INNOVATION OF DIMENSION SHEET AND MEASUREMENT OF DIFFERENT PARAMETERS IN BRAILLE

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR

THE AWARD OF THE DEGREE

OF

MASTER OF TECHNOLOGY

IN

BIOMEDICAL ENGINEERING

Submitted by

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2K17/BME/02

Under the Supervision of

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CANDIDATE'S DECLARATION

I, Avinash Chandra Dubey, 2K17/BME/02 student of M.Tech in Biomedical Engineering, hereby declare that the project Dissertation titled "INNOVATION OF DIMENSION SHEET AND MEASUREMENT OF DIFFERENT PARAMETERS IN BRAILLE" which is submitted by me to the Department of Biotechnology, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technology, is original and not copied from any source without proper citation. This work has not previously formed the basis for the award of any degree, Diploma Associateship, Fellowship, or other similar title or recognition.

Place: Delhi

Date:24/06/2019 **AVINASH CHANDRA DUBEY**

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CERTIFICATE

I, hereby certify that the Project Dissertation titled " INNOVATION OF DIMENSION SHEET AND MEASUREMENT OF DIFFERENT PARAMETERS IN BRAILLE" which is submitted by Avinash Chandra Dubey, 2K17/BME/02 of Department of Biotechnology, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technology, is a record of the project work carried out by the student under my supervision. To the best of my knowledge this work has not been submitted in part or full for any degree or Diploma to this University or elsewhere.

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ABSTRACT

Braille is a system of raised dot used by visually impaired persons which provides medium to learn language. Braille is composed of Braille character which may single or combined together to form word. In this thesis, I have innovated Dimension sheet which is non-functional and functional. In non-functional Dimension sheet Braille numbers are written in (x, y) form which denote coordinate position with respect to X and Y axis. In functional Dimension sheet X and Y coordinates are drawn with the help of Braille slate, stylus and Braille paper. Different Braille dots are placed at different location of (x, y), example (1, 1), (2, 2), (1, 3), (1, 4), (2, 3), (3, 2), (4, 1), (3, 3), (3, 4), (4, 4). Visually impaired learn the number (x, y) from non-functional Dimension sheet and able to find the given number in functional Dimension sheet. This study show that human has the ability to locate the coordinate position by active touch or haptic system. Students are able to locate the position on functional Dimension sheet with average time taken by student is 55 seconds. Average time taken to locate position in functional Dimension sheet depends on the Braille number in the form of (x, y) written on the non-functional Dimension sheet. Time taken to locate the position in functional Dimension sheet increases with (x, y) on non-functional Dimension sheet showing that time taken to search the given number increases with increase in (x, y) value. Braille reading accuracy of different Braille Dimension sheet for different age group of individuals was determined and it was found that there is very small effect of age on Braille reading accuracy. Braille recognition time for different Braille height was observed and it was found that there is an optimum Braille height for which signal perception through is highest and it takes minimum time to recognize Braille character. Braille dot configuration is important factor in Braille recognition and time taken to recognize Braille character. Time taken to recognize Braille character was highest for 5 and 9 which may be due different configuration. Exclusion zone length for different Dimension sheet was determined and it was that its optimum value is 1.5 cm for which time taken to search Braille character is least. Increase in length of exclusion zone length lead to longer time to search Braille character which lead to high recognition time for Braille Dimension sheet. Hand dominance is other important factor in Braille reading. It was found that the student who uses both hand for Braille reading have higher Braille reading efficiency and they require less time to recognize Braille character in comparison to right handed or left handed student. Different hand

movement pattern has different Braille reading efficiency and it was found that parallel hand movement takes less time in Braille reading in comparison to left mark pattern, split pattern, and scissor pattern.

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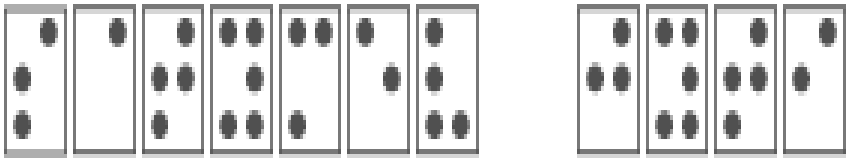

Chapter 1. INTRODUCTION

Braille is an embossed text writing in which each letter of the Latin alphabet has its counterpart in the form of embossed character. Braille is written with embossed paper and it is system through which blind individual can read and write. Braille is an invaluable tool for those who can not use print in extended period of time or in light. Braille has been the major medium of communication for visually impaired individual for more than a century. There has been special Braille code for mathematics, scientific symbols, music, phonetics and other symbol system. Braille dot configuration, Braille dot height, Braille dot number, exclusion zone and hand movement pattern are factors that affect Braille reading. Innovation of Dimension sheet is important for visually impaired people other than reading and writing Braille. There are two types of dimension sheet is discovered, one is non-functional dimension sheet and other is functional dimension sheet. In non-functional dimension sheet, the numbers are written in the form of (X, Y) and other is functional dimension sheet in which coordinated position of X and Y are graphically represented in Braille. Braille reading rate and accuracy was determined in several different age group students and correlation between age and Braille reading accuracy was studied. Braille height is other important factor which help in passing appropriate signal perception. There is an optimum Braille height for which signal perception through hand is highest. Baseline test is perform to test on participant whether they could learn the different character in the form of number written in the form of (X, Y) in dimension sheet. It could test the ability of different age group students in reading and understanding of Braille dimension sheet. Confidence test is perform to test the confidence level in understanding Braille character. Exclusion zone (length) is an area where nothing is placed around Braille cell or cells. Hand dominance refers to whether an individual is right handed or left handed. Hand dominance is an important factor in Braille reading rates.“Literacy is a continuum from basic reading and writing skills all the way up to various technical literacy” (Troughtton,1992, p.14). Literacy skills provides prerequisites for achievement in school to employment and many areas of life (Koenig & Holbrook, 2000). Children who use Braille and print have approximately same literacy development (McCall, 1999). Nolan (1958) stated that before the child can begin learning to read, there must be certain physical abilities and intelligence be present. Highly developed tactile perceptual judgment is required for Braille cells to be identified and pressure used for Braille

