EVALUATION IMPLEMENTATION OF HUMANOID ROBOT FOR AUTISTIC CHILDREN: A REVIEW

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Abstract: Autism is a disease, which affects the child's ability to communicate with those around them and develop mutual relations with them and hence it needs to have a quick and efficient treatment technique. This work aim is to survey the using of robot as an Interactive learning method for teaching children with Autism. Statistics indicate that an increase in the number of kids with autism in the world. This increase in the number of people infected with ASD should have a corresponding increase in the methods of handling and treat the patients. As well as, the high cost of therapy in specialized centers is being a significant problem. Besides, teaching kids is not a trivial task. Therefore, find a suitable method to communicate with kids and make practice the required duties are an essential concern. The results of this work are presenting the types of robot used in teaching autistic kids and presenting proper recommendations like the using of the robot under the supervision of effective human way to teach Autistic kids. Also, there is big needed to open particular institutions for children with autism and provide trainers with the experience and ability to work with this type of children. Moreover, increasing the number of resources provided for research in the learning and teaching kids with Autism.

Keywords: Artificial Robot; Autism; Teaching Methods; Human-Robot Interaction;

I. INTRODUTION

There Autism spectrum disorders (ASD) complicate neurodevelopmental diseases with strong genetic etiologies. While many brain regions associated with ASD pathogenesis, many studies demonstrate that the cerebellum is consistently abnormal in ASD patients, both neuron and functionally. Estimated total costs per year for autistic children in the United States, for example, are between $ 11.5 billion - $ 60.9 billion (2011 US $). Which represents a significant economic burden for direct and indirect costs, from medical care to private education [1].

Humanoid robot frequently has the inherent to interact with people in daily life [2]. They can play an essential role in human society in the future. The new development of human-robot interaction (HRI) is now extending its functions to assist the children suffering from Autism Spectrum Disorders (ASD) in areas of socialization, communication, and playful behavior through robot-based intervention [3]. HRI architecture considers as a new approach to the research on autism. HRI defines as a communication relationship between humans and humanoid robots. Nearly about third of children with autism seem to miss skills in their second year. Approximately 6 per 1000 children under eight years have ASD. Different Methodology uses to act with ASD including studies, diagnostic practice, and an expert [4]. Many researchers conclude that ASDs have a difference of causes, but they agree that ASD affects the same brain systems [5-8]. Moreover, the interview and observational methods have clear advantages and disadvantages. Retrospective reporting may be hard for parents of older offspring. The observations in clinical environments can miss critical features. An acceptable approach would combine an interview and observational measures [9,10].

Autism is a disease, which affects the child's ability to communicate with those around him and develop mutual relations with them. The prevalence of ASD is around 1%, and recent estimation of undiagnosed cases increases it to 1.5% in the UK [11]. Also, about one-third of parents of children with ASD noticed a problem before their Childs first birthday, and 80% saw problems by 24 months. The earliest age of ASD diagnosis is between 4.5 and 5.5 years. ASD incidence dramatically depends on gender, therefore; about four times more boys have autism than girls. In the United States, statistics denote that a child in every 91 children diagnoses with ASD. Moreover, in Malaysia, a child in every 150 children has ASD problem. The increasing prevalence of ASD in different countries all over the world, it is understandable that the need for effective intervention for ASD to be classified as a public health emergency. Figure 1 shows the autism statistics prevalence of children (https://tacanow.org/autism-statistics/). Statistics show an annual increase of the disease about 1 child of 59 in 2018 has with autism in world in comparison of 1 child of 1000 in 1970.

