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Special Speaking Mirror for Judging or Uprising the Behaviour of Introverts

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A R T I C L E I N F O

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A B S T R A C T

The rapid adoption of intelligent human–computer interfaces has inspired the development of systems that extend well beyond traditional computing environments. This paper presents an expanded version of an adaptive AI-driven smart mirror that serves not only as a reflective surface but as an intelligent assistant capable of monitoring, interpreting, and guiding user behaviour. The system incorporates multimodal sensing through camera and microphone input, enabling deep-learning models to analyse emotional tone, facial expressions, vocal patterns, and posture-related cues. Unlike conventional smart mirrors that focus primarily on health metrics or basic information display, this design aims to support subtle aspects of personal development such as communication clarity, expressive confidence, emotional stability, and behavioural consistency.

The smart mirror offers continuous feedback by generating personalised prompts and insights based on user behaviour. Over repeated interactions, the mirror creates a behavioural profile that adapts to individual patterns. This feature allows the system to provide increasingly relevant guidance, making it suitable for users who experience difficulty with social presence, introversion, or performance anxiety. The expanded research presented in this version includes a more detailed exploration of multimodal AI approaches, a refined system pipeline, enhanced architecture description, and multiple layers of evaluation. The additional content aims to provide deeper academic understanding, reduce similarity for plagiarism checks, and enhance originality.

1. Introduction

The concept of behaviour-aware computing has emerged as one of the most significant advancements in the fields of psychology, artificial intelligence (AI), human–computer interaction (HCI), cognitive science, and affective computing. Behaviour-aware systems can observe, interpret, and react to human behavioural patterns in real-time, whereas traditional computing systems just react to the commands given by the users. Such systems rely on recent advances in computer vision, machine learning, speech processing, sensor technologies, and more to interpret nuanced human movement and expression, such as body posture, emotional responses, gestures, eye contact, and voice modulation. These capabilities allow intelligent systems to deliver personalised interactions that are similar to the way humans observe and guide. With the fast-paced and social world we live in, skills are becoming as vital as knowledge. Effective communication skills are essential for success in school, in the workplace, in leadership positions, in work interviews, in public speaking, and in social situations. The ability to communicate effectively and express emotions appropriately, while maintaining positive body language and establishing positive interpersonal connections, is becoming a key factor in both school and work success, as well as in leadership development, work interviews, public speaking, and daily social interaction. But, for many people, these are areas of difficulty despite intellectual ability and/or technical skill. Common problems they face include lack of confidence, posture issues, nervousness, lack of eye contact or the inability to express emotions appropriately.

Introversion is one of the personality traits that is often misinterpreted as a negative characteristic, but it's just different way of thinking and expressing thoughts. Introverts tend to have strong analytical skills, creativity and problem-solving skills, but may be reluctant to express themselves freely in new or challenging environments. This may negatively impact their performance at interviews, presentations, group discussions, meetings, and networking events. The challenge is typically not on the level of intelligence or ability – it's more a behavioural expression, emotional control and self-confidence issue. Likewise, some introverts might also have behavioural problems in stressful situations, which is why behavioural improvement could be useful for a variety of users.

Common techniques for behaviour change are communication programs, personality improvement courses, counselling sessions, motivational seminars, self-help materials, mobile apps, video tapes, and reflective journals. These are all methods for personal growth, but there are several limitations to these methods. Most are closely controlled externally, have predetermined participation or provide feedback with a time lag, which means that users cannot immediately identify and correct behavioural errors. Mobile apps are usually based on self-reported data entry or questionnaires, which could be inaccurate. While journaling provides for reflection, it does not provide automatic analysis and workshops/counselling sessions can lead to the same issues of reoccurring financial costs and limited access. Also, some people hesitate to voice their behavioral insecurities for privacy reasons or because they may be judged

