DESIGN AND DEVELOPMENT OF PLAY STATION TO ENHANCE PSYCHOMOTOR, COGNITIVE AND DAILY LIFE SKILLS OF CHILDREN WITH ASD

A PROJECT REPORT

submitted by

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BONAFIDE CERTIFICATE

This is to certify that the project work entitled "**DESIGN AND DEVELOPMENT OF PLAY STATION TO ENHANCE PSYCHOMOTOR, COGNITIVE AND DAILY LIFE SKILLS OF CHILDREN WITH ASD"** is a bonafide record of the work carried out by

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SIGNATURE

Project Viva-voce held on _____

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ABSTRACT

KEY WORDS: Play station; Motor skills; Mechatronics training

ASD (Autism Spectrum Disorder) manifests from ages 2-3 years old and goes undetected for years. Individuals affected by ASD, lack in gross and fine motor skills like walking, sitting and manipulating objects using hands. There has been a consistent upward trend in the prevalence of autism from 1.16% in 2007 to 2% by 2013. If ASD is not diagnosed at an early age and intervention is not provided at the formative stage, the inclusion of the child in regular routines is a big challenge.

Using this principle, a play station has been conceived, designed and fabricated incorporating 5 different tasks into one system. These 5 tasks aim at enhancing palmer grasp, tripod grasp, later pinch, pincer grasp, depth perception, wrist rotation, elbow movement, targeted walking, pushing, pick and place operations and eye- hand coordination. When a child with ASD uses this setup it goes through a series of activities which include, inserting a coin into a hole, turning a knob to one side or the other, placing a key into a key hole and twisting, bowling a ball towards pins and placing a basketball into a hoop. Visual cues such as glowing LEDs are made use of in the activities and aid the children along with verbal and physical cues.

Using various electronic components such as IR sensors, ultrasonic sensors, timers, dc motors, servo motors, potentiometers and LEDs coupled to a single PIC 16F778A processor the learning of the child is facilitated. The time taken for the child to bowl the ball or place the basketball into the hoop is electronically recorded and analysed to see the

effectiveness of training using play station. Thus, incorporating skills through Mechatronics training can be a working methodology to enhance psychomotor skills, cognitive skills and consequently daily life skills as well.

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CHAPTER 1

INTRODUCTION

ASD (Autism Spectrum Disorder) is a disorder where the brain does not develop at the speed it normally should. The brain development is slower than usual and hence learning is a problem. ASD manifests at the age of 2- 3 years of age and can be detected very early. Children affected with ASD can have a variety of impairments ranging from social skills to motor skills. Children with ASD having motor skill deficits have trouble sitting, walking or even holding objects and placing them [1]. These gross and fine motor skills are required to carry out daily life activities.

There has been a consistent upward trend in prevalence of autism from 1.16% in 2007 to 2% by 2013 [2]. It is said that the numbers will keep growing but the reason is unclear. Motor skills impairment is a universal issue to most ASD affected children as 83% of the children affected with ASD have motor skill impairments [3]. Due to its early manifestation, and ease of detection it is possible to bring the child to a regular life provided very early intervention takes place [4]. Later the intervention, harder it becomes to teach the child any basic skills.

As normal occupational therapy requires the therapist to engage with the child and asses the progress, the therapist may find it tiring to keep up the same facial expression and tone as well as energy because children with ASD are very sensitive to change. An automated mechatronic system to aid the therapists can help in reducing the facial input that must be assimilated by the child as well as provide the stability in tone and energy as

well as repetitiveness that a child with ASD requires to learn a task [5]. When a child is made to perform a task daily the muscles learn this task and hence repetitive exercise may help the child learn the simple motor tasks [6]. Along with the verbal and physical cues from the therapist, visual cues from the setup also help in performing the activity.

Motor skills in normal children develop from imitation activities but imitation quality is lacking in autistic children [7]. Motor skills are a very important part of anyone's life and being always dependant does not give a good quality of life. For the parents as well this problem affects them as they feel unsafe to leave the child unattended for even a second as it might endanger the child. We take things like opening doors and holding pens for granted but they are herculean tasks for children with ASD. To enable them with the power to open doors, place objects, turn keys etc. will improve their daily life activities and help them become slightly more independent.

Many existing robots and Mechatronic kits are made and still in progress for the rehabilitation of ASD affected children. Most of these kits however focus highly on cognitive skills of the children to aid better communication with people. Children with ASD find it difficult to look someone in the eye as the information that is being perceived by the brain is too much for them handle [8]. Social skills are an important part of life and should be focused on but motor skills are highly more important. Motor skills give independence, quality of life as well as a chance to get included in regular activities.

Psychomotor skills are the basic skills to perform any task such as gripping, picking, placing etc. They include gross motor skills such as walking, sitting or bending and fine

motor skills such as picking up objects, placing them, turning knobs etc. These skills are very important for any person and must be inculcated to live independently. This project works towards inculcating these skills in children affected by ASD by designing and fabricating a play station. This play station incorporated 5 tasks including picking up a coin and placing it into a coin slot, turning a knob to one direction or the other, picking up a key placing it in a key hole and rotating it, picking up a ball and placing it through a hoop and picking up a ball and rolling it on a wooden plank to hit pins. This is a novel idea and design and was completely self-fabricated. The system is equipped with many electronic components to measure a child's receptiveness each time it plays and also gives various visual cues. The system is dismountable and modular to make transportation and assembly easy.

This system has been made in the hope that it will help ASD affected children rehabilitate into a normal environment as best as possible. This report deals with the design and fabrication of the system and not with the actual effects it has on the children.

CHAPTER 2

REVIEW OF LITERATURE

2.1 REHABILITATIVE ROBOTICS

Rehabilitative robotics is an upcoming field were robotics is used to train disabled, temporarily injured or slow learners. Robots have the unique capability to continue to do a certain job without tiring, changing tone or the order in which it is programmed. This proves highly productive when it comes to dealing with ASD affected children as they cannot stand even the smallest change. A few robots which have been developed for an overall improvement in ASD affected children are KASPAR and Nao.

The AuRoRa (Autonomous Robotic platform as a Remedial tool for children with Autism) project is a platform where people can make robot s to aid children with ASD [9]. KASPAR is under the Aurora project and is a minimally expressive robot which acts an aid for children with ASD to interact with and break from the isolation caused by not being understood. It was developed in 2009 by B. Robins et.al. [10]

One robot that has gained much popularity worldwide for rehabilitation is Nao. Created in 2008 by Aldeberan robotics, Nao performs various gestures and movements. These movements are imitated by children with ASD and Nao performs image processing to guide them using verbal ques. Once the position has been successfully mimicked, lights in the eyes flash as a positive reinforcement and verbal reinforcement is given as well [11].