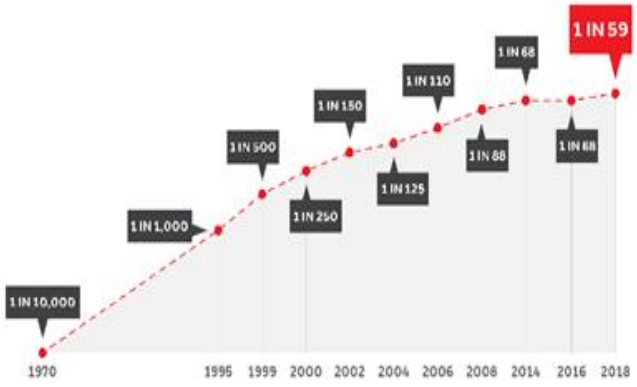

Figure 1: The autism statistics prevalence of children (https://tacanow.org/autism-statistics/)

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Despite differences in the seriousness of the symptoms of autism from case to case, but the patients with autism have difficulties in their mutual social relations, language, and behavior.

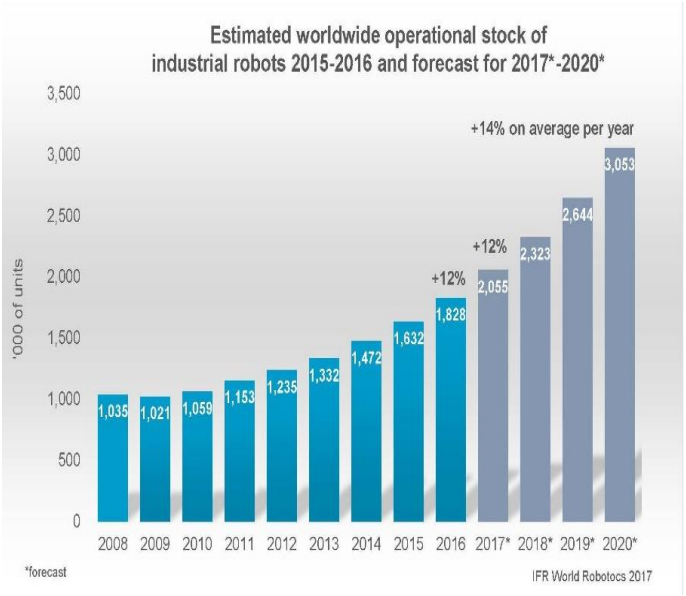

Figure 2: Robots double worldwide by 2020 (https://ifr.org/)

Figure 2 shows increasing of Annual supply of Industrial robots in the worldwide based on the report of international federation of robotics (https://ifr.org/). Also, the research paper published by Jabar H. Yousif [12], did a survey which indicated the using robot in teaching is suitable and much needed based on respond of 94% of Participants in the questionnaire were agreed. Nevertheless, if more than one axis used more energy are required to run the system.

II. LITERATURE SURVEY

Many researchers were discussed and proposed solution for teaching and learning kids with Autism. They implemented different methods. Table 1 presents the main approaches for teaching kids with Autism [13-24].

Also, Kozima, H. [16] implemented the Keepon Robot in Japan, and the result shows that using of robot helped in enhancing the social interaction and feeling in autistic children. Stanton C.M [17] used the AIBO Dog robot in testing the Kids interact and spoke more words to AIBO and enhancing three behaviors like verbal engagement, mutual interaction, and authentic interaction. Duquette A. [18] deployed an experimental using Tito Mobile robot in Canada. The results show that two children engage with a robot mediator determine increased attention in visual contact and physical proximity and in imitating smiling more than the children examine with the human.

Dickstein Fischer L. [19] applied penguin PABI robot in UAS for examining the autistics kids' interaction. Research shows that children with autism fully interacted more with the humanoid robot. Also, applied the behavioral analysis therapy by let child communicates with a tablet computer wirelessly to interface with the robot. Costa, S. [20] used Kaspar robot to examine the body awareness and sense.

Richard Margolin [21] suggested the MILO robot to communicate with autistic kids. Autism specialists who have worked with Milo robot believe that it helped numerous kids to perceive and impart their sentiments, value-based and manage their feelings, apply calming aptitudes and two-sided discussion. Haje Jan [22] adopted Pepper Robot in the USA for teaching the kids with a special need. The results show that the robot helps autistic children to enhance the concept of emotions and learning. Jeff Goodman [23] utilized a MILO robot in the USA for teaching the autistic children. They found that the kids are more involved with Milo robot than with a physician. Huijnen, C.A.G.J.[24] reviewed the using of different kind of robots for teaching children with ASD how to Communicate and enhancing the social interactions with others. The robots includes NAO, KASPAR, Robota, and Probo.

