TheraPlay

Creating an Engaging Robotic Platform for Dyssemic and Autistic (ASD) Children

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TheraPlay

Introduction

Dyssemic (socially challenged) is a term that refers to kids that have trouble communicating their ideas with other people and expressing themselves in general. Autism [1] is a subset of dyssemia and is considered a spectrum disorder meaning that each child has different characteristics in the way autism effects them. More therapy at a younger age has been proven to reduce the effects of this disability. However the cost and availability of good therapists are always challenging. The use of robotics is an ideal method to combat this challenge. The field of robotics is constantly growing and new applications for robots are appearing daily, ranging from industrial to medical applications. Robotics is also currently becoming increasingly relevant in the lives of children and therapy.

Research is being done at major universities on using robots for treating Autism [2]. These robots are not readily available to the public and may need significant robotics knowledge to program and use [3] [4] [5]. This means that in order for children to use these special robots they need special assistance at all times, which we are trying to eliminate in our project. Another major setback with other robots that we have observed is the cost that involves making and using one of these robots. The robots that are being tailored for these specific reasons cost from $3,000 to $30,000 which may not be easily affordable by the average family [6] [7]. This was one of the more pressing issues that we saw with other robots in this field, and we really hoped to mitigate this issue in our platforms. This showed us that robots in the real world currently were not able to have a combination of cost-effectiveness, ease of usage and capabilities. These were the three components that we focused on deeply in all of our platforms and as the project progressed we saw that some of the platforms had limitations while the TheraPlay design was a culmination of all the aspects we wished to incorporate.

Our engineering project will focus on creating an engaging platform that will assist dyssemic children. This will be done through designing and developing different economically feasible robots and comparing their features to see which aspects work and which areas have major limitations. For this project we focused on using LEGO Mindstorms NXT, LEGO Mindstorms EV3, and Parallax Propeller Board of Education as well as a vast kit of parts.

Engineering Goals

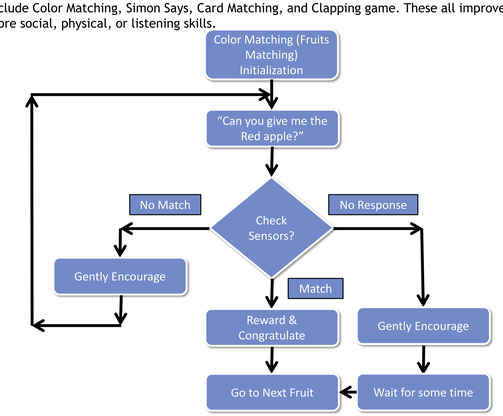
To create an economically feasible robotic platform to engage dyssemic children
To empower parents and enrich their dyssemic children using robot-assisted play therapy sessions
To compare retail low-cost robotics systems for play therapy
To include customizable features on the robot that the child can relate to

Observations of Dyssemic Children

1. Kids are energetic when they enter the classroom but once they sit down, they relax
2. Kids seem to be more attentive when shapes and colors are involved than just plain words
3. Repetition and pointing help get attention and reinforce learning
4. Kids respond well to a reward system; they like "high fives" too
5. Each kid is unique; some can articulate while others cannot; some create noise and other don't like noises
6. Most kids like soothing music and respond well to known voices
7. Kids feed a dog in the classroom
8. Kids are learning a lot about what happens in everyday life

Sample Game Infrastructure

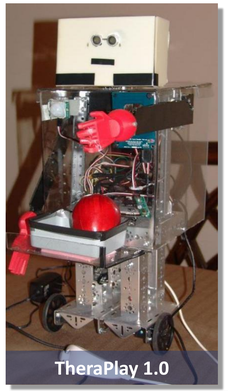
Based on the observations of the Dyssemic children and discussion with the teachers and therapists, we compiled four different games and created a infrastructure for additional games. These games include Color Matching, Simon Says, Card Matching, and Clapping game. These all improve one or more social, physical, or listening skills.



Robot Design Process

FEATURES	NXT	Comments
Processor	Arm7	LEGO Mindstorms gives an excellent platform to customize any design the parents want. However, the having of only one core makes it difficult to monitor two sensors at the same time.
# Cores	1	
# Sensors	4	
# Motors	3	
Software	Pay	
Storage	No	
Expansion	No	

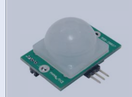
FEATURES	EV3	Comments
Processor	Arm9	EV3 is the newest version of LEGO Mindstorms. It retains all the advantages and disadvantages of the NXT platform. In addition features include; Wi-Fi capabilities, the option to incorporate a micro SD card for increased storage.
# Cores	1	
# Sensors	4	
# Motors	4	
Software	Free	
Storage	Yes	
Expansion	No	



FEATURES	Parallax	Comments
Processor	Propeller	The Parallax microcontroller features 8 cores which allows multiple sensors to be managed simultaneously. In addition, the robot structure is developed aside from Parallax.
# Cores	8	
# Sensors	10+	
# Motors	6	
Software	Free	
Storage	Yes	
Expansion	Yes	

FEATURES	Parallax	Comments
Processor	Propeller	TheraPlay 2.0 improves on the customizability of the robot. In this particular robot an Iron Man exterior was used as an example to showcase the different options that are available.
# Cores	8	
# Sensors	10+	
# Motors	6	
Software	Free	
Storage	Yes	
Expansion	Yes	

Input/Output Device Integration



The proximity (PIR) sensor is not used for any specific game. Instead this sensor is used as a safety device. It scans the area to sense if the child is still present.

