IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 25, Issue 2, Ser. II (Mar. – Apr. 2023), PP 06-18
www.iosrjournals.org

Humanoid Robot Behavior Generation to Improve Social Skill of Autistic Children

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Abstract*—Autism is a neuro-developmental disorder. Its common characteristics are challenges with social skills, lack of communication skill, speech and nonverbal communication problem and repetitive behaviors. One of the major characteristics of autistic children is that they do not want to interact with others. They prefer to be alone. If the parents leave to their child alone as they like and not take treatment, care and monitored, the problem persists, increasing day by day and becomes incurable. This is why children need to be cared for and monitored very carefully to overcome this problem. When an autistic child is treated sincerely without feeling burdened, their mental development is accelerated. When it comes to teaching autistic children, human annoyance, alienation, and arrogance have a detrimental effect on their brains and learning. Another important thing is, when a person teaches, it may happen that the teacher may be annoyed by the repetition of the same subject at some point. Through establishing the behaviors of human beings at the right time of the right attitude in the robot then the robot will be able to repeat those desired behaviors all the time. That's why using humanoid robots to teach children for their social skill development is very effective. We have generated the behaviors that enable humanoid robot to interact with autistic children and by repeating behavior will increase the social skills of autistic children. Here we have generated the behavior of the robot based on anger, sadness, happiness, attention and normal emotion of the children. First robot recognizes their emotion and then perform the appropriate behavior. Experimental results show a 97% accuracy in predicting the child's emotions. We evaluated the social skill improvement of the child with 6 behaviors. Initially, they didn't response against these behaviors. After 8 sessions they responded properly to 1 behavior that seemed to have 33% improvement.*

Index Terms*—Autistic Child, ASD, Social Skills, Neurodevelopmental Disorder*

Date of Submission: 13-03-2023 Date of Acceptance: 28-03-2023

I. INTRODUCTION

Autism spectrum disorder is characterized by persistent deficits in social communication and social interaction across multiple contexts, including deficits in social reciprocity, nonverbal communicative behaviors used for social interaction, and skills in developing, maintaining, and understanding relationships[1]. The central features of Autistic Disorder are the presence of markedly abnormal or impaired development in social interaction and communication, and a markedly restricted repertoire of activity and interest. The manifestations of this disorder vary greatly depending on the developmental level and chronological age of the individual. It is a pervasive developmental disorder/neurodevelopmental disorders[2]. This situation is also called Autism Spectrum Disorder (ASD).

Autistic children have qualitative impairment in social interaction e.g. impairment in the use of multiple nonverbal behaviors such as eye to-eye gaze, facial expression, body postures, and gestures to regulate social interaction, failure to develop peer relationships, a lack of spontaneous seeking to share enjoyment, interests, or achievements with other people, lack of social or emotional reciprocity. They also have qualitative impairments in communication e.g. delay in, or total lack of, the development of spoken language, in individuals with adequate speech, marked impairment in the ability to initiate or sustain a conversation with others, stereotyped and repetitive use of language or idiosyncratic language[2].

It is found that 17 out of every ten thousand children in Bangladesh are autistic [3]. The study further says that children of the city and educated rich families suffer more from this problem. The mass of children affected by autism or neurodevelopmental disorder is significant and we need to take action. Therefore, this is a good time to think addressing the problem.

One year is required to know whether a child is autistic and treatment can be started at the age of 2[4]. This treatment can be psychological, physical, and social. Generally the mental and social problems are high. Caregivers are always required to keep in touch with them for their social and emotional development. And since they are child, caregivers have to interact with them simply because they do not understand and response to all behaviors, especially complex ones. Many times, those who are in contact with them may not be able to behave simply. And for human doing very simple behavior is not so easy all times. As a result, their mental development is hampered. Studies have shown that when simply interact with autistic children, they response to it, thereby reducing their problems. And continuously doing this process can significantly reduce their autism problem. But it is not always easy to make simple behavior for child by a man and it is obviously difficult doing this repeatedly.

Again working parents cannot give the child enough time. So if the robot can be prepared for this, it will be very rewarding. So in this case the humanoid robot can be a very good option. And research has also shown that autistic children are more interactive with robots than humans.

For this reason, the developed countries in the world are using humanoid robot in the treatment of autistic children. If we give proper training to humanoid robots taking into account the economic, social condition of Bangladesh, we will be able to make progress in this regard as in the other countries. And we can change the lives of a large number of our children[5]. The authors of [6][7] compare the treatment results of autistic children using humanoid robot NAO in usual class setting. And they have shown that the social interaction skills are more developed than usual class setting treatment when using a humanoid robot. In [8] the authors used the humanoid NAO robot as therapy assistants in autism treatment.

Yussof and others [9] have developed graphical user interface for interaction between autistic children and robot. They have used Sony video camera and recorded behavior of artistic children with robot. The initial interaction of autistic children is analyzed in this research. The researchers found that humanoid Robot NAO generates more concentrations level to the Autistic Children.

