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Revolutionizing the Fight against Child Cyberbullying: Using Holograms and Voice Recognition as Allies

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Abstract. This research examines the feasibility and effectiveness of integrating holograms and voice recognition technologies as an innovative solution to combat child cyberbullying. By creating an empathetic virtual environment and enabling the early detection of emotional signals, the goal is to provide emotional support and prevent cyberbullying among children aged 9 to 14. The study addresses ethical and privacy considerations and underscores the importance of the responsible implementation of these emerging technologies. The primary focus is to thoroughly investigate the viability and effectiveness of this novel strategy, which combines holograms and voice recognition to establish a safe and compassionate virtual space. Early detection of emotional cues is crucial for identifying potential cyberbullying situations, enabling proactive intervention and timely emotional support. Beyond examining the technical feasibility and practical effectiveness of this solution, the research also carefully explores the ethical and privacy challenges associated with implementing emerging technologies in the context of child protection. Special attention is given to ensuring the responsible deployment of these tools; considering the sensitivity of the target population and establishing protocols that protect the integrity and privacy of participating children. The anticipated outcomes of this study aim not only to contribute insights into the technical viability and efficacy of the proposed solution but also to provide valuable perspectives on how to address child cyberbullying ethically and responsibly within an ever-evolving digital environment.

Keywords. Child cyberbullying, holograms, voice recognition, emotional well-being, innovative technologies, children and technology, digital ethics.

1 Introduction

El Child cyberbullying is a form of harassment among children and adolescents that occurs through digital technologies such as social media, instant messaging, or online video games.

This type of violence involves intentional and repeated harassment, humiliation, threats, and exclusion. Its psychological impact is profound, especially on children aged 9 to 14 a critical stage in the development of their identity and emotional stability.

According to a UNICEF report [1], 1 in 3 young people in the world has been a victim of online bullying. Nationally, the National Survey on the Availability and Use of Information Technologies in Households (ENDUTIH) [2] revealed that in Mexico, 23.5% of children and adolescents aged 12 to 17 have experienced cyberbullying, with a higher prevalence among girls.

In light of this alarming reality, it is urgent to adopt a comprehensive approach that recognizes the emotional vulnerability of minors and proposes proactive solutions. In this context, the innovative combination of holograms and voice recognition technologies emerges as a disruptive and empathetic tool.

These technologies aim not only to counteract the effects of cyberbullying but also to create safe digital spaces that provide emotional support for children.

The use of interactive holograms allows for a constant, compassionate virtual presence, functioning as a digital friend who listens and responds empathetically to the child's experiences, offering comfort and reducing feelings of isolation.

Meanwhile, emotional voice recognition acts as a digital sentinel capable of detecting emotional nuances in a child's speech, identifying patterns associated with bullying, anxiety, or distress. This enables early and personalized intervention that could prevent more severe consequences.

This technological approach goes beyond merely reacting to incidents; it empowers children with tools to manage their emotions, express their experiences, and navigate the digital environment with greater confidence.

Thus, technology is no longer seen as part of the problem but as a proactive ally in supporting children's emotional well-being.

However, the use of these technologies also raises ethical questions about privacy, consent, and the responsible use of emotional data. As these tools continue to evolve, it is essential that their implementation is grounded in a solid ethical framework that places the child and their right to protection and development at the center.

2 Theoretical Framework

2.1 Holography

Holography is a photographic technique that creates three-dimensional images by projecting a beam of light onto a refractive material. When the material receives light from an appropriate angle, it projects an image in three dimensions.

2.2 Hologram

A hologram is a three-dimensional image of an object that can be viewed from any angle. This means that the light reaching the viewer's eyes from the hologram is physically the same as that emitted by the original object. Holograma.

2.3 History of Holography

In 1947, Hungarian physicist Dennis Gabor was searching for a method to improve the resolution and definition of the electron microscope when he accidentally discovered a new technique for forming images. The object he used to create his first hologram was a transparent circular slide containing the names of three physicists he considered significant: Huygens, Young, and Fresnel. He called this process holography, from the Greek holos (whole) and graphos (to write). Although his discovery was initially unsuccessful, the invention of the laser later enabled the development of numerous scientific and technological applications based on holography. In recognition of his contributions, Gabor was awarded the Nobel Prize in Physics in 1971.