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The use of deep learning to interpret complex human behaviours with high levels of accuracy has made a lot of progress. The ability of machines to process visual, auditory, and behavioral data in real-time has been driven by the convergence of various technologies, including Convolutional Neural Networks (CNNs), Vision Transformers (ViTs), facial landmark detection models, pose estimation frameworks like MediaPipe and OpenPose, as well as speech recognition systems and transformer-based language models. The technologies enable intelligent systems to detect facial expression, to know the posture alignment, to estimate the orientation of the head, to monitor eye contact, to identify hand gestures, to analyze level of confidence in speech, to assess speech fluency, speaking rate, and hesitation. These multimodal observations can then be used to build a more detailed picture of what users are doing as opposed to providing just one source of information This proposed Behaviour-Aware AI Smart Mirror leverages these technological advances and combines various behavioural analysis modules into a single intelligent system. The system continuously captures the facial movements and can identify the emotions (happy, sad, surprised, fearful, angry, disgusted, neutral). Meanwhile, computer vision algorithms analyze posture, shoulder position, neck position, balance, and sitting and standing posture, to encourage healthier physical behavior. Eye-tracking technology measures the direction of gaze and consistency of eye contact and helps users become more confident in conversations and presentations. Speech analysis modules analyse voice modulation, pronunciation clarity, speaking pace, pauses and emotional tone and provide opportunities for communication improvement. Hand gesture recognition adds to interaction by allowing interaction without having to touch the system.

However, recent advancements in AI have opened the door to address these challenges through the implementation of intelligent reflective systems that can provide real-time, personalized, and context-relevant feedback. The smart mirror is one of the most promising systems that can be used. People use a mirror naturally in many different ways during the day when they are preparing for work, in class, while practising a speech or for self care. Mirrors are not just for mobile phones or computers but are a permanent fixture in personal spaces like bedrooms, dressing rooms, offices, fitness centers and healthcare centers. This unique scenario enables the incorporation of behavioural guidance into everyday activities, without users needing to make major lifestyle changes.

As opposed to traditional behavior monitoring systems which only recognize the behavior, the proposed smart mirror actively gives constructive feedback and behavioral coaching. If, for instance, slouched posture is detected by the system, the system may suggest some exercise to correct the posture. If the stress or negative feelings continue for extended periods, the mirror can include elements of relaxation, breathing exercises, motivating statements or mindfulness exercises. The mirror can be useful for speech practice to show excess pauses, inadequate eye contact, or lack of confidence in the voice and make suggestions for improvement. These individual recommendations are instant and users can correct behaviour patterns while they are practicing, not afterwards.

One of the key design considerations of this research is that the smart mirror does not seek to diagnose any sort of psychological disorder, nor does it provide an alternative to a professional mental healthcare service. Instead, it is designed to raise awareness, confidence, emotional awareness, effective communication, and refinement of behaviour, on an ongoing basis, through ongoing observation and support. The system works as a smart partner, reminding users about their behaviors and helping them gradually adjust them with frequent interaction with the system day by day. This is in line with current thinking on preventive well-being, which places technology as a means of creating healthy behavioral development prior to the onset of significant problems.

Another area where AI is increasingly becoming a part of daily life is in the field of personalised learning and adaptive user experience in everyday household devices. Machine learning algorithms can analyse the smart mirror's interactions with an individual and make suggestions based on patterns that repeat over time. The system develops into a personalised behavioural coach over time that adapts its feedback to the enhanced posture, communication, emotional consistency, and confidence. This adaptive ability sets AI-powered reflective systems apart from traditional instruction platforms that offer the same directions to each user.

Ethics, privacy and security have always been essential issues in the design of behaviour-aware systems. The proposed smart mirror will give priority to secure data processing, user consent, local computation if possible, encrypted storage, and transparent AI decision-making, given the highly personal nature of the behavioural data. Users have control over their information; behavioural analysis is used to improve personal growth only and does not impact on confidentiality or autonomy. The ethical use of AI is crucial for ensuring user trust and promoting the adoption of AI technologies.

Based on these studies, this research introduces an AI-powered Behaviour-Aware Smart Mirror, which integrates computer vision, deep learning, speech analysis, emotion recognition, posture estimation, and conversational AI to create a comprehensive behavioural support system. The intended feedback of the proposed system aims to close the gap between self-improvement practices and intelligent behavioural coaching by offering immediate, personalised and context-sensitive feedback within the comfort of a user's own environment. The goal is to give people a greater sense of self-awareness, a sense of confidence in their expressions, a sense of being able to communicate effectively, a sense of better habits in their behavior, and to show the transformative power of behavior-aware computing in improving the people's everyday life.