III. HUMANOID ROBOT HELPS AUTISTIC KIDS

Many researchers have used the artificial robot and new development of information technologies in many areas, including design, construction, operation, and education [25]. Survey of prior studies has distinguished HRI as part of the intervention for children with ASD like in [26-30]. The new development in mobile cloud computing could help to produce a portable applications for teaching the autistics kids [31-32].

This work aims to design a comprehensive Learning System Based humanoid robot for Children with Autism. Also, develop interactive materials that help children with special needs for enhancing their communicating and thinking. For example, teaching directions up, down, left and right or responding to various commands such as sitting, standing, walking and lifting objects after recognition and other actions. The child will communicate with the robot as a close-up game, which helps to increase the communication skills and accepting instructions fast.

1- **NAO** is humanoid robots which used successfully to help to teach children as shown in Figure 3. NAO is an ideal platform for teaching and learning concepts with students at all levels. NAO can speak 19 different languages. So, it can incorporate into any lesson to provide classes in various languages like Arabic, English, French, German, etc. Robot NAO is the human-robot interface 'HRI.'NAO can walk, stand up, sit down, play soccer, wander, dance, grasp simple objects, recognize and identify people, understand spoken words, confine sounds, and create speech. The robot has ((legs, body, arms, feet, head, hands, etc.)), cameras, microphones, motors. Also, NAO is the most used humanoid robot for healthcare, research, and education [33-35]. NAO is 58cm tall, autonomous, and a fully programmable robot that can walk, talk, listen and even recognize your face. Different types of Humanoid robot is illustrated in Figure 3.

Figure 3: NAO robot in testing session

2- **Pepper** is a cute faced and Emotional Humanoid Robot [36]. The robot is provided with high-level human interaction and advanced capabilities. Also, the robot is provided with a high-performance voice recognition engine able of identifying inflections, tonality and multiple variations in the human voice. It has 25 sensors, and cameras provide full information about the environment and humans communicating with it. Pepper can also use body language as well, relying on 20 actuators to perform very fluid and lifelike movements. It can communicate using different programming languages like Python, Java and C#. Also, it can recognize more than 20 different human languages like English, Dutch, and French.

3- **Milo** is an advanced social robot that uses children's voices developed by Acapela Group to help children with autism strengthen their communication skills [37]. It can tell or listen to a story. It is a two foot-tall humanoid robot can interact with people using vocal and facial expressions and helping children with autism learn about, practice and build critical social skills.

4- **Aisoy1** is an interactive robot that provides children with special needs with an unusual and robust emotional relationship, helping to develop their kinetic and cognitive skills and increasing their communication with others [38]. The robot performs a host of fun educational games and activities, increasing self-confidence and self-stability.

5- **Kaspar**, a humanoid child-sized robot designed to help children with autism which is developed by the University of Hertfordshire. Kaspar does many things like play games, sings a song, imitates eating, plays the tambourine and combs his hair [39].

6- **Keepon** is a social robot that designed to interact with Autistic for the purpose of studying social development and interpersonal coordination [40].

