Huggy Bear: An Interactive Robotic Companion to Alleviate Loneliness through Embedded Programming

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Abstract*—This paper explores the development of Huggy Bear, an interactive robotic plush toy designed to alleviate loneliness through embedded programming that enables genuine, comforting hugs. Inspired by the experiences of international students facing isolation due to time zone differences, Huggy Bear aims to provide the emotional and physical comfort often lacking in traditional plush toys and existing interactive companions like Hasbro's Furby. Utilizing advanced embedded systems, the design includes circuit creation and coding to control 8 servo motors and 7 sensors, enabling over 12 distinct motions. This allows Huggy Bear to detect human touch and perform natural hugging actions, effectively addressing the condition of skin hunger by releasing oxytocin and reducing stress. This study details the design, implementation, and effectiveness of Huggy Bear, highlighting its potential as a therapeutic tool to improve emotional well-being and offer a sense of companionship to those in need.

I. Introduction

Our inspiration for Huggy Bear comes from our shared experiences as international students. The unique challenges we face, particularly the loneliness accentuated by time zone differences that leave us isolated when our families are asleep, sparked an idea. These quiet, solitary moments often find us seeking comfort, something to fill the void of physical and emotional distance.

As enthusiasts of soft toys, we envisioned giving life to a soft, warm soul in the form of a teddy bear. More than just a plush toy, it's a comforting companion, offering solace in quiet moments. Huggy Bear is a reminder of the warmth of loved ones, bridging the distance with a reassuring hug. It's not just a toy; it's a source of comfort, a piece of home, ensuring you're never truly alone, no matter where you are. [1][2]

II. Related Work

Traditional plush bears are widely cherished for their soft and comforting presence but lack the ability to move or interact dynamically with users, thus failing to provide the profound emotional engagement necessary to alleviate loneliness. In contrast, Hasbro's Furby can engage in simple exchanges and respond to touch with movement and sound, yet it focuses on verbal and auditory interactions rather than physical comfort, making it inadequate for addressing emotional needs related to skin hunger. Skin hunger, or touch deprivation, leads to significant loneliness and emotional distress, with hugs being one of the most effective remedies due to their ability to release oxytocin, the "love hormone," which reduces stress and enhances well-being. Despite these benefits, the market lacks plush toys specifically designed to offer the deep physical and emotional comfort of a hug. While many interactive toys prioritize speech and playful interactions, none focus on the therapeutic benefits of hugging. Huggy Bear aims to fill this market gap by using advanced embedded programming to create a plush toy capable of delivering genuine, comforting hugs, thereby addressing the unique emotional needs of individuals experiencing loneliness and skin hunger.

III. Prototype

A. Initial Sketch

In the initial sketch of Huggy Bear, our design aspirations extend beyond hugging and verbal communication to include interactive elements such as small objects, enhancing the overall user experience with added engagement and entertainment.

Figure 1： Initial Sketch and CAD of the Huggy Bear

B. Bill of Electronics & Work Flow

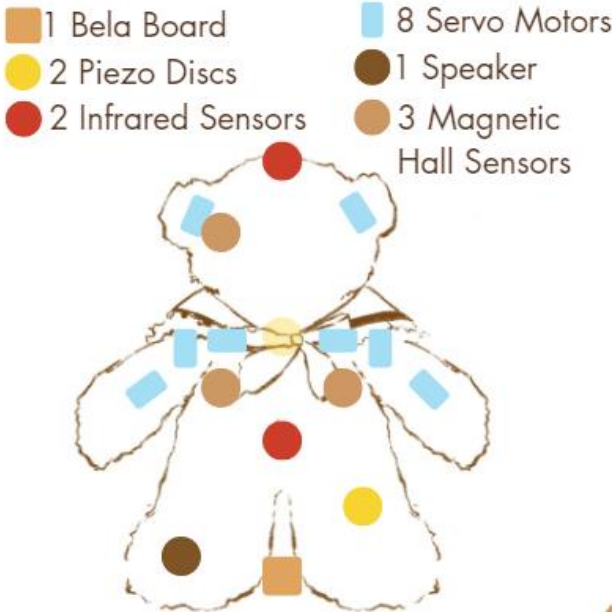

Figure 2： Bill of Electronics

Two piezo disc sensors, two infrared sensors, and three magnetic Hall sensors are employed to detect interactions. Additionally, two servo motors are utilized in the ears, six servo motors in the arms, and one speaker is used to create reactions. The details are illustrated in Figure 3..