2.2 SOCIAL SKILLS

Social skills are a very important part of a person's life. When these social skills are impaired a lot of peripheral benefits also get affected. Many kits have been developed for the enhancement of social skills of children affected with ASD. Some of the more prominent and successful ones are discussed below.

Stone et al. said that imitation of any activity can help improve the targeted skills. 'Romibo', is a robot used to assist therapists, it shows emotions and helps children have interactions [12]. Project AUROSO uses SAR (Socially Assistive Robots) , a newly emerging area of robotics where robots are used to help a human via social interaction [13]. This social interaction is more effective than normal social interaction as the information one must read from a robots face is far less than that of a humans. This gives children with ASD an intermediate step towards social interaction.

Many robots impart social skills by imitation of what they see. Various robots have different ways of getting facial expression across to children with ASD. Keepon is a small robot which is used to interact with children in a non-verbal manner. It vibrates on a platform to convey emotions. It was seen that continuous interaction with it proved effective for children with ASD [14]. Robot Probo is a robot that has a completely expressive face with 20 degrees of freedom [15]. It is used to interact with children with ASD and give various cues to improve their social skills. In 2003, 'Robota', a humanoid, was fabricated by Billard, to aid through imitation [16]. It has artificial intelligence features and the child must imitate what it is doing. Ranatunga et al. used the humanoid

robot ‘Zeno’ to mimic the therapist’s movement and used image processing to verify that the child was performing the same [17].

2.3 MOTOR SKILLS

There are a few robots which aid in enhancing motor skills of children affected with ASD. Though the number is less, it still does exist. Motor skills are highly important to live independently. They are more important than social skills as one must first learn to open doors, sit, hold a spoon etc, before interacting normally with people. Some robots that have contributed to rehabilitation are mentioned below.

‘PlayROB’, a remote controlled device, was used by Kronreif to assist disabled children to play by helping the children perform the task without the social complications. IROMEC (Interactive Robotic social Mediators as Companions) is a device on which children can draw, write, trace their movements and interact [18]. Lego NXT is a very popular way to teach children motor skills. Children can imitate a Lego NXT kit made robot and perform tasks that are programmed onto it [19].

It can be seen that in all these cases imitation is the mode of transmitting the skill and ASD is mainly concentrated on cognitive and social skills development. The research on development of psychomotor skills however is not focused on much. This project is a setup fabricated with the intention of removing the social skillset required to imitate and giving the children a hands on activity which they will learn by trial and error. With the improved motor skills they can achieve with this setup, children with ASD can have a better quality of life.

CHAPTER 3

CONCEPTUAL DESIGN

3.1 PLAY STATION METHOD OF EXECUTION

In Fig. 3.1 the conceptual design is given. This design has taken into consideration the various sensitivities of the children and has incorporated as many grasps as possible. The play station has been designed in such a way that it incorporates 5 different tasks into one play station. These steps are followed in a step wise manner repeatedly to help the children with ASD enhance their psychomotor skills.