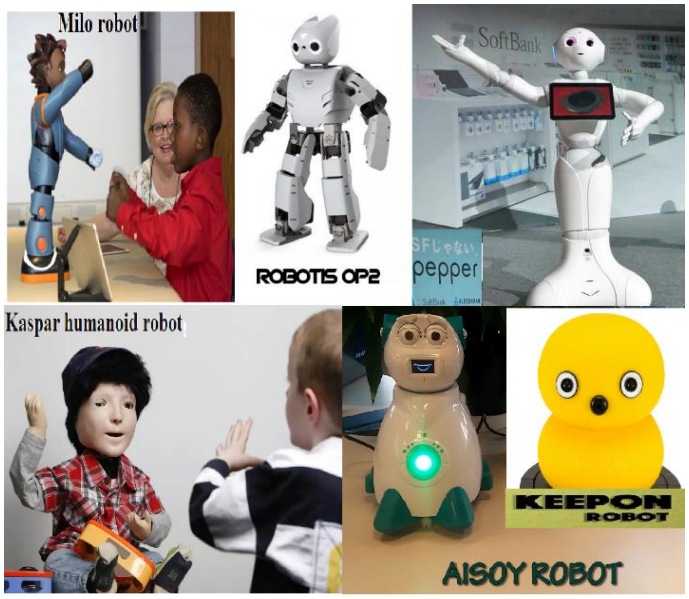

Figure 4: Different types of Humanoid robot

IV. WHAT IS AUTISM SPECTRUM DISEASES (ASD)

ASD is a disease which was termed by "Kanner and Asperger" which is a set of neurodevelopmental disorder in which a person's communication skills are impaired. People with autism have two main symptoms are:

- problems in social correspondence and collaboration and
- Restricted, tedious examples of conduct, interests, and exercises.

The ASD can be classified by different degrees, for example, troubles in social association, verbal and non-verbal correspondence and dreary practices as depicted in Figure 5. The most evident signs are observable when the child is in the middle of 2 to 3 years old. The main danger of ASD is that the patient tries to harm themselves usually biting or head banging against the wall or any other objects. The ASD research statistics reveals that boys are more prone to ASD than that of girls [14,42].

There are different symptoms of each type of ASD. These symptoms are very helpful to classify the patients for categorizing which type of ASD they belong to. The main impairments in Autism Spectrum Disorder appeared in social communications, social interaction and imagination [43]. Figure 6 presented the main impairments in Autism Spectrum Disorder.

Figure 5: Occupational Therapy for Autism

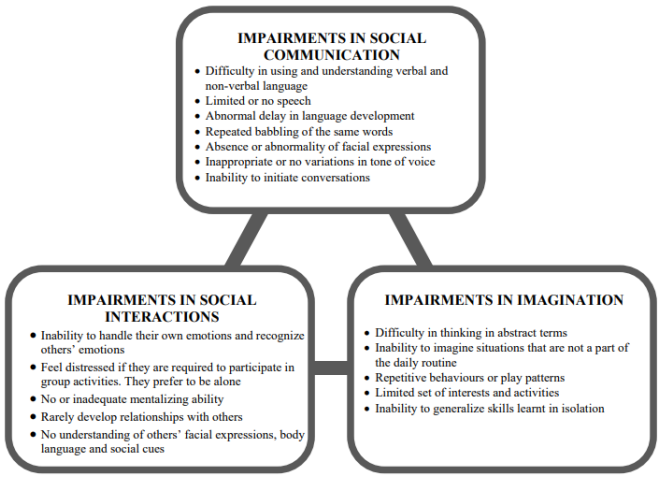

Figure 6: The main impairments in Autism Spectrum Disorder [29]

V. PROBLEM STATEMENT

Statistics indicate that an increase in the number of kids with autism in the worldwide 1/59 cases [44]. This increase in the number of people infected with ASD should have a corresponding increase in the methods of handling and treat the patients. As well as, the high cost of therapy in specialized centers is being a significant problem. Besides, teaching kids is not a trivial task. Thus, finding modern ways of using information technology and artificial intelligence is designed to develop intelligent robots to help children with psychological problems such as autism spectrum disorder, hyperactivity disorders or lack of concentration are essential issues. These robots can be tested on children with autism spectrum in outpatient clinics under the direct supervision of pediatric specialists. Also, find a suitable method to communicate with kids and make practice the required duties are an essential concern. The new development of human-robot interaction (HRI) is now extending its functions to assist the children suffering from Autism Spectrum Disorders (ASD) in areas of socialization, communication, and playful behavior through robot-based intervention. Therefore, this work aims to study and analysis of previous studies of existing system for using different types and shape of robot in autistics children, then use its results as a key for more research to choose the suitable type of robots and methods to enhance the social and communication skills for kids with Autism [45, 46]. The results will help to design and implement a framework for teaching Kids with Autism based robot.