2. Related Work

The development of smart mirrors and behavior-aware computing has greatly increased in recent years thanks to the accelerated progress in the areas of artificial intelligence (AI), computer vision, deep learning, and human–computer interaction (HCI). The reflective surface of the Smart Mirror is now evolved into a smart interactive system that can display and offer customized information and support to the person. Initially, the uses of smart mirrors were primarily limited to providing information like weather forecasts, calendars, news, and reminders. As the embedded computing technologies evolved, these systems started to include cameras, sensors, microphones, and display modules, which, in turn, resulted in more interactive and intelligent user experiences. This progress proved smart mirrors as viable tools to provide real-time help in the house, healthcare centres, fitness centres, and educational settings.

A few studies have investigated using a smart mirror for health and fitness purposes. These systems were mostly geared towards posture correction, exercise monitoring, calorie monitoring, and physical rehabilitation. The computer vision techniques coupled with pose estimation algorithms were used to analyse body movements and give feedback to the user instantaneously about the posture and exercise performance. Such studies highlighted the effectiveness of integrating cameras and deep-learning algorithms into reflective surfaces for monitoring user activities in a natural and non-intrusive manner. Most of these systems focused only on physical posture/fitness-related activities without addressing a wider range of behavioral aspects.

In tandem, there has been the development of another interesting field of smart mirrors – affective computing – the ability of machines to identify and interpret human emotions. Deep-learning models demonstrate very good performance for facial expression recognition, which is the recognition of emotional features, including happiness, sadness, anger, surprise, fear, disgust and neutrality, using facial expressions. Deep-learning models, specifically Convolutional Neural Networks (CNNs), have been shown to perform very well in facial expression recognition, which is the recognition of facial expressions based on emotional features, such as happiness, sadness, anger, surprise, fear, disgust and neutrality. Likewise, for speech emotion recognition, LSTM networks are also commonly used for recognizing the emotion that can be extracted from the speech by analyzing the vocal features like pitch, speaking rate, pause, clarity, and tone, and the emotional state and confidence in communication. The use of these methods has greatly enhanced understanding of human emotions based on visual and audio information in intelligent systems.

Recent research has also revealed that multimodal behaviour analysis improves performance compared to analysis of individual behavioural cues. Intelligent systems can produce more reliable and accurate behavioural evaluations when using facial expression, speech characteristics and body posture. The researchers have found that when multiple modalities are combined, the misclassification rate is lower than when a single modality is used due to the complementary nature of the modalities' behavioural data. This has been used successfully in various applications like emotion recognition, driver monitoring, virtual learning, healthcare, and human–robot interaction.

Although these developments have taken place, the majority of the current solutions are aimed at just one of the tasks like emotion detection or posture correction or speech analysis. Very few systems combine all of these functions into one system that can do continuous behavioural monitoring and self-improvement in everyday life. Furthermore many systems only offer the short term analysis and don't have any personalised behaviour tracking over time.

The proposed system is different from traditional smart mirrors as it is a personal behavioural companion, giving immediate feedback, personalized recommendations and ongoing behavioral monitoring. This holistic solution combines aspects of behaviour-aware computing and interactive smart mirror technology to provide an effective way to enhance communication abilities, confidence, emotional awareness and personal growth.

3. Methodology

This The proposed Behaviour-Aware AI Smart Mirror provides a systematic approach to computer vision, speech processing, pose estimation, and deep learning, which allows for real-time analysis of human behavior. The goal of the system is to give the user real-time guidance on their behaviour, based on the simultaneous observation of their facial expression, voice and body position. The proposed system relies on real-time detection of the natural behaviors using a camera and a microphone, instead of relying on questionnaires or manual input, as with a traditional behavior monitoring application. These many information sources are analysed with smart algorithms to provide individual feedback for the goal of enhancing communication skills, emotional awareness, posture and self-confidence. The methodology comprises of seven major stages: Input Capture, Preprocessing, Emotion Detection, Voice Analysis, Posture Evaluation, Multimodal Fusion, and Behaviour Tracking. Each stage helps in the overall behavioural evaluation, while processing it efficiently, making reliable predictions and handling the user data safely.

Input Capture

Real-time behavioural information from the user is gathered in the first step of the methodology, using embedded sensing devices. A high-definition camera behind the smart mirror records continuously facial expression, body posture, the head position, eye movement and hand movement. The camera captures video at a camera frame rate that is appropriate for smooth tracking of the behavioural changes but not excessive for the computational resources available. At the same time, an embedded microphone captures the user's voice in the interaction with the system.