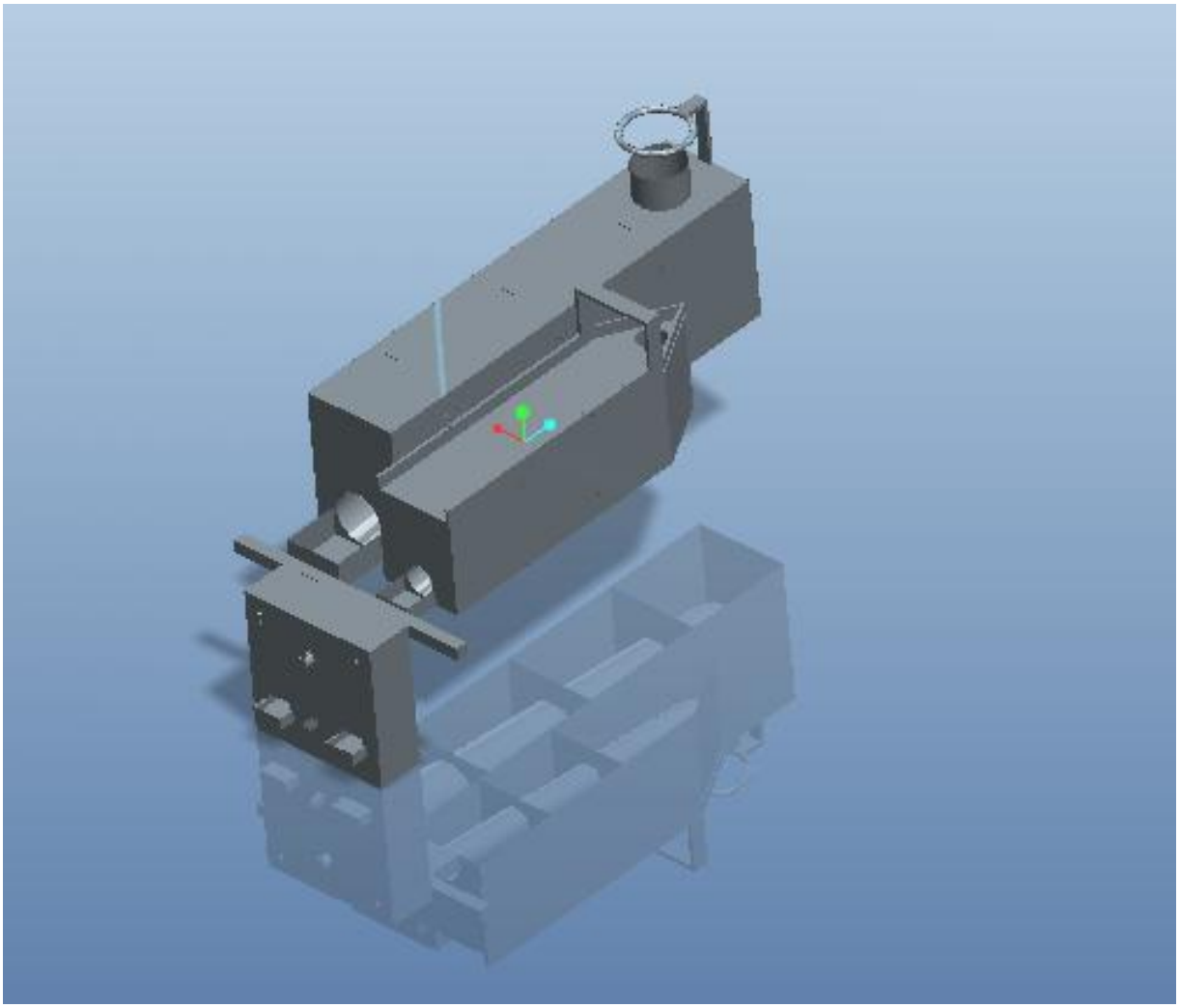

Fig. 3.1 Isometric view of conceptual design

The Steps are as follows; the coin is inserted into a coin slot following which a knob is turned left or right to choose a game, once a game is chosen the respective key drops to a flap and it must be inserted into the respective keyhole. Once the key has been twisted the game starts. If the basketball game has been chosen then the child must pick up the ball and place it in the hoop. If the bowling ball game has been chosen then the child must pick up the ball and roll it on a wooden plank to hit 3 pins at the end of the plank. The time taken to roll the ball to the end or drop it into the hoop is measured. This data can be used to analyse the effectiveness of this play station.

Various visual cues are provided by LEDs placed in the play station that glow on different achievements. The LEDs act as cues as well as positive reinforcement. Other electronics used include IR sensors, ultrasonic sensors, electrical key, potentiometer, dc motors and servo motors.

3.2 LEARNING OUTCOMES

Palmer grasp is one of the main grasps used to hold objects for pick and place operations. It is the grasp which uses all the fingers and the palm of one hand. It is one of the most basic grasps and can be used to turn knobs, pick up balls, catch, throw and hold various objects. Palmer grasp is used in daily life activities like brushing, opening doors, drinking water etc. This grasp has been incorporated by using the basketball game.

Tripod grasp is a grasp used to hold smaller objects in the hand. It uses the thumb, index and middle fingers for grasping. This is one of the first steps towards holding a pen or pencil and writing with it. This grasp is very important as it is used in activities like eating

with a spoon, buttoning shirt, holding clothes pins, Velcro on shoes etc. This grasp has been inculcated by using the bowling ball which has three holes for the fingers.

Pincer grasp is the grasp used in the last stages of pen holding exercises. It involves the thumb and index finger alone. This grasp can be used for any activity that involves pinching. These activities may include picking up small pieces of food, pebbles, holding a pencil, squeezing any sort of liquid from a tube etc. This grasp can been focused on the activity of inserting coin into a slot.

Lateral Pinch is a grasp which is used very often and taken for granted. This grasp uses the thumb and the index finger thumb side. This grasp is used picking up objects, turn flat objects, squeeze toothpaste out of the tube etc. In this play station this grasp has been given importance in the turning key activity and turning of the phase knob to one side or the other.

Along with these main grasps, this setup has been aimed to enhance writ rotation, elbow movement, depth perception, targeted walking and eye hand coordination.

3.3 FACTORS TAKEN INTO CONSIDERATION

ASD affected children have various other issues related to sounds, light, touch and other respective and sensory issues. These factors have been taken into consideration while designing of the play station.

Due to light sensitivity, the LEDs are not very bright but yet they are visible enough to provide visual cues to the children. The touch sensitivity can be tackled by having different textured balls and knobs. The dimensions have been done taking into considering that the children who will use the play station are in the age gap of 4-9 years old. The positive reinforcements are visible enough to be observed but not distracting.

The design must also take into consideration the needs of the therapist or guardian. The design is made modular so that assembly and dismounting is easy. It is a table top activity and hence it is made of light weight wood so that transportation is not an issue. The electrical wiring and processing is concentrated into one console so that there is no issue during assembly.

CHAPTER 4

DETAILED DESIGN

4.1 FLOW OF TASKS

The design is an integration of five different activities. The activities are inserting a coin in the coin slot, turning a phase knob, picking up a key, placing it in the respective key hole & twisting, and then playing that chosen game. The choice of games is basketball and bowling.

The detailed flow is as follows. First the child goes towards the main console; this console has a coin which will have to be placed in the coin slot. Once the verbal command is given the child will pick up the coin using pincer grasp and place it in the slot. IR sensors will sense the presence of the coin and a set of LEDs around the potentiometer knob will glow to indicate success and grab the child's attention towards the next step. During this the coin will come back to the original position for the next trial. He/she is made to rotate this knob in one direction or the other with a palmer grasp to choose between the two main games. Once the knob has been rotated the respective key for the chosen game will drop into a flap with the help of a servo motor and the key hole for the respective game will light up in red with LEDs to give a positive reinforcement and visual cue for the next step. The child picks up the key using a lateral pinch and inserts it into the appropriate key hole and twists the same to initiate the corresponding game. Once the key has been twisted The LEDs around the key hole will go green and the LEDs around the chosen game will glow.

In the case of the basketball game, the child picks up the ball from the holder with a palmer grasp and throws it through the hoop provided at arm's length. The holder consists of IR sensors and once the sensor senses the absence of the ball a timer starts. Once a ball is detected by an ultrasonic sensor placed at the hoop the timer stops and this value is noted down. With this data, it is possible to check if the speed of action has increased. The ball returns via an inclined tube to the original position for the next trial. Once the child masters the first stage of this game, the tube is extended to give practice for better depth perception. The extended tube requires the child to take a step or two depending on the extension and the process of assessment remains the same.

The bowling ball game works with three pins and a bowling ball. The child picks up the ball with a tripod grasp and rolls it across a flat wooden plank. The process of collecting time taken between picking up the ball and the hitting of pins is the same as the basketball game. When the ball strikes the pins, they are lifted using DC motors. The ball falls into the hole placed behind the pins and returns back to the original position for the next trial. There are 3 stages in this game namely beginner, intermediate and advanced. In the beginner stage, any pin hit will cause all 3 pins to lift up giving positive reinforcement. The next stage requires more aim where the LEDs on 2 pins will glow and only those 2 pins must be hit. Once this stage is mastered the advanced stage consists of a single pin's LED glowing and that pin alone must be hit.

SPDT switches are used to detect which stage the child is performing at. '00' is first stage, '01' is second stage, '10' is third stage. When the SPDT switches have value '11' then the trial starts from the console otherwise the ball picking is the first step of the next trial. All the programming is done on a PIC16F877A board. This system is used to aid therapists and gives an added visual cue to help intervention processes.