Jabar H.Yousif and others [10] have presented a survey report on using robot as interactive learning method and recommended the types of robot to use for teaching autistic children. Following its result a framework is designed and developed for teaching children with ASD. The authors have shown statistics of robot related research and teaching for ASD from 2010 to 2019. From the statistics it is found that interest is increased when using robot as a teaching tool. In this research authors also presents a statistical analysis of implemented method of various robot in different country.

Jaishankaar and others[11] present results of effective when parrot like robot for teaching autistic children. Children with ASD interacts with both humans and robot, and it is found that interaction with robot is more effective. They have used a parrot like therapeutic robot to improve learning and social interaction abilities of children with ASD.

A short study including a humanoid robot programmed for a variety of teaching and therapeutic behaviors, such as exercises, singing, explaining, and playing with children, is provided in work of [12]. For a few weeks, a small sample of 15 children with ASD (ages 7–11) were tested utilizing these activities at a local school for children with special needs. The study's goal was to quantify the improvement in a variety of behavior and learning parameters when children participated in activities with a NAO robot alongside the teacher, as opposed to the same type of activities when the teacher was alone. The performance improvement was measured using the NAO robot activity as the independent variable and the dependent behavioral variables (a) number of trials, (b) activity response time, (c) response type, and (d) behavior retention as dependent behavioral variables observed from the responses of the children. The results of these assessments are quantified and compared to average performance levels (as determined by instructors and psychologists). The study's findings were regarded to be very positive, demonstrating the ability of robotic toys to help youngsters with ASD learn more effectively. The findings of this study also support the low-cost development and use of robotic toy systems for educational and therapeutic purposes.

In the mentioned study, they generated the behaviors of robots manually. There was an experienced teacher of autistic children or a doctor or a psychologist all time during sessions. During sessions, the expert determines which behavior should be generated by the robot. Then he commands the robot for making the behavior.

People in our country are not very aware about autism.

Many people think about socialization and do not express their children's weakness at an early stage and assume in a way it will gradually get better. Gradually the problem does not get better but the problem becomes more complicated. As a result, progress is less likely to occur when treatment begins, and it may take longer to recover as soon as treatment begins. In this case, the behavior of children in our country is different from other countries and this study is needed separately for the children of our country. And in this case, it is necessary to show the contribution of humanoid robot. The results of foreign research cannot be generalized for the children of our country.

We focused on the development, implementation and testing of an interactive social skill development platform using humanoid robot (NAO). Even small things in autistic children need to be taught with observation over a long period of time. Since the autism level of our children is more pronounced than in developed countries, it requires long term treatment. Hopefully the use of robots in this case will be very fruitful. Because long time human annoyance will not come to the robot.

We have created several behaviors in NAO humanoid robot so that robots can mimic human behaviors. Humans themselves create these behaviors for robots. But since the duration of our treatment will be longer, our productivity will decrease if we take the help of humans to create robotic behavior for such a long time. So in this research we created behaviors in robots based on children's emotions so that robots are not always dependent on humans. Happiness, Sorrow, Anger, Attention and Normal these are the 5 Emotions.

In our study, we tried to train the robot in such a way that it detects the autistic child's face and reads the face for understanding his/her emotion so that it can make perfect behavior against the detected emotion. Continuing this learning step for a long time, the use of robots will be very normal and realistic. After teaching these robots can be used for children's social skill improvement in school or home.

Our humanoid robot can predict child's emotion and response with appropriate behavior. We got 97% accuracy in predicting the child's five emotions. We evaluated the social skill improvement of the child with 6 behaviors. Initially, they didn't response against these behaviors properly. After 8 sessions they responded properly to 1 behavior that seemed to have 33% improvement.

II. SYSTEM DESCRIPTION

A. Environmental Setup

Human Session: During the human session an extra table was brought in the middle of the room with two chairs on either side. Teacher in one chair and child in the other.

Fig. 1: Room setup for human-child session

It was set with two cameras stands on either side. A camera was set up for the whole part of teacher and small part of the child. The other was for the whole part of child and small of the teacher.

Robotic Session: We put the robot on the big table on the right. The child was sitting in the chair in front of the robot. One mobile camera was attached to the door of theroom and another opposite the door. That is, the whole session was captured for post-processing with two cameras on either side of the table.

Fig. 2: Room setup for robot-child session

A camera was set towards the child as a whole and partly towards the robot. The other was set towards the robot in full and in part towards the baby.

B. Autism Level Screening

Child's Basic Information: We considered the following basic information of the child for autism level screening.