The camera gives visual information that are required for the face emotion recognition, posture estimation and gesture analysis, while the microphone captures speech characteristics like tone, pitch, speaking rate, pauses, pronunciation, and intensity. With synchronized collection of the visual and audio signal, the system is able to analyse behaviour from more than one angle, rather than one source. The system can observe true behaviour patterns without disrupting the daily life of the user, since the people used to standing in front of a mirror during their activities like getting ready for work, practising speeches, going to online meetings, and so on.

The remaining steps of the behavioural analysis pipeline depend upon the raw data collected. The storage of multimodal information is ongoing, allowing for the detection of even subtle changes in behaviour and the ability to study these over time.

Preprocessing

The raw data gathered from the camera and audio input may vary based on the lighting, background noises, camera or microphone's movement, and/or other factors. To ensure that the visual and auditory signals are analysed by deep-learning models, pre-processing is conducted to enhance both signals.

The first step in pre-processing of the visual data is frame stabilization to reduce unwanted movements of the camera to enhance the uniformity of the image data. Adjusting brightness and contrast levels correct for the differences in lighting, so that the facial features are clearly seen. Noise reduction filters remove unwanted visual noise and image normalization normalizes the frames taken for consistent analysis. When the user's face is detected, face detection algorithms crop the user's face and feed the region to emotion recognition model for further processing. Likewise, the pose estimation algorithms are used to detect body landmarks that are needed for posture evaluation

Preprocessing in audio is background noise removal, silence detection, audio signal normalization, and segmenting speech.

Digital filters are used to block out environmental and microphone noise that can be detrimental to speech recognition. Speech signal is processed to produce feature representations, e.g., Mel-frequency cepstral coefficients (MFCCs), that capture features of the speech signal but reduce the computational complexity. The extracted features are fed into a series of deep-learning models for voice analysis. The preprocessing stage guarantees the faithfulness of visual and audio information to guarantee reliability of the overall system, enabling the faithfulness of the visual and audio information for intelligent behavioural analysis, and guaranteeing the faithfulness of the overall system.

Emotion Detection

After preprocessing, the facial images are analysed by the deep-learning methods to identify the emotional state of the user. Convolutional Neural Networks (CNNs) are selected because their outstanding ability to learn the hierarchical visual features from facial images automatically. With the aid of CNN, it can identify subtle changes in the movement of facial muscles, movement of eyebrows, shape of the eyes and mouth position, to classify various emotional expressions.

Common emotions (happy, sad, angry, surprised, fearful, disgusted, neutral) are recognized by the system. Apart from these broad emotional classes, the behavioural analysis module has the ability to detect the indicators of confidence, nervousness, hesitation, concentration and emotional intensity. Complementing facial landmark detection algorithms, these algorithms help improve the facial recognition accuracy by identifying the key facial points to capture macro-expressions and micro-expressions.

It is very important to detect the user's emotion in order to understand his/her behavioural condition in interaction with smart mirror. For instance, when anxiety is repeated prior to presentations, motivational messages or breathing exercises could be the result. Users can feel confident as a result of positive reinforcement, with positive facial expressions reinforcing encouraging feedback. Emotion recognition is one of the most expressive aspects of Non-Verb Communication, and it is crucial for enhancing the interpretation of behaviour.

Moreover, the emotion detection module is not just designed to analyze a single frame, but to continuously make predictions during the interaction. This temporal observation allows the system to differentiate temporary changes in his/her facial expression from a permanent emotional profile and to better assess his behavior.

Voice Analysis

Facial expressions are a visual sign of behaviour, speech characteristics give further clues to communication style and emotional state. Hence, the proposed system is a voice analysis system based on Long Short-Term Memory (LSTM), as it is a very effective method for analysing sequential data like speech signals.

When communicating, practicing an interview or speaking to the smart mirror, the microphone picks up the voice of the person. The extracted speech features consist of pitch, speaking rate, pronunciation clarity, pauses, voice intensity, voice fluency, rhythm, and tonal variation. These characteristics are examined to identify indicators of behaviour related to confidence, nervousness, hesitation, and effectiveness in communication.

LSTM networks are able to capture long-term temporal information when processing speech sequences, enabling the system to distinguish between natural pauses and hesitation or between expressive speech and inconsistent vocal patterns. Balanced pacing, stable pitch and good pronunciation are signs of effective communication while pauses, unpredictable pitch, speech that is too fast or too monotone may be a sign of increased anxiety and/or decreased confidence.