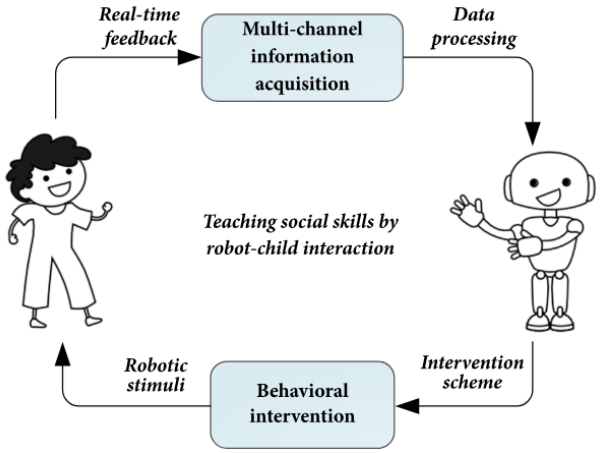

Figure 7: A basic overview of the robot application for autism intervention.

VI. CONCLUSION AND RECOMMENDATIONS

With the high increase in the number of autistic children, it is necessary to work together with parents, educators and children to come up with the best interactive technology to help autistic kids. It is essential to identify the basic needs of suffering children and what can develop their skills. Also, verify the kids respond significantly to the robot is much needed. The idea is that the child can interact with the robot easily and quickly because he deals with it as a game which could improve his emotional, social and mental skills.

The result of this work is to suggest robots as a solution that could play a critical role in responding to the robot and improving the child's emotional, social and mental skills. Today, one in 59 children diagnosed with autism spectrum disorder is diagnosed. This is a 78 percent increase in just four years [29]. This trend has significant implications for the healthcare budget in countries because the constant cost estimates for treatment of ASD patients range from four to six times higher for patients with autism. Figure 8 illustrates the number of published articles in ScienceDirect directory that implemented the artificial Robot as a teaching tools.

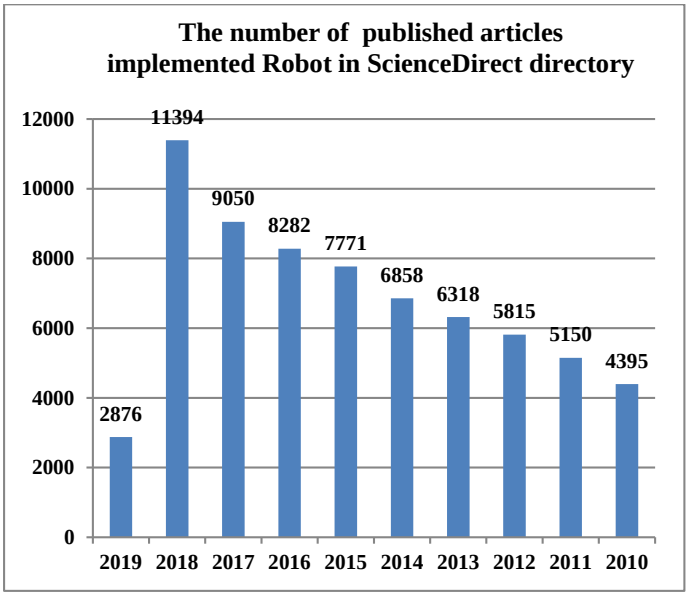

Figure 8: The number of published articles implemented Robot in Science direct directory

Also, many research papers that use the robot in Autism and published work in the ScienceDirect directory. Figure 9 presents the article numbers that deployed NAO robot in teaching kids with Autism.