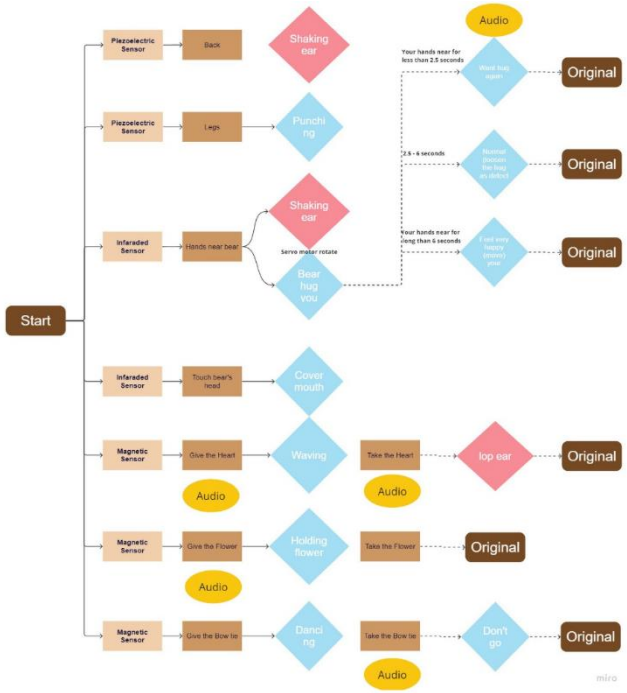

Figure 3： Work Flow

C. Building the Circuit

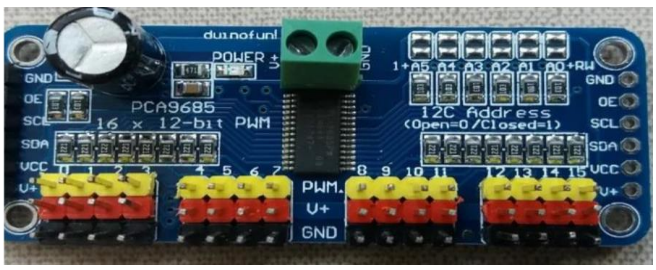

Figure 4： PCA9685

Normally, controlling more than two motors simultaneously leads to voltage and current instability. After extensive troubleshooting, we resolved this by integrating PCA9685 to control eight motors efficiently. Our 500-line code rigorously tests different degrees, speeds, and interactions with Huggy Bear.

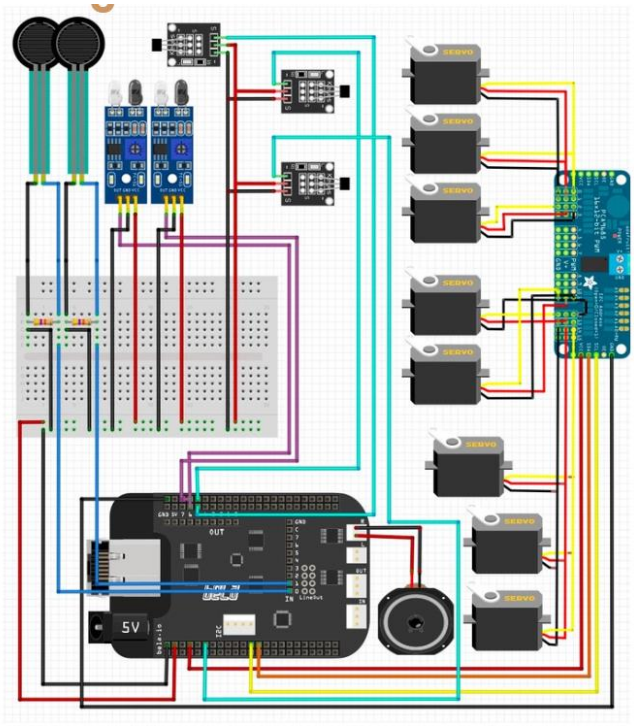

Figure 5： Design of Electronics

D. Manufacturing

Laser cutting is employed to construct the robotic arm for Huggy Bear. Additionally, the body and chair are modeled and subsequently fabricated using a 3D printer.