Child's Name:	
Date of Birth:	
Current Age:	
Gender:	Male Female
Educational Level(If any):	
Current Therapy:	Speech/Language Occupational Physical Communication Behavior Joint Action Routines Pecs Others

TABLE I: Child's Basic Information

Query	(A) Never	(B) Just a little	(C) Often	(D) Very Much
Has full speech (verbal and speaks in phrase)	1	2	3	4
Able to back conversation	1	2	3	4
Able to back conversation	1	2	3	4
Uninterested in breaking objects	1	2	3	4
Making organized answer	1	2	3	4
Making organized comment	1	2	3	4
Respond to their name easily	1	2	3	4
Maintains eye contact	1	2	3	4
Can get dressed by him/himself	1	2	3	4
Enjoy looking around	1	2	3	4
Likes to stay in group	1	2	3	4
Easily play games with other children	1	2	3	4
Engage in pretend play with other children	1	2	3	4
Struggles to understand other people's feelings	1	2	3	4
Doesn't upset by small changes	1	2	3	4
Has excessive interests	1	2	3	4
Free from repetitive behaviors such as: Hand-flapping	1	2	3	4
Toe walking	1	2	3	4
pacing back and forth	1	2	3	4
Lining up objects	1	2	3	4
itive to: Smells	1	2	3	4
Tastes	1	2	3	4
Touch	1	2	3	4
Loud noise	1	2	3	4
Bright lights	1	2	3	4
Struggles to socialize with other children	1	2	3	4
Likes physical contact	1	2	3	4
Shows awareness of dangerous situations	1	2	3	4
Can easily make new friends	1	2	3	4
Hasn't Addiction in special foods	1	2	3	4

TABLE II: Behavior

Behavior: We have used the M-CHAT as a reference for determining the questions in the table above, although it may not be possible to include all of the questions from the M-CHAT because it is intended for children between 16 and 30 months of age, whereas our work is intended for children between the ages of 14 and 20 years. Using this table we calculated the autism level of the children. The total marks of the 12 children are as follows 58, 60, 63, 65, 67, 76, 89, 91, 95, 95, 97, 98 and level from 1(58)-11(98).

C. System Configuration

Experiments were run on a computer with an Intel Core i7 processor running at 3 GHz using 15.6 GB of RAM, running Ubuntu Linux version 20.04LTS.

Memory	15.6 GB
Processor	Intel® Core™ i7-9700F CPU @ 3.00GHz × 8
Graphics	llvmpipe (LLVM 12.0.0, 256 bits)
OS Name	Ubuntu 20.04.3 LTS
OS Type	64-bit
Gnome Version	3.36.8

TABLE III: System Configuration

III. IMPLEMENTATION

In this section We have given a detailed description of our developed model and methodology. How much social skills can be developed for autistic children using this model and how much works more needs to be done in the future.

A. System Development

We used the autonomous, programmable medium-sized humanoid NAO robot version 6 to conduct our research work. France robotics company Aldebaran Robotics which was acquired by Softbank Group developed this robot. The robot has been used in education, research, healthcare and entertainment for over 20 years. It has the ability to make a variety of poses/behaviors, including talking to people, dancing, walking, singing etc. NAO robot can easily walk and run even when the speed and direction are changed. Its walking speed is similar to that of a 2-year-old child, which is usually 0.6 km/h.

1) NAO Humanoid Robot: NAO has 25 degrees of freedom (DOF), 11 for the lower part including legs and pelvis and the rest 14 for the upper part including it's struck, arms and head. Each leg has 2 DOFs at the ankle, 1 at the knee and 2 at the hip. Each arm has 2 DOFs at the shoulders, 2 at the elbows, 1 at the wrists, and 1 another additional DOF for the hand's grasping. Each organ can be folded at an angle of at most 45° at the DOF. As a result, many gestures like those of a young child are possible by the robot.

Specification: It has 4 GB DDR3 RAM. It has seven sensors that are located on the head, hands and feet to perceive the environment and position yourself. It has 4 microphones for voice recognition and sound localization, 2 speakers for text-to-speech analysis of different languages, 2 HD cameras for computer vision including face and shape recognition. It is able to understand 22 languages including English, French,Spanish and German.[13]

Name	Specification
Height	574 mm (22.6 in)
Depth	311 mm (12.2 in)
Width	275 mm (10.8 in)
Weight	4.836 kg (10.66 lb)
Power supply	lithium battery providing 62.5 Wh at 21.6V
Autonomy	90 minutes (active use)
Degrees of freedom	25
CPU	Intel Atom E3845 Quad Core @ 1.91 GHz
RAM	4 GB DDR3
Storage	32 GB SSD
Built-in OS	NAOqi 2.8
Compatible OS	Windows, Mac OS, Linux
Programming languages	C++, Python, Java, MATLAB, Urbi, C, .Net
Simulation environment	Webots
Cameras	2 HD OV5640 67.4° DFOV cameras

Sensors	4 microphones, sonar rangefinder, 2 infrared emitters and receivers, inertial board, 9 tactile sensors, 8 pressure sensors
Connectivity	Ethernet, Wi-Fi a/b/g/n

TABLE IV: Specification of NAO V6

Software: NAO robot is controlled by Linux based operating software NAOqi. NAO version 6 uses openembedded-based OS NAOqi 2.8. It has a graphical programming tool called Choreograph, simulation software package and software development kit (SDK). It supports C++, Python, Java, MATLAB, Urbi, C, .Net. For our research work we program in python 2.7 as NAO version 6 support only python 2.7 version.