4.2 BASKETBALL GAME

The basketball hoop comes with a board which is attached to the last box with smaller wood pieces. The pipe of the basketball protrudes out of the hole to collect the ball effectively. Box 1 has an oval at the back to collect the ball from box4 and 3 directly in case of stages 1 and 2. It has been fabricated as in the fig. 4.1. The PVC pipe attached to box1 is cut into half to a certain point to let the ball drop from height. The pipe was given a constant 5 degree slant to facilitate rolling of the ball. There are provisions made for keeping the IR sensors on the holder and ultrasonic sensor on the hoop. The electronics are confined to box1 and box 4 and so the box 4 electronics must be easily detachable and attachable when needed.

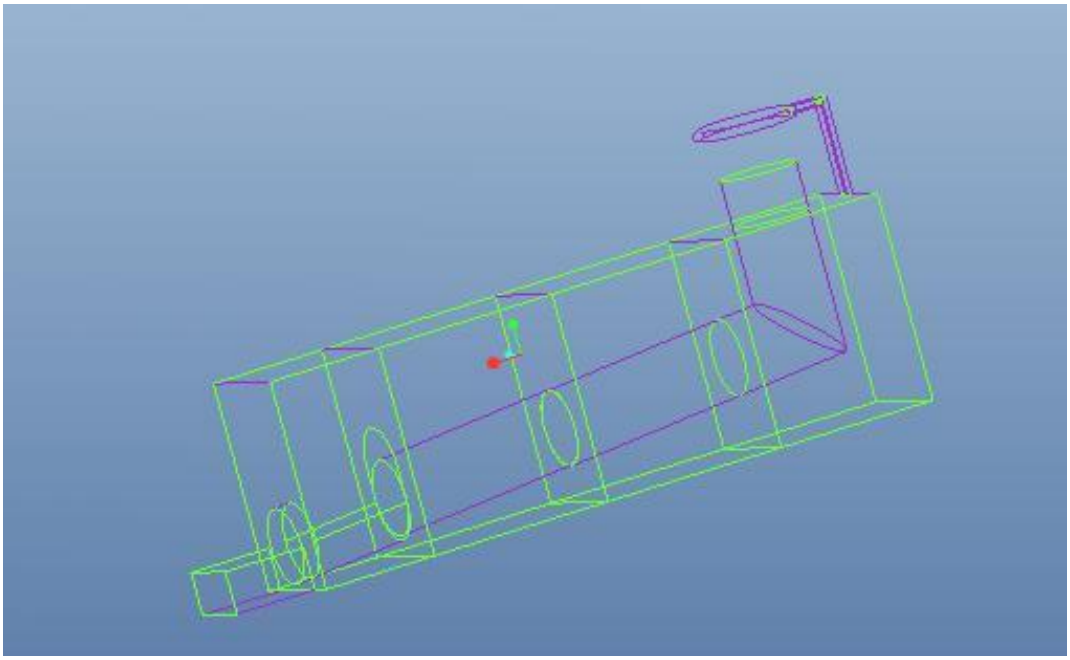

Fig. 4.1 Basketball wireframe diagram

4.3 BOWLING BALL GAME

The bowling ball game is designed is such a fashion that the ball falls in to a hole placed behind the pins after it hits the pins. The pipes are fit at 5 degree angles with Anabond**.** The pins must be actuated to lift up as they will block the ball if they are not. A frame like

structure was put up on top of the pins; it holds 3 mini DC motors for each pin. Fig. 4.2 shows a wireframe diagram of the fabricated model. Lining of height 4cm was used along the length of the setup so that the ball does not bounce or fall off the sides. Enough space is given between the pins so that rolls can hit individual pins as well as two pins at once for stages 2 and 3.

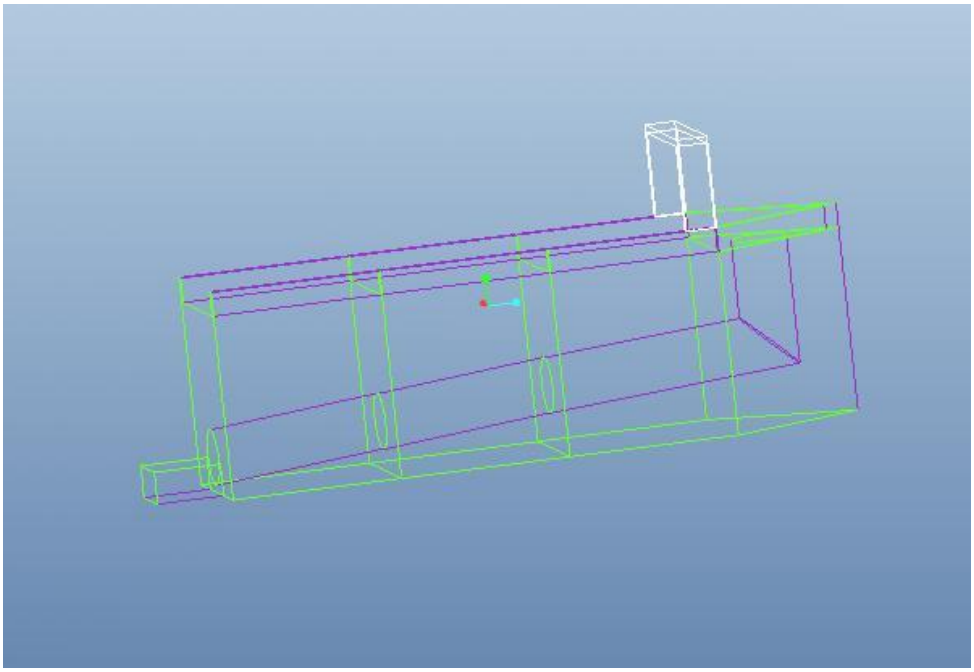

Fig. 4.2 Bowling wireframe diagram

4.4 CONSOLE

The console consists of most of the electronics in the play station. The console consists of an IR sensor for detection of coin, Electrical keys for the task of inserting and twisting key in key hole, potentiometer to choose games and servo motors to actuate flap to drop keys with key chains. They coin has a coin slot as well as a holder for the coin to go back to the holder after one execution for the next trial. The coin slit , holder and potentiometer are kept in the centre of the console where as the key and key holders are kept on the respective sides to avoid confusing the children. The console is shown in fig. 4.3. The console also plays host to the PIC 16F877A and wires. They are placed behind the front

panel in a small shelf like cut out. The SPDT switches are present on on the bowling side of the console on the edge for easy access.