With technological advancement, techniques for generating images or videos using modeling software such as Autodesk and projecting holograms using projectors or monitors have become common. The process typically begins by capturing a physical model of any object or person with cameras positioned from multiple angles. This allows the creation of a reference image for the final hologram design. The captured images, known as perspectives, are sent to the modeling software where they are edited and shaped into the desired 3D figure.

Another technique, known as the particle model method, involves generating images through heated air particles. The image, produced by a projector or laser, is reflected by these particles, resulting in a three-dimensional image. Because the hologram is a reflection of the projected image, it appears in full color. The air can be heated using a radiator. As the particles rise in wave patterns, they form a sort of mirror through the hot air currents. Dust particles in the air also contribute to better light reflection and dimension at specific angles. One major advantage of this type of hologram is its ability to be interactive and penetrable it exists in a nonphysical medium, so the image does not distort when touched. These characteristics make it particularly useful for presentations and exhibitions.

2.4 Characteristics of Light Waves

Light is a form of electromagnetic radiation visible to the human eye. It has a dual nature, behaving both as a wave and as a particle (photon). Light waves can propagate even in a vacuum, without the need for a material medium.

When light strikes a surface, reflection occurs, allowing objects to be seen by returning part of the light to the environment [3]. Depending on the surface, reflection can be classified as:

- Specular reflection: Occurs on smooth surfaces such as mirrors, where the reflected rays remain parallel [4].
- Diffuse reflection: Occurs on rough surfaces, causing the rays to scatter in different directions.
- Extended reflection: A combination of specular and diffuse reflection, typical of semi-polished surfaces.
- Scattered reflection: Irregular dispersion that does not follow the classical laws of reflection.

The law of reflection applies: the angle of incidence is equal to the angle of reflection, and both rays (incident and reflected) lie in the same plane with respect to the normal (a line perpendicular to the surface) [5].

3 Method

3.1 Methodology

This study was conducted using a prospective approach for data collection. According to information provided by the Secretariat of Education, Science, Technology, and Innovation (CCT-SECTI), the municipality of Nicolás Romero has a total of 452 educational institutions, of which 78 are at the primary level and 42 at the secondary level [6]. The target population consisted of girls, boys, and adolescents between the ages of 9 and 14, enrolled in the fourth, fifth, and 6th grades of primary school, as well as the 1st and 2nd grades of secondary school, in both public and private institutions.

To calculate the sample size, the formula for a finite population (N) was used. This is an adaptation of the formula for infinite populations, adjusted to account for the effect of a limited population:

$$n = (N * Z^2 * p * (1 - p)) / (e^2 * (N - 1) + Z^2 * p * (1 - p)),$$

where:
n = sample size,
N = total population (total number of students),
Z = Z critical value of 1.96 (for 95% confidence level),
p = estimated proportion of the population with the characteristic of interest (0.5, for maximum variability),

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@author: Carmen
"""

def calculate_sample_size(N, Z=1.96, p=0.5, e=0.05):
    q = 1 - p
    numerator = N * (Z**2) * p * q
    denominator = ((N - 1) * (e**2)) + ((Z**2) * p * q)
    n = numerator / denominator
    return round(n)

