



Tiny Teeth, Smart Technology: The Rise of Robotics in Paediatric Dentistry

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Abstract

Dental anxiety is a significant challenge in Paediatric dentistry, often leading to delayed treatment and worsening oral health. The integration of robotics in healthcare, including macro-, micro-, and bio-robots, offers a promising solution. In Paediatric dentistry, humanoid robots can reduce fear and improve cooperation by creating a familiar, engaging, and reassuring environment for children. By diverting attention from discomfort and minimizing negative perceptions, these robots help prevent avoidance behaviours. Overall, robotic assistance can make dental visits more interactive, comfortable, and child-friendly, enhancing the overall treatment experience.

Keywords: Paediatric Dentistry, Robotics, Humanoid Robots, Dental Anxiety, Behaviour Management, Artificial Intelligence, Oral Health Education, Patient Cooperation.

INTRODUCTION

Anxiety is a human emotion involving behavioural, affective and cognitive responses to the perception of danger.

Dental anxiety, which manifests as irrational, intense, and negative emotions associated with visiting the dental office and dental treatment.

Dental anxiety is common in children and is considered a normal part of development. It is also the most frequently encountered behavioural issue in paediatric dental care.

Behaviour guidance in paediatric dentistry, as defined by the American Academy of Paediatric Dentistry, is a continuous interaction between the dental team, the child patient, and their family. Its goal is to ensure safe, effective, and medically necessary dental care while managing the child's behaviour.

However, significant dental anxiety that causes avoidant behaviour can have a negative effect on a child's oral health.

To overcome this challenge, human-like robots, known as humanoid robots, have been thoughtfully introduced.

Rapid advancements in science and technology have made robotics a key field, especially in medicine. Medical robots are classified into macro, micro, and bio-robots, with macrorobots used in rehabilitation and surgery, and bio-robots designed to mimic human thinking. Their success has extended into dentistry, improving diagnosis and treatment while helping reduce dental anxiety in children.

Humanoid robot is a robot designed to resemble the human body in appearance and behaviour. It typically has a head, torso, arms, and sometimes legs, allowing it to interact with people in a more natural and engaging way.

Humanoid robots in therapy can foster a calm and reassuring environment, helping to reduce stress and enhance cooperation in children. They also assist in automating repetitive tasks, such as pre-treatment communication, thereby saving time and improving efficiency for paediatric dentists. Overall, the integration of robotics can lead to better treatment outcomes and may lessen the reliance on sedation or general anaesthesia.

Traditional behaviour guidance methods include, Communication techniques, Psychological approaches and Protective measures.

APPLICATION OF ROBOTICS IN PAEDIATRIC DENTISTRY:

- **Distraction and Entertainment:** Robots entertain children with storytelling and games, distracting them during dental procedures and reducing anxiety, making the experience more comfortable.
- **Patient Education:** Humanoid robots personalize interactions and teach children about oral hygiene in a fun way, promoting positive attitudes and healthy dental habits.
- **Customized Treatment Planning:** Humanoid robots help dentists design personalized treatment plans for children using patient data, suggesting suitable care and treatments.
- **Interactive Waiting Room Experience:** Humanoid robots interact with children in waiting rooms, collect dental information, and use AI to analyse it, helping dentists understand each child's needs better.
- **Assistance in Procedural Explanation:** Humanoid robots monitor children during treatment, track progress and hygiene habits, and provide real-time feedback to help dentists adjust care as needed.

DIFFERENT HUMANOID ROBOTS USED IN BEHAVIOUR MANAGEMENT:

1. ASIMO (advance step in innovative mobility)

ASIMO is an advanced humanoid robot designed for natural human interaction. It can recognize objects, faces, voices, and gestures, allowing it to understand and respond to people. ASIMO follows individuals, answers questions, and communicates in multiple languages. It can remember about 10 faces and interact with them personally by name.

Its role in Paediatric Dentistry:

- i) Reduce dental anxiety by,
 - Talking in a friendly, simple manner
 - Creating a playful environment
 - Diverting attention from instruments
- ii) Acts as distracting tool by,
 - Conversation
 - Movements and gestures
 - Interactive activities
- iii) Aids in behaviour management by,
 - a. Tell-Show-Do
 - Explains procedures in child-friendly language
 - Demonstrates actions before treatment
 - b. Modeling
 - Shows "brave" behaviour for the child to imitate
 - c. Positive Reinforcement
 - Praises and encourages the child
- iv) Improves communication by,
 - Using simple speech and expressions
 - Interacting socially with children
 - Responds to voice and actions
- v) Enhances dental education by,
 - Teaching proper brushing techniques
 - Explaining dental procedures
 - Promoting oral hygiene habits



Interactive activities



Brushing technique demonstration

2. NAO:

The NAO robot helps children learn languages and supports speech therapy and education. It also promotes healthy habits, aids children with autism, and provides comfort during dental treatments.