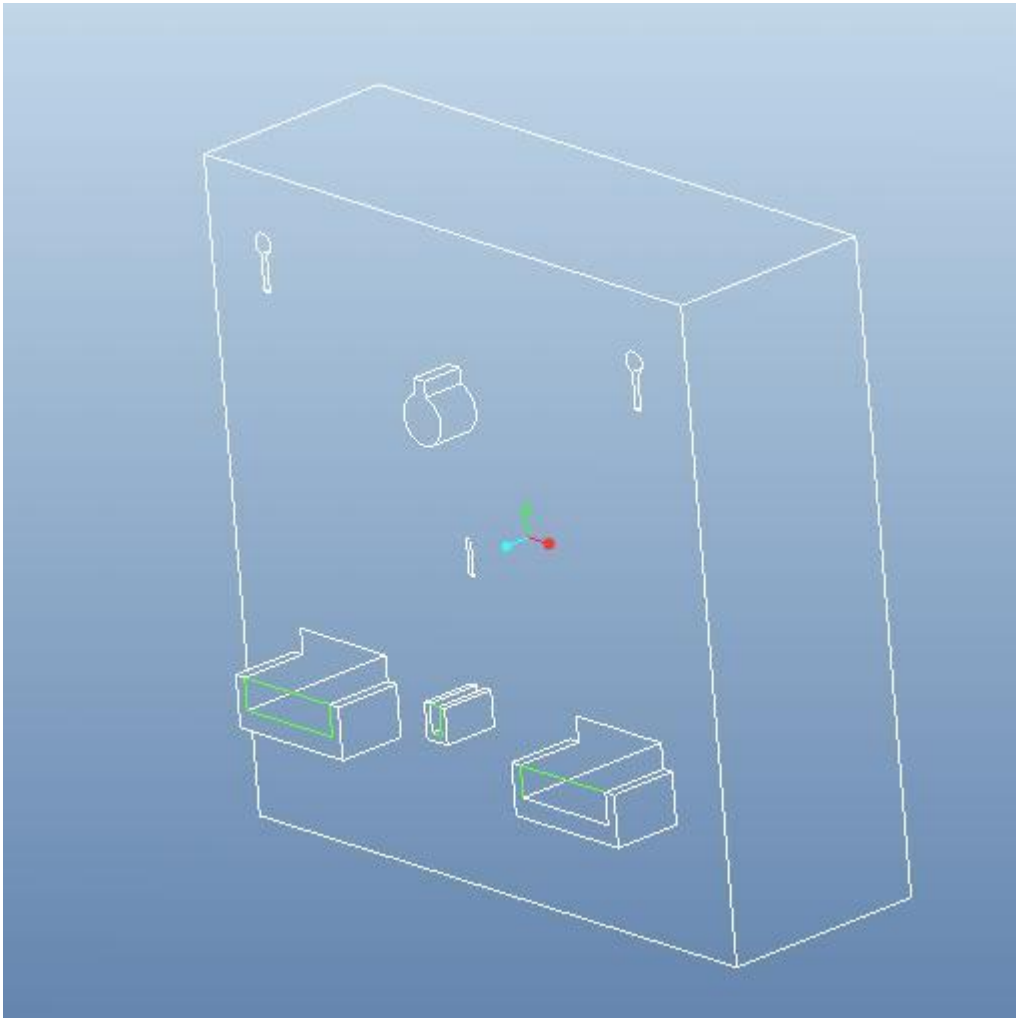

Fig. 4.3 Console model

4.5 FLOWCHART OF ELECTRONIC SYSTEM

The flowchart for the electrical operations programmed onto the PIC16F877A is as follows. Table 4.1 gives a list of variables used in the flowchart. The variables can be equated to 0 if the corresponding component is not triggered and 1 if it is. The SPDT switches are equated to ‘00’ ‘01’ ‘10’ and ‘11’. Ultrasonic sensor gives distance output. Timers are present in the microcontroller and are made use of. Potentiometer gives a

value between 0 to 1023 which is scaled to get 0-5 value. Servo motor must be given degree values to rotate.

Table 4.1 Variables of electronic system

SNO	COMPONENT	VARIABLE	I/O VALUES
1	IR Sensor to detect coin presence	ir3	0,1
2	IR sensor to detect presence of basket ball	ir1	0,1
3	IR sensor to detect presence of bowling ball	ir2	0,1
4	Potentiometer as a knob	Pot	0-5
5	Electrical key for basketball game	k1	0,1
6	Electrical key for bowling ball game	k2	0,1
7	Servo motor for basketball key flap	s1	Degrees
8	Servo motor for bowling ball key flap	s2	Degrees
9	Ultrasonic sensor to detect basketball in hoop	us1	Distance
10	Ultrasonic sensor detect bowling ball in hole	us2	Distance
11	Ultrasonic sensor to detect bowling ball	us3	Distance
12	Mini DC motor for pin 1	m1	0,1
13	Mini DC motor for pin 2	m2	0,1
14	Mini DC motor	m3	0.1
15	Timer for basketball	t1	Start, stop
16	Timer for bowling ball	t2	Start, stop
17	SPDT switch for stage selection	w1	0, 1
18	SPDT switch for stage selection	w2	0,1
19	LEDs around the potentiometer	l1	0,1
20	LEDs around basketball keyhole	l2a®,l2b(g)	0,1
21	LEDs around bowling keyhole	l3a®,l3b(g)	0,1
22	LEDs around basketball game	l4	0,1
23	LEDs around bowling game	l5	0,1