For face detection of the children from their whole image captured by NAO we used a python library called OpenCV. OpenCV is an Open Source Computer Vision Library with thousands of computer algorithms implemented. Its main features include image processing, video analysis, camera calibration and 3D Reconstruction, 2D Features Framework, Object Detection, High-level GUI, Video I/O etc.

B. Data Collection

We went to a private school called Families For Children (FFC), sector 10, Uttara 1230, Dhaka to collect data. Prior permission has been taken from the guardians and school authority. In our study, we worked with data from 12 children. Of which 6 are boys and 6 are girls and age is between 14 to 20 years. We made 8 sessions for each 3 hours with the child using humanoid robot. One teacher was appointed for each child to complete the session.

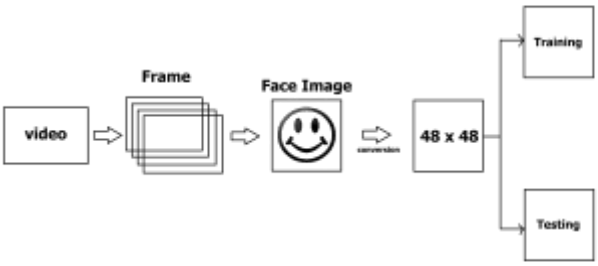

Fig. 3: Data conversion flow

C. Data Pre-processing

We first recorded a lot of videos of their different times with a mobile camera. Some videos are of their teachers taking their classes, some of which our volunteer and we have spent time with, and some of which we have with the robot. There are 20 videos of teachers taking classes and their total length is 30 minutes. And we captured these videos in about 5 days. Videos with other humans and robots are a total of 37 videos and their total length is 5.5 hours.

After the video captured, we made a program with the help of Python’s openCV library and made all frames from these videos. Then we separated the faces from each frame through face detection and gave the size 48×48. We used haarcascade-classifier to detect faces. Since the faces were taken from the videos, many photos of the same face were found at very short intervals. So by checking the hash of the image, 5 images have been chosen and one of them has been taken as a representative. The algorithm then convert the resized face portion of the image to a array.

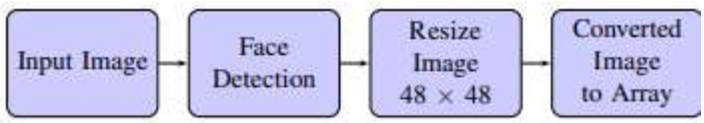

Fig. 4: Data Preprocessing Flow

After receiving the 48 × 48 face images, they have been labeled with the help of expert psychologist from the clinical psychology department of Dhaka University, i.e. we have created a database by identifying which ones are sad, which ones are happy, which ones are angry, which ones are attention and which ones are normal. In the case of labeling we have taken 5 emotions sad, happy, angry, attention, normal. Thus, we created a database with about 10,000 images and ran our model on it.

D. Data Analysis

Our NAO robot take photo of autistic children, passes the image as input to our model. After taking the photo of children we have to detect the face of the child since our robot will generate action on the emotion of the child. So, face detection module find out the emotion of the child.

Fig. 5: Dataset Sample

E. Overview of the Model

In our research, we have developed a convolutional neural network model. The neural network has three types of layers.

a) input layer b) output layer c) hidden layer. Hidden layers are in the middle of input and output layers. There can be multiple hidden layers. Each layer is connected to its previous and next layer by an edge and the nodes of each layer have a certain value. The value of the input layer is given first. The values of the next layer are extracted sequentially. And each edge/connection has weight. The weight of the edge of the node that contributes the most to the value of the next node is a little higher. Information from each layer is transferred to the next layer. In this way, the input reaches the output layer. If the difference between the output and the desired output is greater than the expected error, then the value of the nodes and the weight of the edge/connection are updated through backpropagation. Thus, as a result of repeated training, the model becomes ready for good predictions. We used 5 folds and 10 fold cross validation for CNN model training and testing.