Its role in paediatric dentistry:

- i) Reduce anxiety and fear by,
 - Interacting through speech, gestures, and even dancing, which distracts and calms them.
 - Creating a friendly, non-threatening environment—especially useful for anxious or first-time patients.
- ii) Behavioural Guidance & Cooperation by,
 - Guiding children step-by-step through procedures.
 - Explaining what will happen in simple, child-friendly language.
 - Improving cooperation using techniques similar to “Tell-Show-Do.”
- iii) Distraction During Procedures by,
 - Talking, play games, or tell stories during treatment.
 - Acts as a cognitive distraction, reducing perception of pain.
- iv) Special Needs Support:
Particularly beneficial for children with conditions like,
 - Autism Spectrum Disorder
 - Attention Deficit Hyperactivity Disorder

Interactive activities



Role of NAO in ASD children-

- a. Improves Social Interaction
 - NAO encourages eye contact, turn-taking, and basic conversation.
 - Children often find robots less intimidating than humans, making them more willing to interact.
 - Helps practice greetings, facial expressions, and social cues.
- b. Provides Predictable & Structured Communication
 - NAO speaks clearly, uses simple language, and repeats instructions consistently.
 - This predictability reduces confusion and anxiety in autistic children.
 - Routines can be programmed, which is very comforting for them.
- c. Enhances Attention & Engagement
 - Movements, lights, and voice capture attention better than traditional teaching.
 - Keeps children focused during therapy sessions or learning activities.
- d. Supports Emotional Recognition
 - NAO can demonstrate basic emotions (happy, sad, surprised).
 - Helps children learn to recognize and respond to emotions—an area often challenging in ASD.
- e. Assists in Learning & Skill Development Used in therapies to teach:
 - Communication skills
 - Daily routines (brushing, dressing)
 - Academic basics (numbers, colours) Learning becomes interactive and game-like.



Social interaction



Demonstration of basic emotions

3. ROBOKIND R25:

Its role in Paediatric Dentistry,

- i) Behaviour management:
 - The robot interacts with the child using speech, facial expressions, and gestures.
 - Helps guide children to behave cooperatively during procedures.
- ii) Reduction of dental anxiety & fear:
 - The child focuses on the robot instead of the procedure, reducing stress and panic.
- iii) Distraction during treatment:
 - The robot engages children through:
 - Talking
 - Asking questions
 - Showing expressions
 - This diverts attention from pain or discomfort during procedures.
- iv) Positive reinforcement:
 - The robot can:
 - Praise the child
 - Encourage good behaviour
 - This builds confidence and cooperation during dental visits.

- v) Communication & education:
- Explains procedures in a child-friendly way.
- Helps children understand:
- Oral hygiene
 - Dental procedures
 - Improves acceptance of treatment



Interactive activities



builds confidence and cooperation during dental visits.

4. PEPPER:

The Pepper robot demonstrates efficient performance in interaction and response behaviour. It can navigate environments with obstacle avoidance, recognize faces and objects, and communicate through speech and dialogue.

Its role in paediatric dentistry:

- Reduces Anxiety and Fear by,
 - Talking in a calm, friendly voice
 - Uses gestures, facial expressions, and humor
 - Distracts kids with conversations or games
- Provides Distraction During Procedures:
Pepper can:
 - Play interactive games
 - Tell stories or jokes
 - Sing songs or show animations
 - This keeps children engaged so they focus less on pain or discomfort.
- Educates Children About Oral Health:
Pepper can explain:
 - Proper brushing and flossing techniques
 - Importance of dental hygiene
 - What will happen during a dental procedure
- Improves Communication:
 - Acts as a “social bridge”
 - Encourages children to express feelings
 - Builds trust before treatment begins
- Helpful for Special Needs Children:
Pepper is especially useful for children with,
 - Autism spectrum conditions
 - Sensory sensitivities
 - Communication difficulties



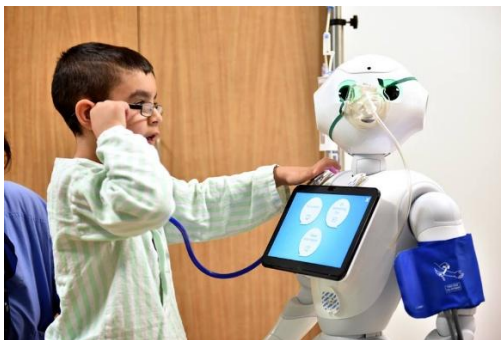
Talking in a calm, friendly voice



Educates Children About Oral Health

Role of PEPPER robot in ASD children:

- i) Social skills training
 - Teaching eye contact, turn-taking, greetings
 - Practicing conversations in a low-pressure environment
 - Children may treat the robot like a peer, improving engagement
- ii) Emotion recognition
 - Pepper can express basic emotions (happy, sad, etc.)
 - Helps children learn to identify facial expressions and tone
 - Its simpler expressions are easier to interpret than human faces
- iii) Play-based therapy
 - Games, dancing, storytelling
 - Interactive tablet + voice prompts
 - Promotes joint attention and engagement
- iv) Neurorehabilitation support
 - Used in hospitals and clinics
 - Children often perceive Pepper as safe and friendly, increasing cooperation



Social skills training



Emotion recognition

5. iRobiQ:

- Reduces child fear & anxiety during dental treatment
- Improves cooperation of children
- Acts as a distraction tool (videos, talking, interaction)
- Works as a friendly companion in clinic
- Supports behaviour management techniques
- May reduce need for sedation



CONCLUSION:

Robotics in paediatric dentistry offers significant benefits by improving children's comfort, reducing anxiety, and enhancing communication through interactive and engaging approaches. Robots can assist in behaviour management, education, and guidance during dental procedures, making treatments more effective and child-friendly. Overall, robotics holds great promise in transforming paediatric dentistry, with the potential to provide safer, more efficient, and more positive dental experiences for children in the future.

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