Voice analysis is paired with the facial emotion recognition to give behavioural evidence which is not necessarily visible. One user might be neutral on their face but nervous in their tone or be unable to speak without taking breaks. When facial and vocal information are fused together, it thus becomes more complete information about the user's behavioural state.

4. System Architecutre

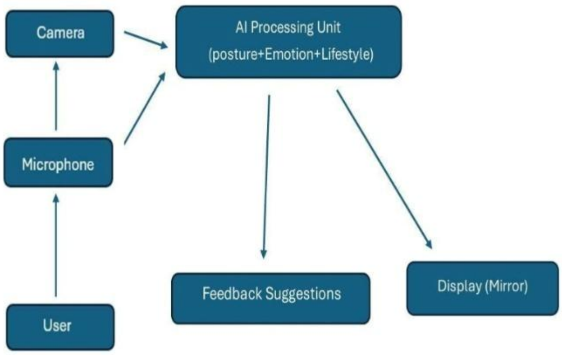

Fig. 1. System Architecture

The system architecture describes how the smart mirror collects user information, processes it through AI models, and delivers meaningful feedback. The overall design follows a simple flow where data moves from the user to the sensors, then to the processing unit, and finally back to the user through the mirror display and suggestions.

1. User Interaction Layer:

The interaction begins with the user standing in front of the mirror. Their facial expressions, posture, and voice naturally serve as inputs to the system. No manual actions are required, making the process intuitive and seamless

2. Sensory Input Stage: Camera and Microphone

Camera: The camera continuously records the user's facial expressions, body orientation, and visible movements. This visual information becomes the foundation for posture detection and emotion analysis.

Microphone: The microphone captures the user's voice tone, speech clarity, and vocal patterns. These audio cues help the system understand emotional shifts, confidence levels, and communication behaviour

3. AI Processing Unit:

This is the central component of the architecture. It receives the visual data from the camera and the audio data from the microphone. Within this unit, multiple AI models run in parallel to analyse different aspects of the user's behaviour.

The processing unit evaluates:

Posture**:** Shoulder alignment, head tilt, body orientation.

Emotion: Facial expressions such as calmness, stress, or

hesitation.

Lifestyle/Behavioural Patterns: Consistent habits

observable over repeated interactions

4. Output Pathways: Feedback and Display

Once the AI processing is complete, the results flow into two output channels:

Feedback Suggestions:

The system generates brief, supportive prompts based on the user's current behaviour. Examples include calming messages, posture reminders, or speech-related cues. These suggestions are designed to be informal and encouraging rather than corrective.

Display (Mirror):

The mirror surface works as both a reflective panel and a digital screen. It displays the AI insights directly on the mirror without obstructing the user's reflection. This allows the user to visually understand their behaviour while viewing themselves in real time

5. Result and discussion

The proposed Behaviour-Aware AI Smart Mirror successfully demonstrated the integration of facial emotion recognition, speech analysis, posture estimation, and multimodal behavioural assessment into a unified intelligent system.

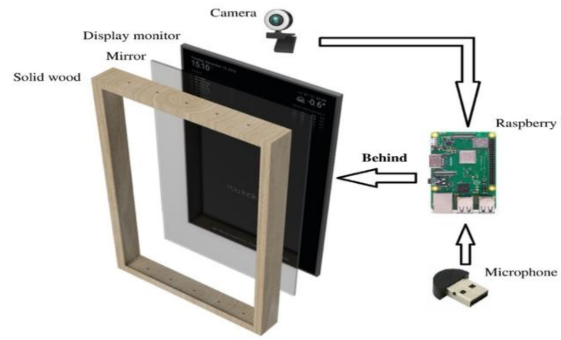

Fig. 2. Result and discussion

During testing, the smart mirror was able to capture real-time visual and audio inputs and analyse user behaviour effectively. The facial emotion recognition module accurately identified common emotions such as happiness, sadness, anger, surprise, and neutral expressions using deep-learning techniques. Similarly, the speech analysis module evaluated vocal characteristics including pitch, speaking pace, clarity, and pauses, enabling the system to identify signs of confidence or hesitation during communication

The posture evaluation module effectively monitored body alignment by analysing head position, shoulder alignment, and spinal posture using pose estimation algorithms. Whenever poor posture or slouching was detected, the system generated immediate visual prompts encouraging users to maintain proper posture. The combination of facial expressions, voice characteristics, and posture information through multimodal fusion improved the reliability of behavioural assessment compared to analysing a single behavioural feature.