The RFID sensor is used in the matching game. This game allows kids to scan the correct card onto the RFID to teach valuable listening skills.

The ColorPal sensor is used in the color matching game. This game tests the kid's ability to identify the correct fruit and place it in the basket in front of the robot. Helps with social skills.

The PING sensor is used in conjunction with the PIR. This sensor scans the area moving from left to right and once it senses a target it focuses and stops searching.

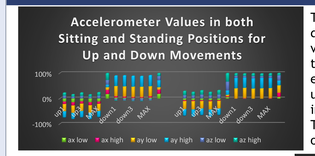
The Veho speaker is used to play encouraging music after the kid does something. Music is played whether the kid did something right or wrong.

The LCD screen incorporates a reward system that tracks the progress of the child. It also gives the child a visual on what each game is asking for.

The nunchuk is used for the built in accelerometer. This device is used for the Simon Says game, which tests the physical ability of the child

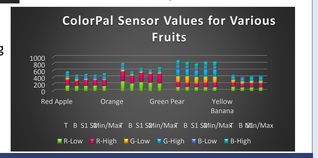
The Sound Impact sensor is primarily used in the listening game, which tests the ability of the child to listen and follow a set of instructions

Sensor Variation



The accelerometer was extremely user-dependent, in the sense that the readings varied depending on the height and position of the user. Because of this problem, it was essential to create a calibration program to sync up the user's environment with the range incorporated in the accelerometer program. These are sample calibration readings based on our environment and height.

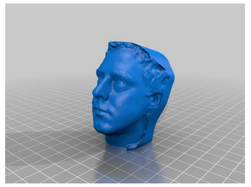
While programming, it was made apparent that each fruit had a range of color values because the sensor registered different colors depending on the orientation of the fruit. To account for the different values, readings were taken of each fruit in different positions which include: top, bottom, side 1 and side 2. These values were then compiled into a range with the lowest and highest color values being used.



Customizability

3D Printing

3D printing technology provides a unique feature for our robot. The outside features of the robot can be custom designed for the specific child. This gives a personal connection between the child and the robot which is very crucial for them when dealing with emotions and sentiments. For example the outside could resemble a friend, parent, or favorite superhero.



Toy Adaptation

It is essential for the robot to maintain a friendly exterior so that the child is not afraid to approach the robot. By fusing a stuffed toy with a robotic infrastructure it allows the child to view the robot as a friend without sacrificing any valuable features. The stuffed toy used can change depending on the preference of the child and what is most comfortable for them.

Results and Analysis

ROBOT FEATURES	NXT	EV3	TheraPlay 1.0	TheraPlay 2.0	Ultimate
Motion recognition	1	1	3	4	4
Hand movements	1	1	1	1	1
Neck movements	1	1	1	1	1
Mouth movements	0	1	1	1	1
Mobility	0	0	1	1	1
Display (Touch)	0	0	0	1	1
Voice Recognition	0	0	0	0	1
Facial expression	0	0	0	0	0.5
Configurability	1	1	0	1	1
Feature TOTAL	**4**	**5**	**7**	**10**	**11.5**

Application	NXT	EV3	TheraPlay 1.0	TheraPlay 2.0	Ultimate
Student Monitoring	0	1	3	4	4
Card Matching	0	0	4	4	4
Counted Clapping	1	1	3	3	3
Color Matching	3	3	4	4	4
Follow Movement	0	0	3	3	3
Application TOTAL	**2**	**3**	**5**	**5**	**5**

COST ($)	NXT	EV3	TheraPlay 1.0	TheraPlay 2.0	Ultimate
Processor Board	373	350	130	130	130
Software			0	0	0
Build Material			30	50	80
Included I/O			0	0	0
Additional I/O	35	0	207	316	376
TOTAL ($)	**408**	**350**	**367**	**496**	**586**

	NXT	EV3	TheraPlay 1.0	TheraPlay 2.0	Ultimate
Cost per Feature	**102**	**70**	**52.43**	**49.60**	**50.96**
Cost per Application	**204**	**116.67**	**73.4**	**99.20**	**117.20**

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Conclusion

We conclude that a low-cost robotic platform is feasible and we showcase this with a prototype. Each of the Platforms can be used incrementally by parents to help their dyssemic children. TheraPlay (Parallax Basic) is more customizable and provides better Cost per Feature or Game and LEGO Mindstorms provided better configurability but is not accurate in monitoring children. In addition, adding the toy exterior was extremely successful in providing a more friendly appearance instead of the normal, robotic feel. Attaching the LCD display was beneficial in creating a colorful visual and to help track the progress of the children and give encouraging feedback.

Acknowledgments

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