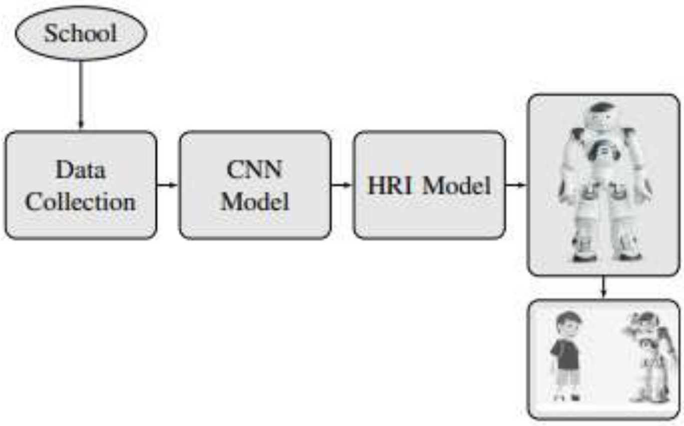

Fig. 6: Flow chart of the full process

$\psi(x) = \frac{1}{1+e^{-x}}$, Tanh $\psi(x) = \frac{1-e^{-2}}{1+e^{-2x}}$

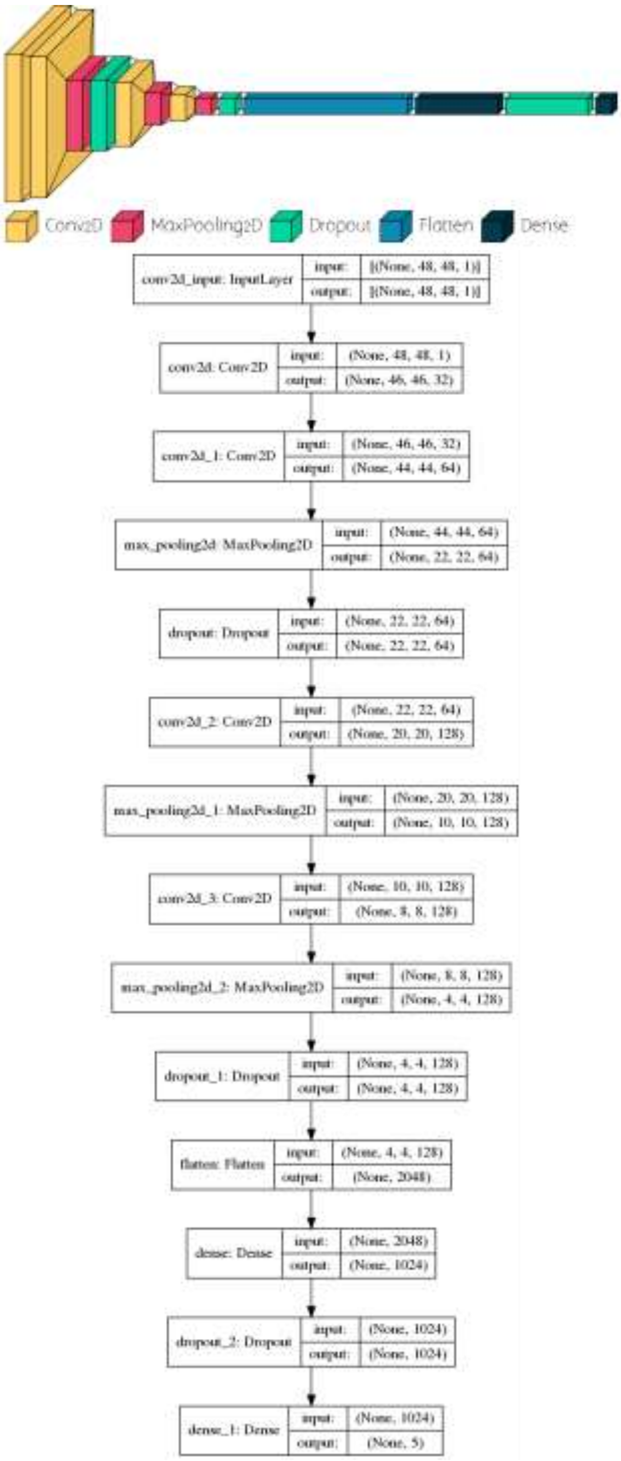

Fig. 7: CNN model

Activation Function: Activation functions are transfer functions. The activation function determines whether the output value of a node will go to the node of the next layer. If any data or information is important then the activation function sends it to the next layer. There are many types of activation functions for deep learning. ReLU $\psi(x) = x1_{x\geq0}$,

x

Sigmoid, LeakyReLU $\psi(x) = x1_{x\geq0} + \alpha x1_{x\leq0}$ are the most commonly used. We have used *softmax* activation function for output layer. The softmax activation function sum up the outputs to 1 so that they can be used as probabilities.

$$\frac{e^{z_i}}{\sum_{j=1}^{K} e^{z_j}} \quad (1)$$

Parameter Initialization: Two types of initialization are used for the initialization of bias and weights of the neural networks. One is zero initialization and the other is random initialization. For zero initialization $w = 0, b = 0$. We used *zero initialization* for bias initialization. The most commonly used random initialization method is *Xavier* $N(0, \frac{2}{n_i})$ and *Glorot* $N(0, \frac{2}{n_i + n_{i+1}})$. We used *glorot initialization* for kernel initialization.

Loss Function: The difference between actual data and predicted data is called loss. The function by which this loss is calculated is called the *loss function*. And with this *loss function* we can understand how well a model works. If the prediction is far from the actual value, then the loss function returns a much larger number. According to the type of learning, there are two types of loss function: a) Regression loss b) Classification loss Regression returns any continuous value. Classification on the other hand predicts finite categories.

Mean square error / Quadratic loss / L2 loss, Mean absolute error / L1 loss, Mean Bias Error etc. are used as loss function in case of regression.

$$MSE = \frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}{n} \quad (2)$$

$$MAE = \frac{\sum_{i=1}^{n}|y_i - \hat{y}_i|}{n} \quad (3)$$

$$MBE = \frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)}{n} \quad (4)$$

On the other hand, in case of classification, Hinge loss / Multi Class SVM loss, Cross Entropy Loss / Negative Log Likeability etc. are used as loss function.

$$SVMLoss = \sum_{j \neq y_i} max(0, s_j - s_{y_i} + 1) \quad (5)$$

$$CrossEntropyLoss = -(y_i log(\hat{y}_i) + (1 - y_i) log(1 - \hat{y}_i)) \quad (6)$$

We used *cross entropy* loss function here.