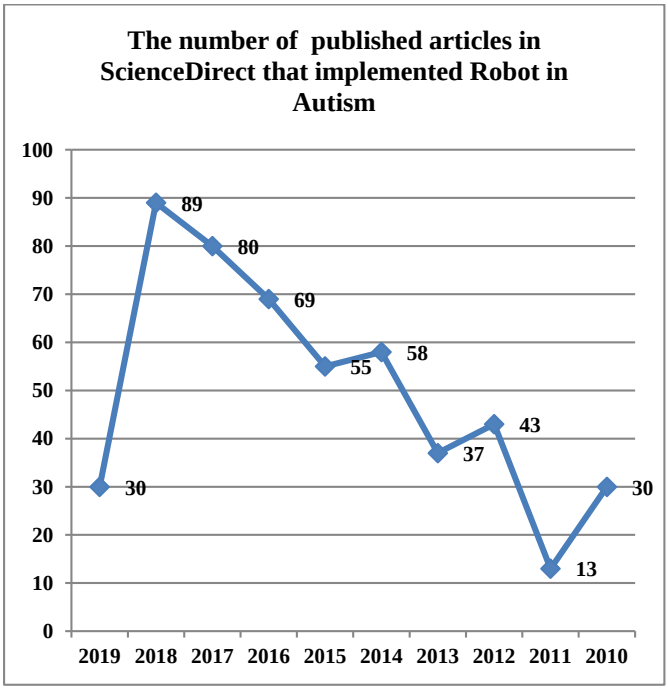

Figure 9: The number of published articles in ScienceDirect that implemented Robot in Autism

Also, Many researchers were implemented the NAO robot as teaching tools. Figure 10 depicts the number of published articles in ScienceDirect that implemented ANO Robot.

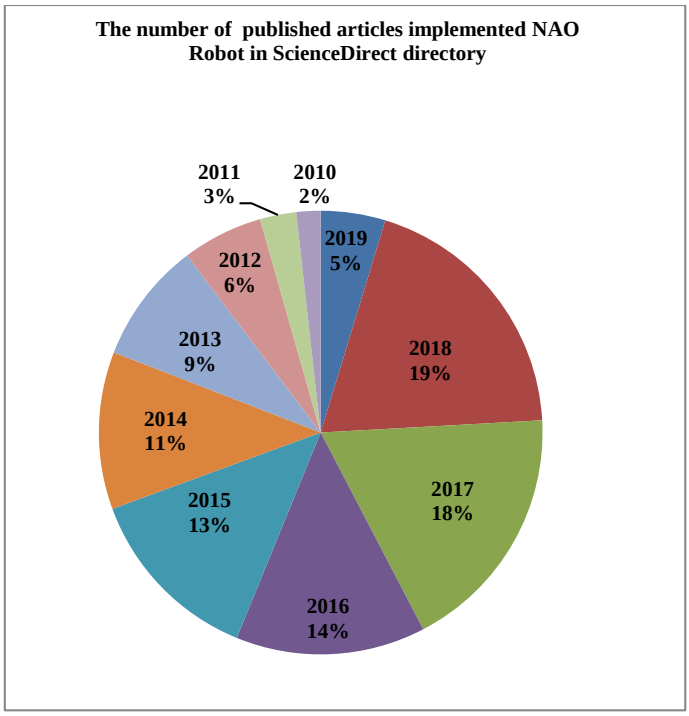

Figure 10 number of published articles in ScienceDirect that implemented ANO Robot.

I. Conclusion

The Literature is clearly indicate that more work is needed to follow the rapid increasing in the number of kids with autism. Results show that UAS is had more research for dealing with ASD by 14 research papers. England is coming in the second stage with 3 research paper. Also, Spain is take the third place with two research papers. The current study gave evidence that Robot-assisted therapies helped children with autism spectrum disorder (ASD) respond more to robots rather than humans. However, most of the current social robots remain controlled by therapists and still require a lot of time, energy and human resources. Figure 11 shows that different methods were implemented in teaching kids with Autism like robot, Human, Mixed method using robot and human and some other methods. The most method is using robot.

II. Recommendations

We must meet the needs of all children to ensure that they have a good education so that they have the opportunity to gain self-confidence to show the potential and progress in the education curriculum better and faster.