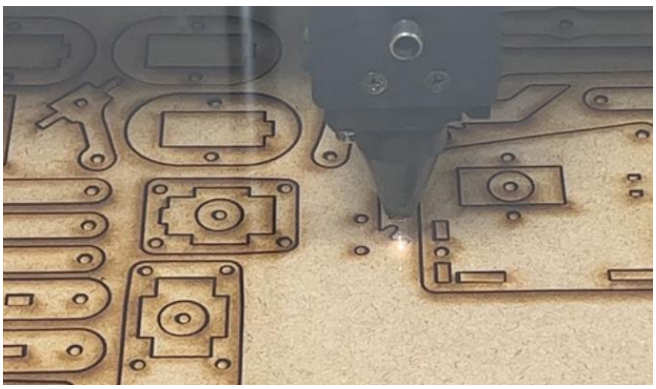

Figure 6： laser cutting of the robotic arm

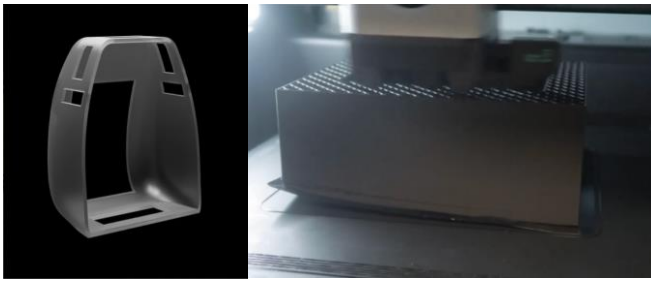

Figure 7： modeling and 3D Printing

The huggy bear have 8 motors and 7 sensors. Each robotic arm has three degrees of freedom and can easily simulate human actions such as bunching, clapping, and waving.

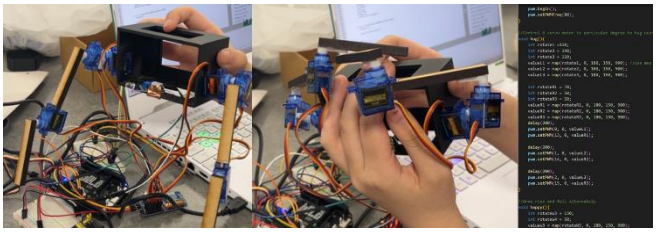

Figure 8： Test of the prototype and code

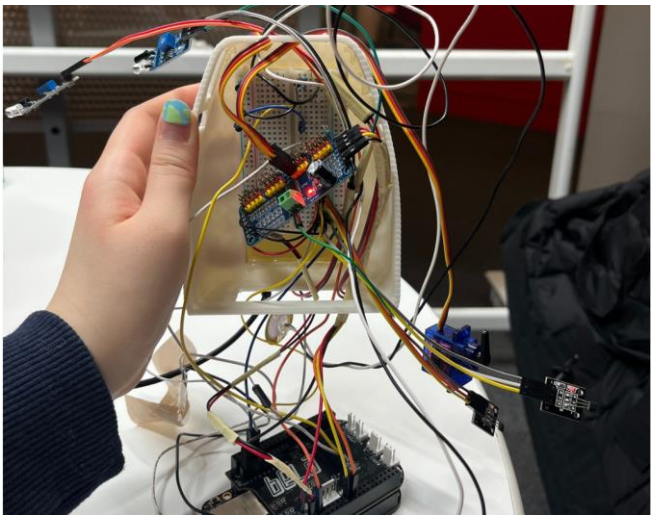

Figure 9： The internal structure of Huggy Bear

IV. INTERACTIONS

As a student from Imperial College brimming with curiosity and a passion for innovation. With a strong foundation in hardware and embedded systems, as well as proficiency in SolidWorks, I am equipped to tackle complex challenges head-on. I am excited about play a role in shaping the future of technology.

A. Hug-- Infrared Sensor 1: Belly

We have identified twelve distinct types of interactions, with the primary one being a hug.

When the infrared sensor in the belly detects a user's hand approaching, the two servo motors in the ears will shake, and the six servo motors in the arms will rotate to a specific degree to initiate a hug with the user.

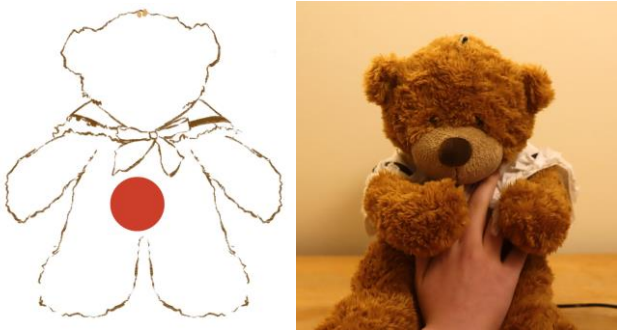

Figure 10 & 11： Huggy Bear give hug; Infrared sensor in Belly

Hug condition 1: Hug too short time

We monitor the duration for which the infrared sensor detects the user's hand. If the hug lasts for less than 2.5 seconds, the speaker in Huggy Bear will say, "Come back here!" This prompts the user to initiate another hug.

Hug condition 2: Hug normal time

If the hug duration is between 2.5 and 6 seconds, Huggy Bear will release the hug and return to its original position once it detects the user's hands leaving.

Hug condition 3: Hug too long time

If the hug duration exceeds 6 seconds, Huggy Bear will perform a happy action. Once it detects the user's hands leaving, it will release the hug and return to its original position.