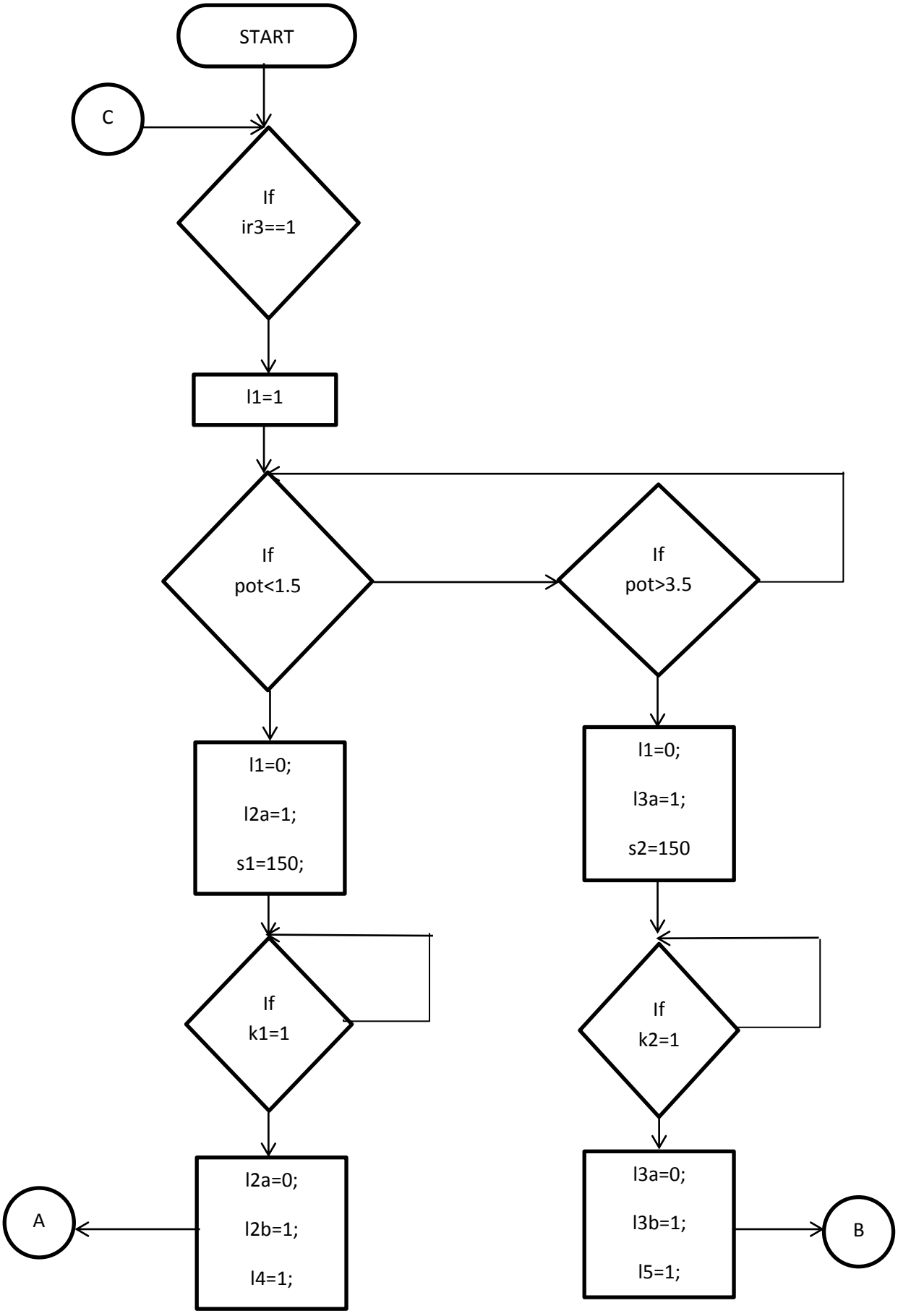

Fig. 4.4 Flowchart of electronic system

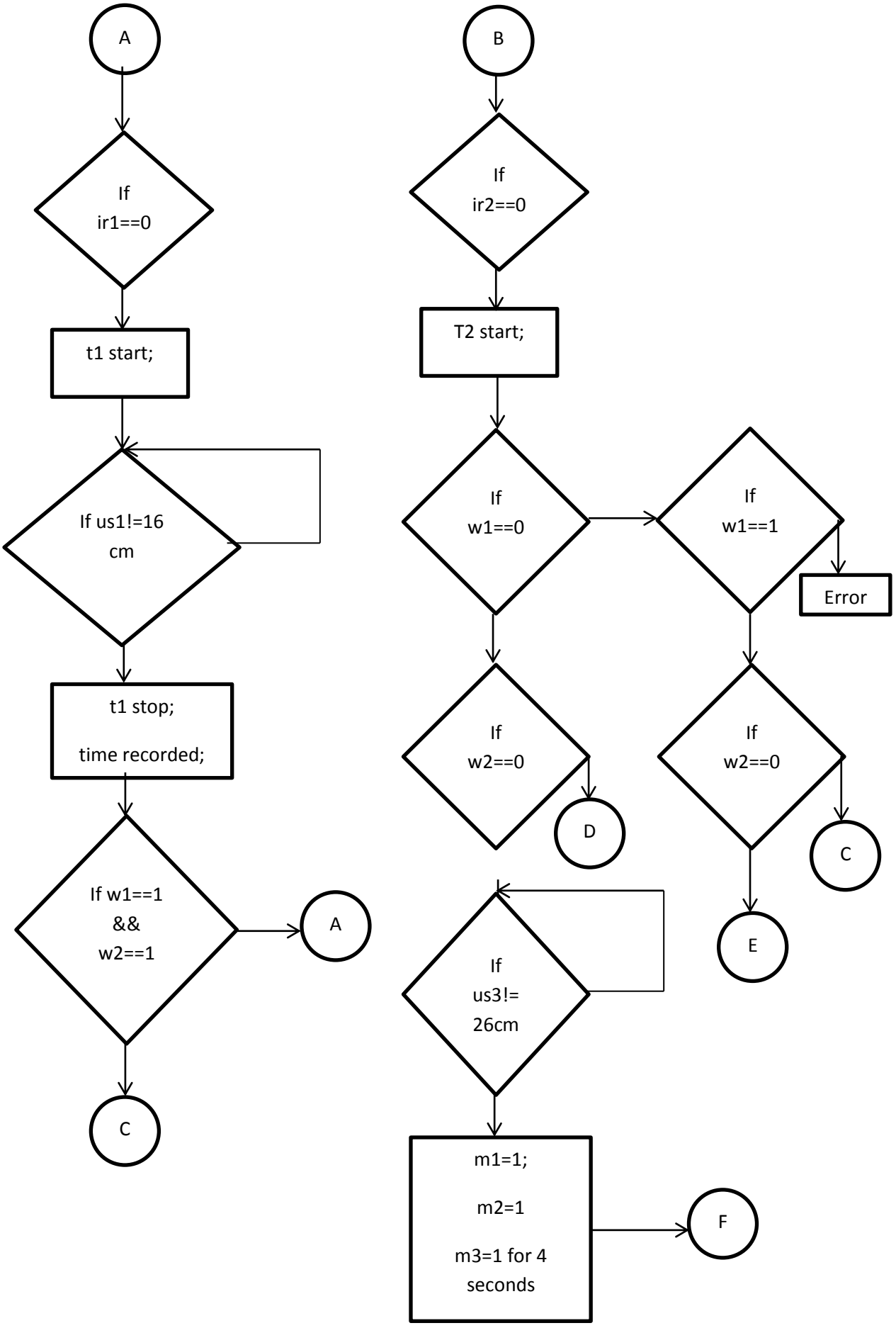
A
If
ir1==0
t1 start;
If us1!=16
cm
t1 stop;
time recorded;
If w1==1
&&
w2==1
A
C
B
If
ir2==0
T2 start;
If
w1==0
If
w1==1
Error
If
w2==0
D
If
w2==0
C
E
If
us3!=
26cm
m1=1;
m2=1
m3=1 for 4
seconds
F