The results of the comparison concluded that not to over-generalize, because students with autism can differ from each other like any other students, requiring different methods. Robot repetition is an innovative way to teach children with spectrum rather than to teach school lessons where the robot can be used at home or anywhere. The use of the robot in education helps children with autism to show greater abilities to manage the

social and sensory challenges of the school environment and to control the stress and anxiety they can face. As well as the use of tablets or laptops to help with the completion of school work, instead of handwriting, which helps students to overcome many of the difficulties of passing skills. It was also noted that one of the most important barriers to the education of children with autism is funding, lack of knowledge and training, lack of specialized support staff and lack of adequate resources for education and classroom size. Therefore, it is very useful to open special institutions for children with autism and provide trainers with the experience and ability to work with this type of children. And increase the amount of resources provided for research in this direction because it has a positive impact on the society and families that suffer greatly, whether on the finance or social side.

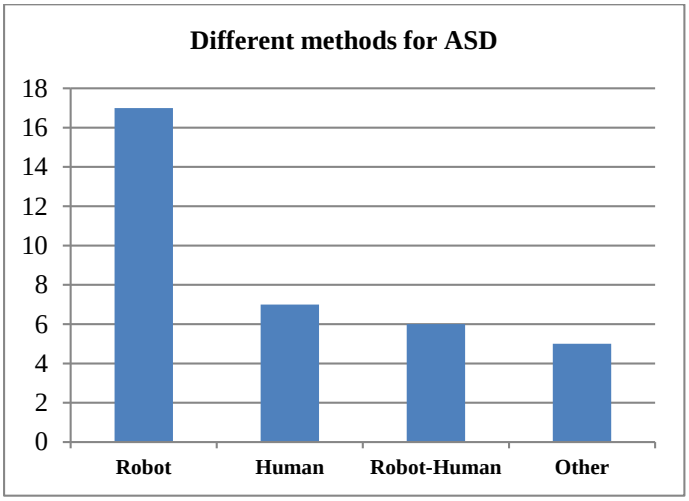

Figure 11: Different methods for dealing with ASD

Table 1: survey of research papers and methods of ASD

Author/ Year	Year	Robot Name	Location	Implemented Method
[5] Ismail, L. I	2012	NAO	Malaysia	Robot-based Intervention Program (RBIP).
[13] Bernardo, B	2016	NAO	Portugal	Tutor Mode
[14] Dautenhahn, K	2009	Kaspar	UK	Human–robot interaction experiments
[15] Rosenthal-von	2013	Pleo	Germany	Design principles (interaction video vs. torture video)
[16] Kozima, H	2007	Keepon	Japan	The result shows that the using of keepon enhance the social interaction and feeling in autistic children
[17] Stanton C.M	2008	AIBO Dog robot	USA	Kids interact and spoke more words to AIBO and enhancing three behaviors like verbal engagement, reciprocal interaction, and authentic interaction.
[18] Duquette A	2008	Tito Mobile robot	Canada	Two children engage with a robot mediator determine increased attention in visual contact and physical proximity and in imitating smiling more than the children examine with the human.
[19] Dickstein Fischer L.	2014	Penguin PABI robot	USA	Research shows that the children with autism fully interacted more with the humanoid robot. Applied Behavioral Analysis therapy where the child interacts with a tablet computer wirelessly interfaced with the robot.
[20] Costa, S.	2015	KASPAR	USA	Examine body awareness and sense
[21] Richard Margolin	2016	MILO robot	USA	Autism specialists who have worked with Milo robot believe that it helped numerous kids to perceive and impart their sentiments, value-based and manage their feelings, apply calming aptitudes and two-sided discussion.
[22] Haje Jan	2016	Pepper Robot	USA	Results shows that robot help autistic children to enhance the concept of emotions and learning.
[23] Jeff Goodman	2017	MILO robot	USA	Researchers found that the autistic children are more involved with Milo robot than with a physician.
[24] Huijnen, C.A.G.J.	2017	NAO, KASPAR, Robota, Probo	USA	Review the using of different type of robots for teaching ASD children a Social interactions and how to Communicate.

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