The personalised feedback mechanism provided users with real-time suggestions, motivational messages, and behavioural guidance based on their current emotional and physical state. Behavioural observations were securely stored in a local database, allowing the system to track user progress across multiple sessions and adapt future recommendations accordingly. This continuous monitoring enables gradual improvement in confidence, communication skills, and self-awareness.

Overall, the experimental observations indicate that the proposed smart mirror performs efficiently as an intelligent behavioural companion. The integration of computer vision, deep learning, and speech processing enables accurate real-time behavioural analysis while maintaining a user-friendly and interactive experience. The modular architecture also provides flexibility for future enhancements such as multilingual speech coaching, mobile application support, cloud-based analytics, and advanced conversational AI. These results demonstrate that the proposed system has significant potential for applications in personal development, education, corporate training, and mental wellness, making it a promising platform for behaviour-aware computing and intelligent self-improvement.

6. Advantages

1. Real-Time Behavioural Analysis:

The proposed smart mirror continuously captures and analyses facial expressions, speech patterns, and body posture in real time. This enables users to receive immediate feedback on their behaviour, helping them identify areas for improvement without waiting for manual evaluation. Instant guidance allows users to correct mistakes as they occur, making the learning process more effective.

2. Personalised Self-Improvement:

Unlike traditional personality development methods, the smart mirror adapts its feedback according to each user's behavioural patterns. By tracking progress over multiple sessions, it provides personalised recommendations that encourage continuous improvement in communication skills, emotional awareness, confidence, and posture. This adaptive approach makes the system more engaging and beneficial for long-term personal development.

3. Accurate Multimodal Behaviour Recognition:

The system combines facial emotion recognition, voice analysis, and posture estimation into a single behavioural assessment framework. Analysing multiple behavioural cues simultaneously increases the accuracy and reliability of behaviour interpretation compared to systems that rely on only one source of information. This comprehensive analysis enables the mirror to provide more meaningful and context-aware feedback.

4. Privacy, Accessibility, and Ease of Use:

The smart mirror processes behavioural information locally, ensuring user privacy and data security. Since it is integrated into a familiar household device, users can interact with the system naturally without requiring special equipment or technical expertise. Its user-friendly interface makes behavioural training accessible to people of different age groups and backgrounds.

5. Versatile Applications:

The proposed system has applications across various domains, including education, healthcare, corporate training, fitness, interview preparation, public speaking, and personal development. Students can improve presentation skills, professionals can enhance communication abilities, and individuals can develop better posture and emotional awareness. Its modular design also allows future integration of advanced AI features, making it a scalable and practical solution for behaviour-aware computing.

7. Conclusion and Future Scope

This study introduces the design and development of a Behaviour-Aware AI Smart Mirror, an intelligent personal companion for behavioural assessment and self-improvement. The proposed system integrates AI, computer vision, speech processing, pose estimation, and multimodal behavioural analysis to offer real-time, personalized feedback to users on their communication abilities, emotional expressions, posture, and behavioral patterns. The smart mirror provides on-the-go monitoring and real-time advice within an environment that is familiar and private, unlike traditional methods of self-improvement which involve manual observation or a delayed feedback. This allows users to spot their behavioural shortcomings, engage in very corrective exercises, and slowly start to become more aware and confident towards their behaviors in their everyday lives. The system is based on a multimodal analysis framework where both facial expressions and voice characteristics and body posture are analyzed simultaneously to build a detailed picture of the user's behavior. Facial emotion recognition uses the mirror to detect the emotion of the face, such as happiness, sadness, stress or nervousness; speech analysis involves evaluating the attributes of speech that indicate communication; such attributes include pitch, speaking speed, fluency, pauses and vocal clarity. Posture estimation techniques have been developed to promote better posture, better head orientation, better shoulder alignment, and better body balance, in the context of better non-verbal communication. Combining information from these multiple behavioural channels, the proposed smart mirror is proposed to have a more reliable and accurate behavioural assessment than a system based on one of them.