Fig. 4.4 **(contd.)**

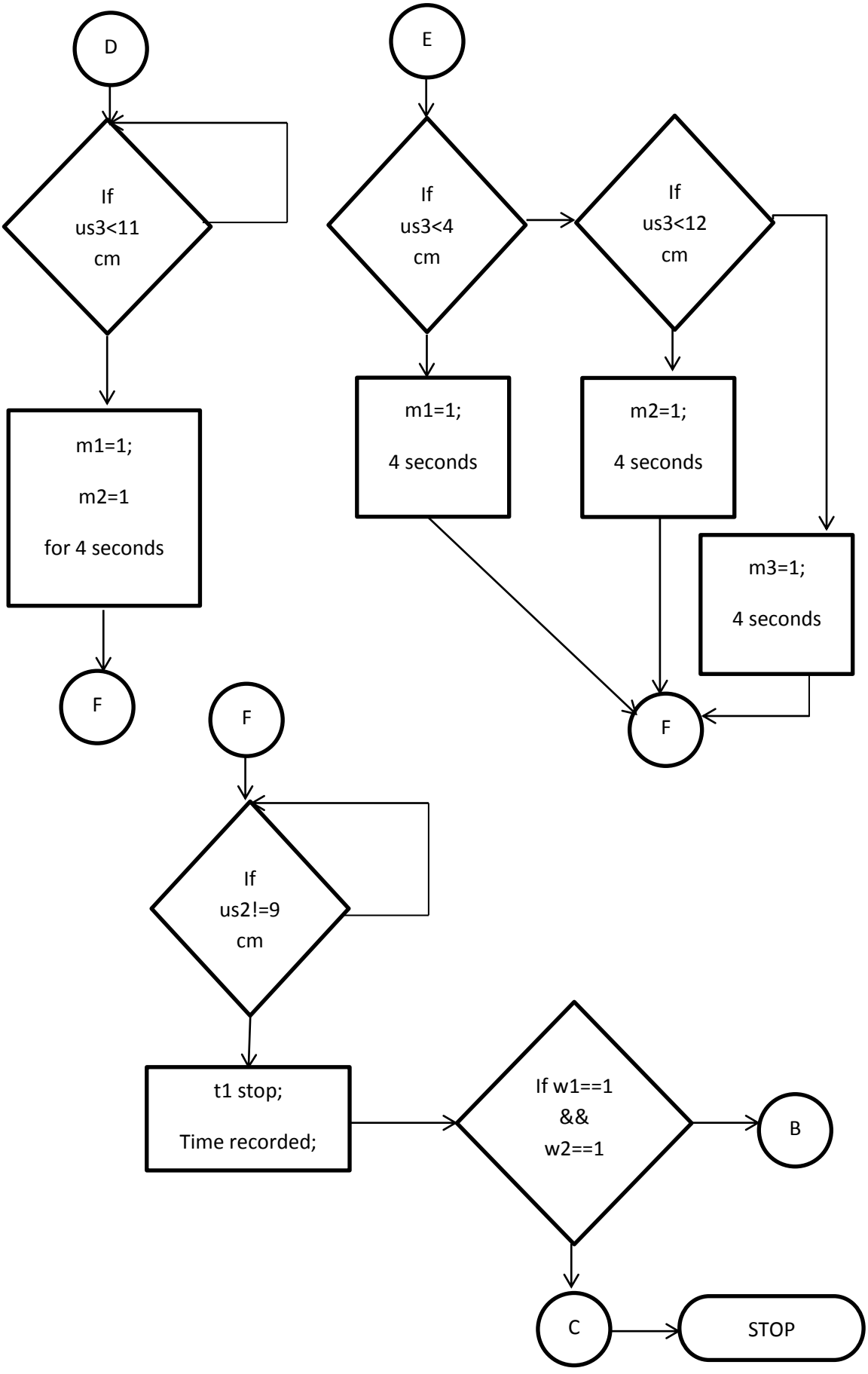
D
If
us3<11
cm
m1=1;
m2=1
for 4 seconds
F
E
If
us3<4
cm
If
us3<12
cm
m1=1;
4 seconds
m2=1;
4 seconds
m3=1;
4 seconds
F
F
If
us2!=9
cm
t1 stop;
Time recorded;
If w1==1
&&
w2==1
B
C
STOP

Fig. 4.4 **(contd.)**

CHAPTER 5

FABRICATION

Fig. 5.1 shows the fabricated model of the system. This system has been designed to aid therapists to enhance the motor skills of children with ASD. It focuses on four kinds of grasps, palmer grasp, tripod grasp, pincher grasp and lateral pinch. It also emphasises on wrist rotation, elbow movement, depth perception and eye-hand coordination.

