism, and even elderly people. It will be using facial expressions in real-time video as automated emotion recognition and a computer advisor that advises on how we can react appropriately [54], [59].

ERS can be potential in marketing strategy. Such example in brand awareness, product acceptance can be analyzed based on the response of human facial expressions in a live launch or video and images [54]. For example, a small group of people in a room are introduced to a product, and their reactions through facial expressions will be recorded and evaluated by ERS whether they are happy, disgusted, or anxious.

In another aspect, in video games, the developer of games has an objective which is to “fulfil his or her dream” while playing games through immersive gameplay, interesting storyline and intensive graphics [55], [56]. Implementation of emotion detection can improve engagement between entertainment agents and end-user by alternatively using multimodalities such as speech recognition and EEG in the controller which can improve

understanding of human emotions towards intangibles products such as music or movies [54]. In addition, with virtual reality (VR) technology in recent years, the developer can enhance the game further with real-time ERS usage towards understanding the player.

#### 4.3. Gaps

With the valuable insights based on the previous paper, there are several gaps identified that motivate this study. The objective of this study particularly is to gain insights into adopters’ perspectives. The results of performing SLR are to understand the recent study on ERS and the existing gap between previous research and studies. From the results of performing the SLR on the specified topic, in Malaysia, there is a smaller number of returned publications with only 37 papers (see Fig.1), specifically, studies regarding ERS adoption. Previous research signifies that ERS contributes within the aspect of the engineers and scientists, however, in real-life problems, there will be a different situation that might not apply.

Based on the Lens search, the availability of ERS is limited due to ERS being practically known amongst researchers related to the field of computer science, engineering, artificial intelligence and information systems. And when we narrowed down the scope to Malaysia, the trend of publication is slower during the early year between 2011-2016 due to the technology is still in a growth state. However, in 2017-2021, the publications are getting momentum again along with the advancement of technology, and emotion recognition has gotten recognizability throughout Malaysia. Next, we dive deep into the adoption towards the Malaysian population. In 2021, there one paper signifies the acceptance of Malaysian university students towards ERS [39]. This paper discusses the perspective of Malaysian university student awareness towards ERS whether they know about ERS and are ready to adopt the technology or they are still unaware of the technology.

In conclusion, there is still a lack of studies related to ERS in Malaysia and ERS adoption and readiness in Malaysia. This study will help to gain better insights on the perspective of ERS adoption and readiness and contribute to the practitioners and policy making by the government to ensure that ERS is more practical to use amongst users and important determinants of user’s adoption in ERS.

#### 4.4. Limitations

Conducting the SLR studies, and analyzing the previous paper, some limitations have been found and highlighted by the previous researchers. Firstly, the security and privacy from the emotional recognition. As machines evolve for to better over the next few years, there is a part where for humans, exposing privacy is the last part to do. Although in marketing, there is a benefit of ERS to be implemented, however, there is a risk to privacy and security, as capturing facial recognition and analyzing text data mining can feel like invading privacy and security breach without consent.

Secondly, another study [42], suggested that there is uncertainty for ERS as a limitation due to recognizing human emotions can create fear amongst humans. Specifically, in the workplace, emotion will play an important role in determining performance, productivity and efficiency, however, there will be at times when humans do not want to be measured for their emotions and observing their behaviour, therefore, will create unpleasant surroundings.

Next, from the perspective of social science, there is a limited number of papers from SLR conducted that focuses on ERS readiness and adoption. There is a need to understand the perspective of users that will be going to face the technology and the perceived usefulness of the technology matters in predicting accurately the technology will be performing in real-life.

#### 4.5. Future Directions

The papers reviewed, sourced from Lens, suggest that there is a need for more research on ERS, as its applications have the potential to benefit individuals and societies in everyday life, particularly in Malaysia. Furthermore, ERS can play a significant role in industries, as highlighted by previous researchers, due to the rising importance of AI development in the fourth industrial revolution (IR 4.0). As we move towards the fifth industrial revolution (IR 5.0), with a focus on enhancing human-computer interaction, the relationship between ERS and AI is of particular importance. ERS can serve as a subpart of AI, enabling robots to better understand and interact with humans, and enhancing the overall HCI experience [57]. Therefore, further research on ERS is necessary to explore its potential applications and benefit in various contexts, including education, healthcare, and entertainment, and to pave the way for the development of more advanced HCI technologies in the future.

With the evolution of industries towards education, the use of ERS has the potential to improve the interaction and feedback in online education [58]. Research has shown that incorporating emotional recognition into online learning can enhance the learning experience by creating a more authentic and engaging

environment [58]. Therefore, the adoption of ERS in education could be beneficial for instructors, institutions, and students, and could serve as a step towards more advanced human-computer interaction (HCI) technologies. Such applications of ERS in education can pave the way for future proofing and the development of more advanced HCI systems that enable personalized learning experiences. Furthermore, utilization of ERS in the education sector can facilitate for better adoption rates of ERS in other sectors as the youths familiarize to the technology during their formative years.

The implementation of ERS in the future has significant potential for the development of advanced technological possibilities. However, it is crucial to identify the readiness for ERS adoption, as the successful integration of new technologies into daily life requires thorough research to identify the influencing factors. Therefore, further research is needed to determine the readiness of societies for ERS adoption and to support further findings. Such research can inform the development of policies, guidelines and recommendations for the integration of ERS into various contexts and can contribute to the overall success of ERS adoption.

Lastly, ERS engineers and practitioners need to be aware of the importance of ERS readiness, as the expectations for ERS to work in the real world and be accepted by societies may differ from their technical requirements [40], [59]. Therefore, future research should focus on identifying the readiness factors of societies in adopting ERS, which can provide valuable insights for ERS engineers and practitioners in developing ERS systems that align with societal expectations and values. By considering societal factors and readiness levels, ERS systems can be tailored to meet the specific needs of different contexts, which can contribute to the successful adoption and implementation of ERS.

#### 5. Conclusion

With the ubiquity of computer technologies and smart devices in all aspects of human life, technological advancement is increasingly important in our daily lives. In this context, ERS can serve as an efficient bridge towards IR 5.0 innovations and enhance existing technological applications. ERS technologies leverage various modalities such as facial expressions, speech, and physiological signals to detect and interpret emotional states, which can provide valuable insights into human behaviour and enhance the overall user experience. With technologies becoming more intelligent and collaborative, researchers expected a wider range of benefits will materialize for us to experience across communities as well as generations [10], [57], [60].



Therefore, continued research and development in ERS technologies is crucial to realize its potential applications and benefits in various domains and pave the way towards more advanced and sophisticated technological solutions in the future.

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