# Application with N = 68232
sample_size = calculate_sample_size(68232)
print(f"Required sample size: {sample_size}")
```

Fig. 1. Sample Size Calculation in Python.

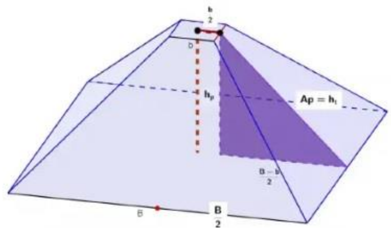

Fig. 2. Holographic pyramid.

e = margin of error (typically 0.05 for 5%).

This formula is an adaptation of the sample size calculation for infinite populations, adjusted to account for the limited size of the population.

As a data collection technique, a survey was conducted using a structured questionnaire consisting of 17 closed-ended questions with multiple-choice options, divided into five sections:

1. Demographic Information.
2. Experiences with Cyberbullying (children and adolescents aged 9 to 14).
3. Use of Emerging Technologies to Detect Cyberbullying.
4. Perceptions of Parents and Educators on Cyberbullying and Emerging Technologies.
5. General Opinions.

3.2 Holographic Implementation

3.2.1 Holographic Pyramid

The holographic pyramid is a system that is used to project all kinds of elements in three dimensions on a metal structure, cardboard on which the light-emitting equipment rests, which will be the pyramid as shown in figure 2.

When the film is illuminated with the same light source, a three-dimensional image of the original object is produced:

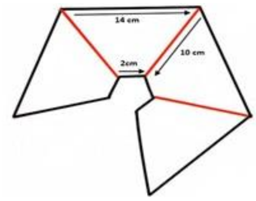

Fig. 3. Paper mold for trapezoidsde.

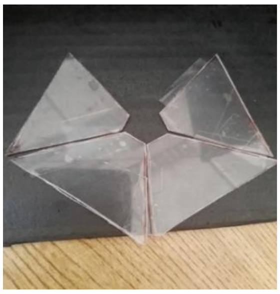

Fig. 4. Four-piece trapezoid-shaped cuts.

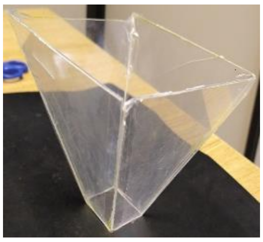

Fig. 5. Holographic Pyramid.

To build the pyramid, several tests were carried out on the following materials.

- In plastic the image looks relatively good but somewhat opaque.
- In acrylic, depending on the thickness, the image was cut or duplicated.
- On acetate the image is seen with less definition.

For the construction of the pyramid, it is necessary to draw a trapezoid as shown in figure 2 with the following measurements: minor base 2 centimeters, major base 14 centimeters and height 10 centimeters.

The trapezoids are drawn and then the trapezium-shaped molds are cut, four cuts are made on CD covers, in the shape of a trapezoid as shown in figure 4.

The four pieces are glued with tape and secured with silicone, the final result is shown in Figure 4.

3.2.2 Hologram Projector Box

The following materials were used for the construction of the hologram projector box:

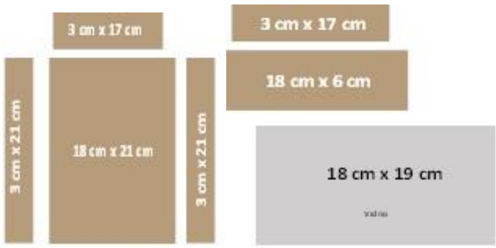

Fig. 6. Projector Box Parts.

Fig. 7. Projector Box for the Hologram.

- Cardboard: for the structural prototype, due to its low cost and easy handling.
- Silicone: as an adhesive, adding stability and sealing.
- Matte black paint: applied internally to reduce reflections.
- Glass: as a projection surface, allowing the adequate transmission and reflection of light.

The measurements of each of the pieces are shown in Figure 6.

This modular design allows holographic images to be reproduced with good visual quality in low-light environments, offering an effective tool for educational demonstrations, optical experiments or multimedia applications. The result of the construction of the project box is shown in Figure 7.

3.3 Artificial Intelligence (AI) System Components

3.3.1 Cyberbullying Detection System

- Trained with NLP (Natural Language Processing) models.
- Able to detect:
  - Offensive language, threats, insults,
  - Sarcasm or microaggressions through semantic analysis,

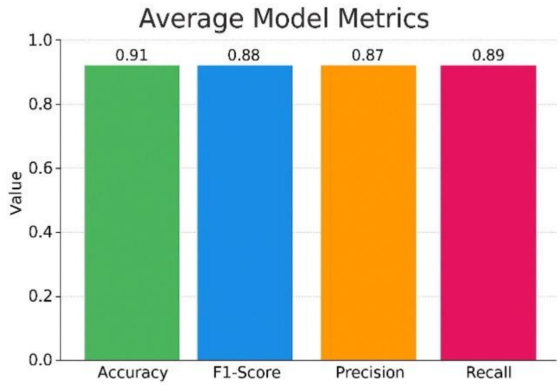

Fig. 8. Average model metrics.

- o Offensive images and memes with computer vision,
- o Real-time integration into chats, social networks, messaging apps, etc.

- Real-time integration into chats, social networks, messaging apps, etc.

3.3.2 Model and Architecture

Implement the artificial intelligence model capable of denouncing offensive or cyberbullying comments in free text.
Base model: BERT (Bidirectional Encoder Representations from Transformers)
Architecture: 12 layers of transformers, 110 million parameters
Dataset used: HateXplain, Cyberbullying Detection Dataset, OLID (Offensive Language Identification Dataset)
Techniques applied supervised fine.tuning, data augumetation, tokenization with WordPiece.

- Evaluation metrics: Accuracy, F1-score, Recall y Precision.
- Results achieved:
  - o Accuracy: 91.3%,
  - o F1-score: 0.88 (bullying class) indicating high detection performance,