F. NAO Robot Behavior

We set 5 emotions for child to make our robot's behavior. These are a) happy, b) sad, c) angry, d) attention and e) neutral.. We used frame based algorithm to activate the robot's behavior. When the child is in *happy mode*, our robot shows him/her various postures (such as walking, standing, sitting etc.). When in *sad mode*, NAO robot asks, "*Are you upset? What happened to you? Tell me, your mind will get better*". When in *angry mode*, we keep the robot quiet. When in *attention mode*, our robot says of itself, "*My name is NAO, I can walk, I can talk.*". When in *normal mode* NAO robot try to make attention of the child by speaking "*hello..hello*".

IV. RESULT AND DISCUSSION

We ran our model for 12 children for eight sessions. At first session the children were not very interactive with the robot but after all sessions they were very interactive. We checked the interaction of children for six behaviors by the trained humanoid robot. The children responded properly for one behavior, that seemed to have 33% social skill improvement.

Model Accuracy

We ran our model for 5 fold and 10 fold cross validation separately. After performing the evaluation, we got the following outcomes for different activation function. When the sigmoid activation function is used

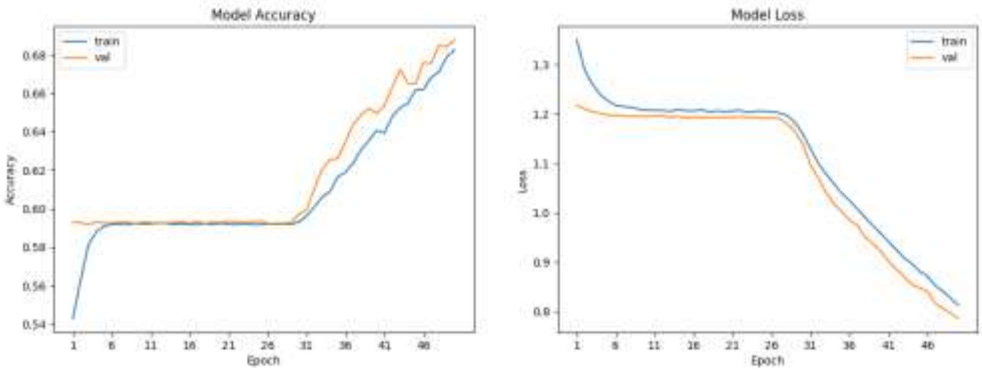

Fig. 8: Model Accuracy and Loss Result for sigmoid activation function (5 fold)

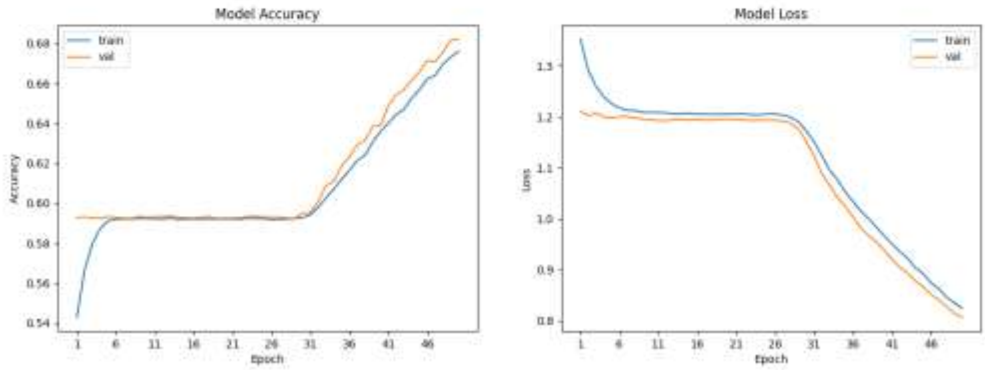

fig. 9: Model Accuracy and Loss Result for sigmoid activation function (10 fold)

When the LeakyReLU activation function is used -

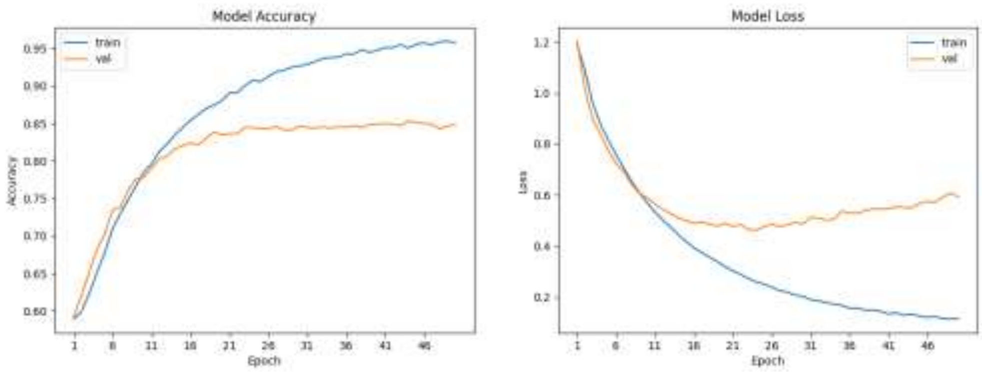

Fig. 10: Model Accuracy and Loss Result for LeakyReLU activation function (5 fold)