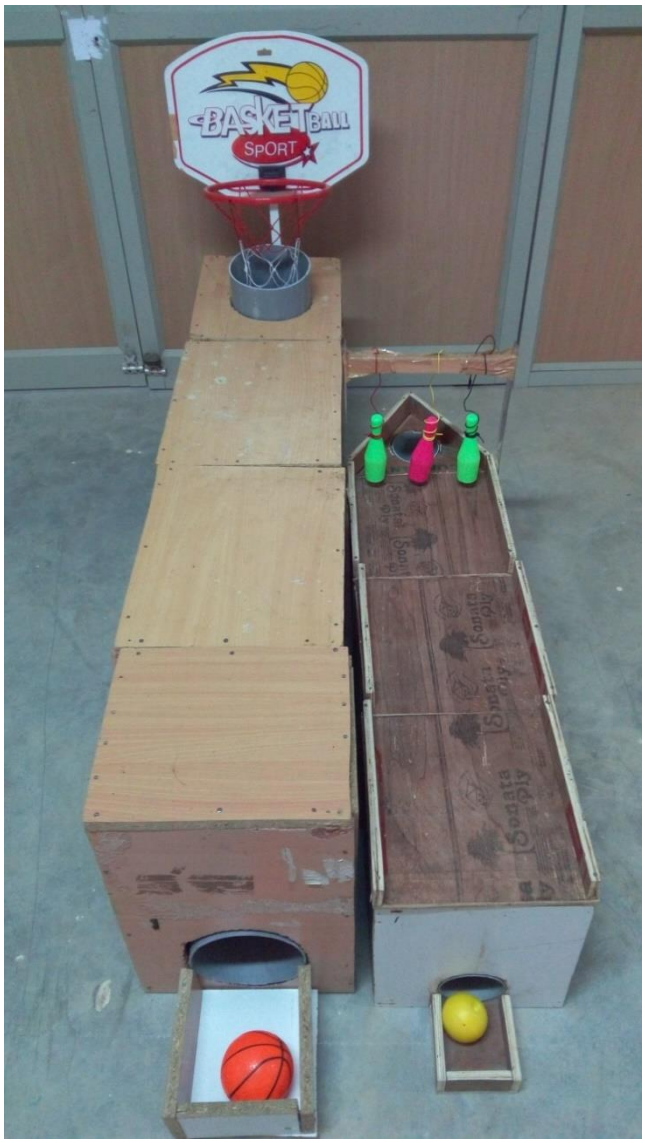

Fig. 5.1 Play station

5.1 DESIGN SPECIFICATIONS

The design of the device is in such a way that, it can be mounted or demounted, and takes up a total of 150cm × 60cm (5 ft × 2 ft) area in its extended position. It has been made of 2 types of wood namely ply wood (1.2cm thick) and softwood (2cm thick). Ply wood has been used for the bowling ball setup where as softwood has been used for the basketball setup. This wood has been used to make the individual pieces light weight. The ball retrieval system is an inclined PVC pipe at an angle of 5 degrees. For bowling and basketball the pipe diameter is 9cm and 16cm respectively for ball diameters of 6cm and 10cm respectively.

The bowling ball setup has been split into 3 main parts for easy assembly; 1 box with holder, one box, one box attached to triangle for retrieving the ball. The detailed measurements for these 3 parts have been given in Table 5.1. The basketball set up has been split into 4 main parts, one box with holder, 2 middle boxes, one box with basketball hoop attachment, where the middle 2 parts act as the extension for the last 2 stages. The detailed measurements for the basketball game are given in table 5.2. HOLE PLACEMENT column gives the bottom most tangent that the pipe must touch. The centre is made at centre of the plank with varying heights.

The console is 45 cm × 45 cm with various holes in for coin slot mechanism , electrical key, potentiometer and flap mechanism. It is also used to mount the PIC16F877A onto it.

Table 5.1 Bowling wood details

SNO	COMPONENT	NUMBER OF COPIES	MEASURMENTS (Height(cm) × Breadth(cm))	HOLE PLACEMENT (cm above bottom)
1	Side planks of boxes	6	30 × 28	Nil
2	Side planks of triangle	2	30 × 25	Nil
3	Top lining of boxes	6	4 × 28	Nil
4	Top lining of triangle	2	4 × 25	Nil
5	Top of boxes	3	28 × 26	Nil
6	Top of triangle	1	22 × 26 (equilateral triangle)	4
7	Front and back of boxes	6	30 × 26	1.2
				3.65
				3.65
				6.1
				6.1
				8.55
8	Holder base	1	11 × 11	Nil
9	Holder side lining	2	4 × 11	Nil
10	Holder front lining	1	4 × 8.6	Nil

Table 5.2 Basketball wood details

SNO	COMPONENT	NUMBER OF COPIES	MEASURMENTS (Height(cm) × Breadth(cm))	HOLE PLACEMENT (cm above bottom)
1	Side planks of box1	2	44 × 25	Nil
2	Side planks of box 2,3	4	44 × 40	Nil
3	Side planks of box 4	2	44 × 35	Nil
4	Top of box1	1	25 × 30	Nil
5	Top of stage box 2,3	2	40 × 30	Nil
6	Top of box 4	1	35 × 30	6
7	Front and back of boxes	8	44 × 30	2
				4.2 to 27.19
				4.2
				7.69
				7.69
				11.19
				11.19
				14.25
8	Holder base	1	18 × 18	Nil
9	Holder side lining	2	9 × 18	Nil
10	Holder front lining	1	9 × 15	Nil

The wood used was ply wood and soft wood for bowling and basketball respectively. The wood pieces cut in the dimensions from table 1 and 2 are nailed together to form the boxes. The PVC pipes are bonded into place after being cut to the exact size.

CHAPTER 6

CONCLUSION

Based on various papers and studies done by various researchers the needs for ASD rehabilitation was realized. Further research helped gain knowledge on the various issues that children with ASD face on a daily basis. The sensitivity issues were researched and it was seen that psychomotor skills is a highly neglected rehabilitation field. Based on various parameters and needs a design was conceived.

This design focused on 4 major grasps which can be incorporated by 5 tasks namely coin insertion, knob turning, key insertion and turning, basketball pick and drop and bowling pick and roll actions. The design was modified to suit the children and therapist. The electronics required were mapped out and added into the design.

Various woods and PVC pipes were taken and the design was developed into a fully self-fabricated model. This model is modular and can be assembled and dismantled for easy transport. Later the flowchart of the electronics was developed and included in the fabrication to give the end product.

In this way a play station for enhancement of psychomotor, cognitive and daily life skills of children with ASD was designed and developed successfully. Hopefully this setup will help children with ASD adapt and get included in the normal routine to have a normal independent lifestyle.

This setup can be further improved by programming a tracking into it. This tracking system can be connected to the therapist's phone via bluetooth. With the tap of a button the information about what cues were required to perform the task can be recorded by the system. The system can be programmed to prepare instant graphs on request and can keep separate data sheets for different children. This system can also be programmed to do image processing to see the improvement in grasping technique of the child in the games.

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