  - o Training Time: 6 hours on GPU (NVIDIA RTX 3090).

Figure 8 shows the average metrics obtained by the model during validation.

3.3.1 Interactive Hologram

- Projection using hologram technology (Pepper's Ghost).
- Design with an empathetic, friendly and reassuring personality.
- Interact with the child:

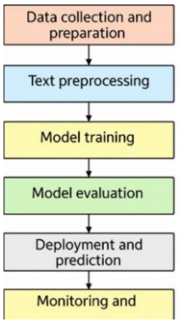

Fig. 9. Machine Learning Model.

– Offers comfort and tools to respond to bullying.
– Gives advice on how to act.
– Automatic help protocols can be activated.

3.3.4 Emergency Response Module

Connected with:

– Contactosrusted contacts (Parent, guardians).
– Educational institutions.
– In severe cases, local emergency services.

Must be customized according to country/laws/locatione

3.3.5 Ethics and Privacy Module

– Protection of minors' data.
– End-to-end encryption.
– Informed consent from parents and schools.
– Periodic ethical auditsn.

3.4 Development process

3.4.1 Phase 1: Research and Prototyping

– Case studies of child bullying.
– Compilation of real datasets.
– Hologram Prototype Design (Software & Hardware).

3.4.2 Phase 2: Training the AI Model

– Using the BERT Model for Language Analysis.
– Train on specific bullying datasets.

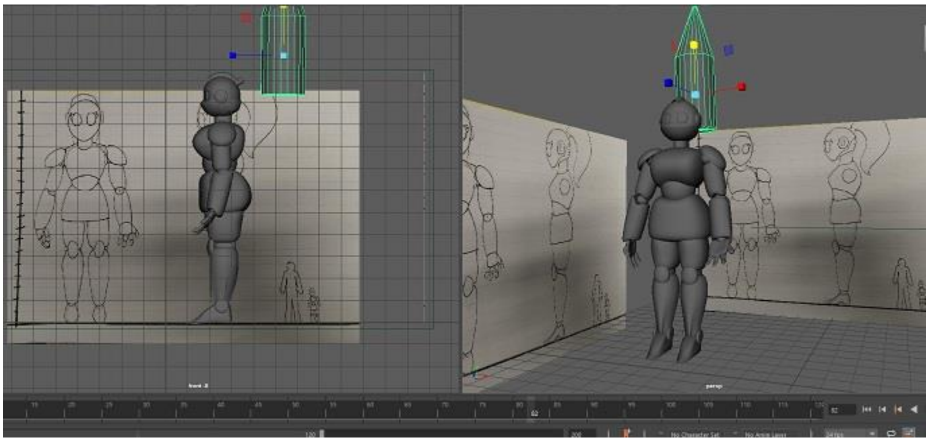

Fig. 10. Front and side character modeling with Autodesk Maya.

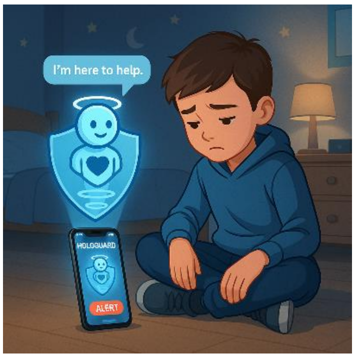

Fig. 11. Integration of Artificial Intelligence, hologram and response protocol.

– Accuracy testing, minimization of false.

3.4.3 Development of the Hologram

- Diseño3D design of the wizard (friendly character).
- Integration with display devices.

3.4.4 Phase 3: Pilot tests

Deploying the system in a controlled school environment.

3.4.5 Total Integration

Connection between Artificial Intelligence + Hologram + Response Protocol.
Simulation of real cases.

3.5 Exploring Prevention, Follow-up and Argumentation Variables in Child Cyberbullying

The preliminary experimental design to explore variables that could influence the effectiveness of strategies for the prevention and management of childhood cyberbullying. The objective is to identify effective combinations between technology, educational intervention and social participation. The variables are:

1. Prevention Strategies:
   - Levels: Digital education, awareness and promotion of healthy online behaviors.
   - Method: Comparison between groups with and without intervention.
2. Tracking Technologies:
   - Levels: Holograms, voice recognition and combination.
   - Method: Measurement of effectiveness in early detection and intervention.
3. Caregiver Involvement:
   - Levels: Low, moderate and high.
   - Method: To evaluate the impact according to the level of early supervision.
4. Frequency of Interventions:
   - Levels: Scheduled versus interventions based on system alerts.
   - Method: To compare the effect on incidence and emotional impact.
5. Emotional Feedback from Technology:
   - Levels: Technology with or without emotional response.
   - Method: Analysis of its influence on the child's response and the overall effectiveness of the system.
6. Integration into the School Curriculum:
   - Levels: School curriculum incorporating cybersecurity education versus standard curriculum.
   - Method: To evaluate the incidence of cyberbullying in different school contexts.
7. Post-Incident Psychological Support:
   - Levels: Different access to support services.
   - Method: Evaluation of well-being according to the level of care received.

8. Impact Assessment in the School Community:

   – Levels: Degree of Participation of the school community.

   – Method: Analysis of the effect on sustainability and effectiveness of interventions against cyberbullying.

This design provides a comprehensive view of the factors that affect the effectiveness of interventions against child cyberbullying.

4 Discussion of Results

This study explores the effectiveness of strategies for the prevention and management of childhood cyberbullying through a preliminary experimental design. It is proposed to evaluate various variables using Likert screens to identify effective combinations between technology, education and social participation.

1. Cyberbullying Prevention:

Participants will assess the clarity, usefulness and effectiveness of the educational strategies implemented and speech recognition.

2. Technological Monitoring:

Analyze the perceived ease of use, efficacy, and security of technologies such as holograms and speech recognition.

3. Caregiver Involvement:

Assess the level of involvement, quality of emotional support, and collaboration with technology.

4. Frequency of Interventions and Emotional Feedback:

To compare scheduled and alert-triggered interventions and assess the impact of emotional feedback on child well-being.

5. Integration Curricular

Inclusion of cybersecurity content in the school curriculum, highlighting its relevance and usefulness.

6. Subsequent psychological support:

Evaluate the availability, accessibility and empathetic quality of post-incident care services.

7. Community Impact:

Value school participation and the perception of a safer and more supportive community.

The results will allow us to identify patterns of acceptance, correlation between variables and key elements to optimize future interventions.

The implementation of innovative technologies requires guaranteeing the emotional protection and privacy of children. To do this, it is essential to follow clear guidelines on privacy and consent in data collection, ensuring that it is informed and voluntary, and establishing transparent policies on its use and access. Information security must be supported by effective cybersecurity measures, as well as confidential and anonymous handling of sensitive data. Technological transparency is also essential, which implies clear communication with children and their caregivers about the operation and purpose of the technologies used.

Likewise, a continuous ethical evaluation must be carried out that considers all the actors involved and respect for children's rights must be integrated in all phases of the project. These elements are key to strengthening the trust, legitimacy and effectiveness of the technologies used in the prevention of child cyberbullying.

5 Conclusion

The integration of emerging technologies, such as interactive holograms and voice recognition systems, is an innovative proposal in the prevention of child cyberbullying. This technological synergy not only addresses current problems, but also projects a sustainable and adaptive emotional support model, aligned with the well-being and protection of children in digital environments.

From a psychoeducational perspective, the constant presence of the hologram acts as an emotional support agent that validates the child's experiences and reinforces their resilience and self-esteem. At the same time, the ability to recognize speech allows the early identification of linguistic patterns associated with risk situations, enabling preventive intervention and not merely reactive intervention.

Likewise, the system promotes a more inclusive and emotionally safe educational environment, by integrating continuous feedback and affective accompaniment. Its evolutionary design allows it to adapt to the transformations of child development, guaranteeing a personalized and contextualized response.

The consolidation of this proposal requires a research and development agenda focused on the following axes:

- Optimization of artificial intelligence algorithms sensitive to the emotional context, for greater precision in the interpretation of affective signals.
- Incorporation of emerging technologies (virtual reality, artificial emotional intelligence) that enhance the accompaniment experience.
- Cultural and contextual adaptability, to ensure effective implementation in diverse contexts.
- Interdisciplinary collaboration with experts in children's mental health, ensuring the therapeutic rigor of the technological design.

- Development of ethical frameworks and robust privacy protocols, fundamental for the trust and acceptance of the system.
- Long-term impact monitoring, to assess the sustained effect on users' emotional health.
- Active participation of the educational community, as a key agent in the implementation and continuous improvement of the system.
- Constant updating in the face of technological and social changes, guaranteeing the validity of the proposed model.

These lines of action seek to strengthen the multidisciplinary and inclusive approach to intervention, consolidating a digital environment that prioritizes children's rights, emotional health, and safety.

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