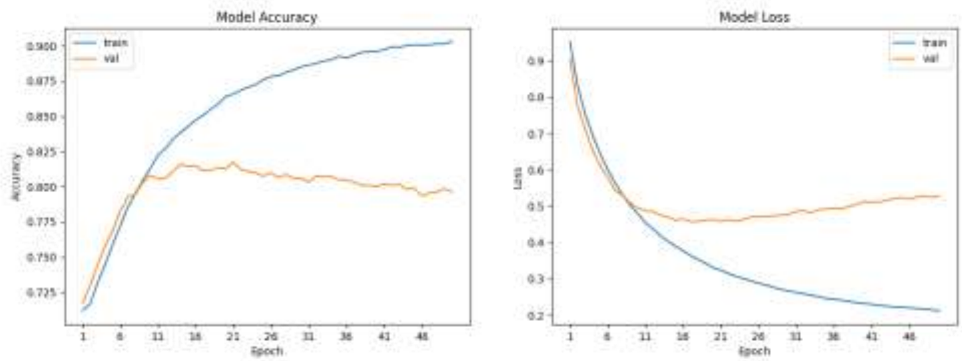

fig. 11: Model Accuracy and Loss Result for LeakyReLU activation function (10 fold)

When the *ReLU* activation function is used –

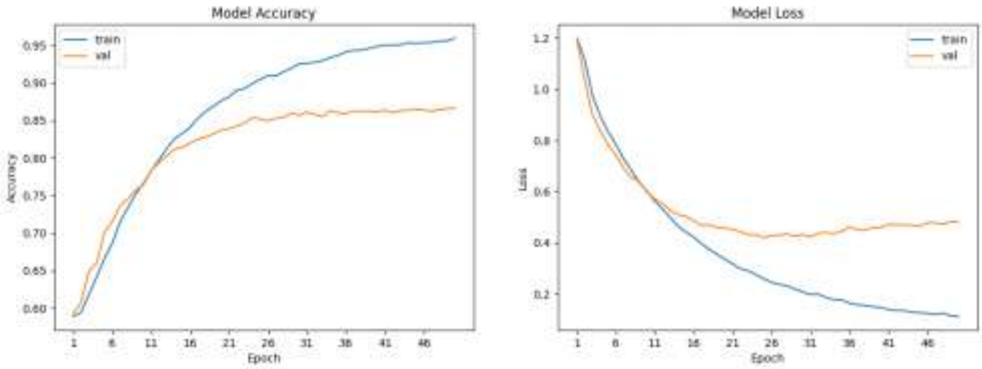

fig. 12: Model Accuracy and Loss Result for relu activation function (5 fold)

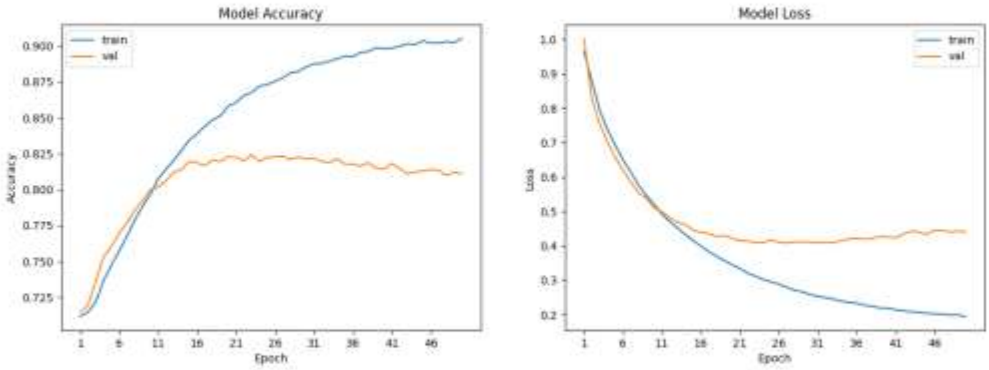

fig. 13: Model Accuracy and Loss Result for relu activation function (10 fold)

We made the model with total of 13 layers of 5 types. Layers are *Conv2D, MaxPooling2D, Dropout, Flatten, Dense*. In the above figure, we see that when more epoch passes the accuracy increased as the model can be learned each time when an epoch passes using backpropagation. Then model adjusts its weight and bias for reaching near to the actual output. And after 1000 epochs we get the highest accuracy which is 97%.