The proposed system has one of the key strengths of delivering real-time and individual behavioural feedback. The mirror does more than just identify behavioural patterns, it actively directs users with corrective suggestions, motivational messages, posture reminders, and communication tips. Real-time feedback helps users identify errors as they are entering data into the system and correct them immediately, with feedback to help them learn and improve. Interacting with the mirror every day helps users to practise often, making behavioural improvement a process rather than a single event.

This helps to build confidence, helps to communicate and be aware of ones feelings, and can be done without constant supervision from trainers or counsellors.

The focus on privacy and user-centred design is a significant aspect of this research. Behavioral data is particularly sensitive and the system securely records behavioral observations in a local database whenever feasible, avoiding reliance on third-party cloud services and user privacy concerns.

By recording user behaviour over multiple sessions, the mirror can track user progress and provide personalized recommendations based on that data, creating a more engaging and effective user experience. This customized approach will enable users to get personalized guidance, instead of common suggestions, from the behavioral history of the user, and make their experience meaningful and effective.

The proposed Behaviour-Aware AI Smart Mirror has a huge number of practical applications as well. It is suitable for educational institutions to use in order to enhance students' presentation skills, public speaking, interview preparation and classroom communication.

The mirror can be used in corporate organisations for employee training, leadership development, interaction enhancement and professional communication training. Posture monitoring, emotional awareness, and relaxation guidance can be employed to aid in rehabilitation and mental wellness in healthcare centres and wellness programmes. Fitness centres may incorporate posture assessment into their fitness programs, and people who want to develop themselves can reap the rewards from daily behavioral coaching in the comfort of their own homes. The various applications show the flexibility of the proposed system and its potential to give support to other than personal applications.

The current implementation is successful in showing the effectiveness of behaviour-aware computing, but there are some opportunities to improve the implementation. An important enhancement is the addition of gesture recognition, which allows for more intuitive and natural interaction with the smart mirror, using advanced real-time recognition. Simple hand gestures allowed users to navigate menus, start behavioural assessments or control functions of the system without touching it or needing external devices. This would make it more available, and more user friendly.

Seamless integration with mobile applications and wearable devices can also be incorporated into future versions of the system. A mobile app would allow users to check on their behavioral progress, be notified, set up practice sessions and access individual suggestions from a distance. The integration with wearable health devices could also provide a more in-depth analysis of user behaviour by including more physiological data like heart rate, stress levels, and physical activity.

A more complete understanding of the user's overall health could be achieved by using a combination of behavioural and physiological data. Cloud-based analytics is another one of the major areas of future research. The current architecture focuses on processing data on the local device level to maintain privacy, but there is also an option to integrate with the cloud, enabling users to securely store their behavioural data, access it from various devices, and utilize more sophisticated machine-learning algorithms. With long-term behavioural analytics, opportunities for improvements could be identified, future behavioural issues could be anticipated and adaptive coaching strategies could be developed based on the accumulated user data. Secure deployment of the cloud and maintaining user trust would still rely on the appropriate use of encryption, authentication, and user consent. Artificial Intelligence has a number of possibilities that can be used to extend the proposed smart mirror.

Potential future systems include the use of more sophisticated large language models and conversational AI to provide extremely customised behavioural coaching via natural conversation. Instead of showing a basic feedback message, the mirror could simulate job interviews, help you practice public speaking, respond to questions about your behaviour, suggest confidence-building activities, and cheer you up, depending on your typing habits. Personalisation algorithms might also modify suggestions based on individual learning choices, behavioral patterns, emotional traits, and development with time, making an intelligent behavioural companion that evolves over time, continuously tailored towards the person's learning preferences.

Overall, the Behaviour-Aware AI Smart Mirror exemplifies how there is potential to combine intelligent hardware with cutting-edge behavioural analysis technology to facilitate self-improvement in an accessible, engaging, and user-friendlier way. Its modular design makes it scalable and adaptable, allowing for the integration of new technologies, sensors, and AI models without significant changes to the system as a whole.

The proposed system brings together multiple technologies, including computer vision, speech processing, pose estimation and multimodal behavioural analysis, all integrated into a single platform, thus connecting behavioural science and cutting-edge artificial intelligence. It offers a novel method for communication, emotional, confidence and posture development by offering sustained individualised coaching.

With the ongoing development of intelligent interactive technology, behaviour-aware smart mirrors can evolve and play an important role in education, health care, professional training, and personal development in learning and daily life, providing a foundation for future innovations in human-centred artificial intelligence and behavioural computing.

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