Figure 12： Hug from Huggy Bear

B. Shy-- Infrared Sensor 2: Head

The infrared sensor detects whether the user touches the bear's head. In response, six motors rotate to cover the mouth. The motors return to their original position once the sensor detects that the user's hand has left.

Figure 13： Huggy Bear cover mouth and shy

C. Shake Ear-- Piezo Sensor 1: Back

A piezo sensor is installed on the back of the bear. When the bear leans on the chair, this sensor may be activated, introducing an element of randomness and enhancing the bear's lifelike behavior.

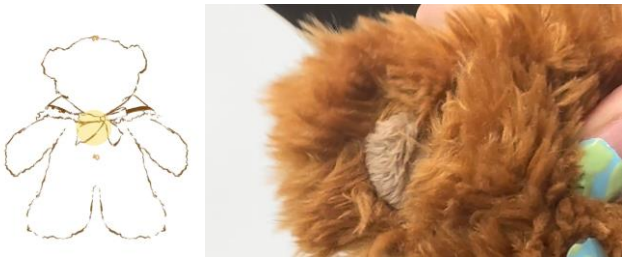

Figure 14： Huggy Bear shake ear

D. Punching-- Piezo Sensor 2: Leg

When the leg of the bear is pressed, the piezo sensor detects this action. In response, the bear will perform a punching motion with both its left and right hands.

Figure 15: Huggy Bear cover Bunching and sensor's location

E. Holding Flower—Magnetic Sensor 1: Flower

When you give Huggy Bear a flower, the magnetic sensor detects this action, prompting Huggy Bear to hold the flower. It will return to its original position when the sensor detects your hand leaving.

Figure 16： Huggy Bear holding flower and sensor's location

F. Beat Chest and Lop ear —Magnetic Sensor 2: Heart

Upon giving Huggy Bear the heart, its arm will beat its chest, symbolizing affection. Additionally, Huggy Bear will vocalize, saying "best friend" to acknowledge the gesture.

When the heart is taken from Huggy Bear, it will express a sense of sadness and disappointment by lowering its ear slightly. Huggy Bear will then vocalize, saying, "I'm staying here," conveying its feelings of attachment and longing.

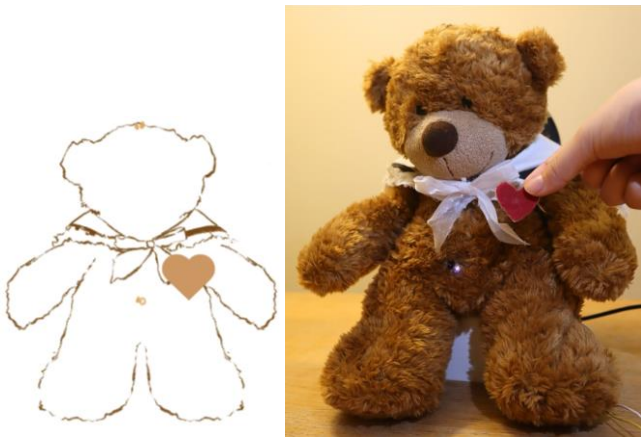

Figure 17: Sensor's location; Give heart to Huggy Bear

E. Dancing—Magnetic Sensor 3: Bow Tie

Upon receiving the bowtie, Huggy Bear will engage in a dancing motion. However, when the bowtie is taken away, Huggy Bear will assume a "don't let go" position, expressing reluctance. Additionally, Huggy Bear will vocalize, saying "boo," signifying its disappointment.

Figure 18: Sensor's location; Take Bow tie from Huggy Bear

V. Conclusion

Huggy Bear represents a significant advancement in providing emotional support through technology. By simulating genuine hugs and fostering emotional connections, it serves as a therapeutic companion for individuals facing loneliness. Continued research and development can further enhance its effectiveness, making it a valuable resource for promoting emotional well-being and alleviating feelings of isolation.

VI. Author Experiences

As a student from Imperial College brimming with curiosity and a passion for innovation. With a strong foundation in hardware and embedded systems, as well as proficiency in SolidWorks, I am equipped to tackle complex challenges head-on. I am excited about play a role in shaping the future of technology.

VII. Refernces

1. Moerman, C.J., Van Der HEIDE, L. and Heerink, M., 2019. Social robots to support children's well-being under medical treatment: A systematic state-of-the-art review. *Journal of Child Health Care*, *23*(4), pp.596-612.
2. Wu, J., Yuan, Y. and Dai, Y., 2022, May. Feasibility Study of Portable Simulated Pet 'KEDAMA'for Relieving Depression. In *International Conference on Human-Computer Interaction* (pp. 290-304). Cham: Springer International Publishing.