Layer Name	Type	Shape	Param
conv2d	Conv2D	(None, 46, 46, 32)	320
conv2d 1	Conv2D	(None, 44, 44, 64)	18496
max pooling2d	MaxPooling2D	(None, 22, 22, 64)	0
dropout	Dropout	(None, 22, 22, 64)	0
conv2d 2	Conv2D	(None, 20, 20, 128)	73856
max pooling2d 1	MaxPooling2D	(None, 10, 10, 128)	0
conv2d 3	Conv2D	(None, 8, 8, 128)	147584
max pooling2d 2	MaxPooling2D	(None, 4, 4, 128)	0
dropout 1	Dropout	(None, 4, 4, 128)	0
flatten	Flatten	(None, 2048)	0
dense	Dense	(None, 1024)	2098176
dropout 2	Dropout	(None, 1024)	0
dense 1	Dense	(None, 5)	5125

TABLE V: Model summary

B. Robotic behavior's sample collection

Here are some output images captured in our training session for different emotions.

Fig. 14: Output images for different emotions

C. Social Skill Improvement

From the collected basic information and behavioral data we measured the autism level of the children as issued before. We did eight sessions on robots and humans at ‘Families For Children’ a autistic children’s school. In these eight days we have conducted some practical experiments on the behavior of robots. Notably, the robot greeted, asked name, asked if eaten food, taught his poetry, and asked to speak. We did the same test in three days 8 times. They interacted more from the first day to the second day, and more from the second day to the third day. Robot made salam to him, although he could not always give a complete answer. In some cases, children repeated the same thing. That’s a lot for an autistic child. When Asked the name, children tried to respond sometimes. When asked ’How are you?’, children tried to respond sometimes. When called by name, children answered by rising hand. When robot showed up/down behaviors the children interacted and commanded robot to up/down. For the above first four behaviors children interacted correctly sometimes not all time. But in last two behaviors the children interacted perfectly and enjoyed.

Behavior	Outcome	Points
Ask name	Can response with name	0
How are you?	Can response (i. e Good)	0
Salam	Can’t answer, try to repeat	0
Call by name	Raise hand	0
Robot up	Command robot to up	1
Robot down	Command robot to down	1

TABLE VI: Social Skill Development

By analyzing these outcomes we see that the total point is 2 out of 6 that is 33 percent improvement, but we can’t say this for a general case. We performed this study for very short time and with a few sessions. For saying this improvement for general case we need to take many sessions and for long period of times. In our case study at least we can say that this models works for improving social skill of autistic children.

Here, we see that children respond properly against the behavior ’Robot up and down’. There are 6 behaviors where first 4 are speech/listening behaviors and last two visual behaviors. As NAO robot looks as a child and perform simple visual behavior so children responded against this behavior easily.

For various social reasons, autistic children in our country are not easily accepted by the general population. That’s why parents don’t want to reveal this problem to their children. In some cases, they take the child to a medical or an autistic school for treatment. But even in these cases, parents do not want to help researchers with their children’s information. They have a fear that their child’s information will be leaked out. So, in this case, in order to gather information, we had to explain a lot to the parents, and we had spent a long time doing so. Maybe if this information collection became easier, many people would be interested in doing research on this subject in the future. To accomplish this, we must raise public awareness about these issues through a variety of activities, seminars, and writings on the individual, family, society, and state levels. The government should provide funds to these organizations that are working for autistic children. Another thing to note in this case is that the use of robots is very fruitful. They were initially opposed to it, wondering what kind of robot they should get and what would happen if they did. But when we took the robot, teachers, guardians, and kids were all happy to see the robot look like human.

In this paper, we used a CNN model that can predict a autistic children’s emotion in real-time. And by getting the predicted emotion robot can create a simple behavior for autistic children to do the same behavior.

Although humanoid robots have been used in medical and schools for the treatment and education of autistic children in developed countries, its introduction has not yet begun in our country. As an early study we examined the child’s emotions and determined some simple behaviors of the robot. This research could be further improved in the future. Our study did not determine different behaviors for children of different ages. In future, robots need to apply different behaviors based on different age groups. Also, different behaviors can be given based on the gestures of the child such as whether he is sitting or standing or lying down. And when the use of robots in this sector becomes easier, it is possible to further improve the research work based on various feedback from parents, teachers and doctors.

Another very important thing we found in this session is that in this 8 sessions they have adopted the robot so much and remember that the first day when the robot got up and sat down they watched it closely and the next day they told the robot to get up and sit down. And on the last day they were asked if they liked it and they all expressed happiness. And in order to realize how much they have adopted this robot, their teacher asked them if they would beat it if it was used in their teaching. One of the children cried with emotion. We think it is very commendable that a robot that has been able to bring so much emotion to children despite being an instrument. And from the results, we are hopeful that the long-term use of this robot will further accelerate the social development of children.

The practical usability and scalability of the ideas described in this paper can be followed for improving social interaction of autistic children.

ACKNOWLEDGMENT

This work is funded by the Centennial Research Grant, University of Dhaka and ICT Division, Government of the People's Republic of Bangladesh.

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