reading is in narrow range (Holland, 1934). If the pressure applied is very low then it does not stimulate sufficient number of nerve ending and if excess pressure is applied than it creates general tension and stop the discrimination ability. Blend (1946) in comparison of reading processes between sighted children and blind children, he states that " the final results are the same, the mechanics only differ, while Braille is necessarily a slower medium". He states that " the sense of touch is but another entrance to the mind".Burklin (1932) found that vertical arrangement of Braille dots in Braille cell is the best possible arrangement for Braille reading and readability of the letter of alphabet is determined by configuration of dot and not by number of dot. Fertsch (1947) investigated handedness and hand dominance problem in Braille reading. On the basis of hand dominance, readers are classified into "right hand dominance", "left hand dominace" and " hand equal" groups. Both Burklin (1932) and Fertsch (1942) describes two types of finger movement in Braille reading. One finger usually the right index finger was used for overall view of the word or synthesis. The other left index finger was used for analysis.

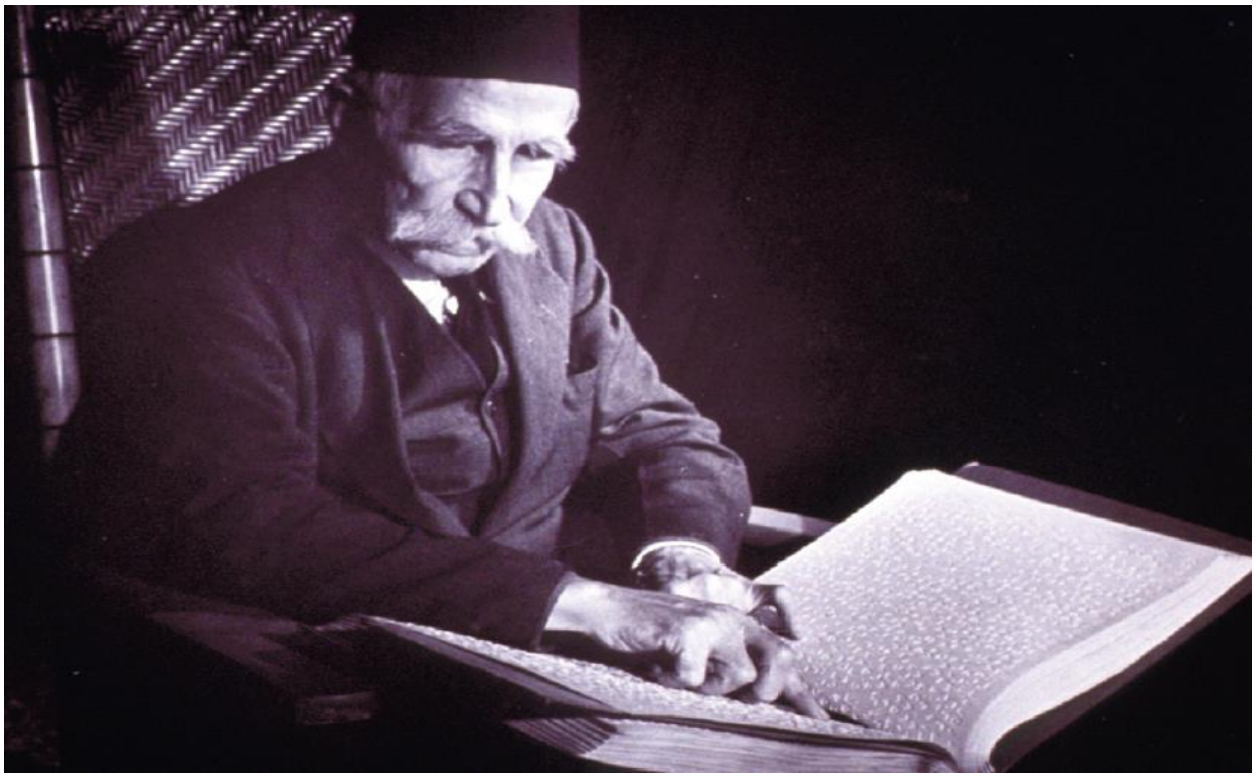

FIGURE 1.1 - A blind man reading a Braille book in 1938 at the New York association of the blind (Source: Image courtesy of the National Library of Medicine)

Chapter 2. LITERATURE REVIEW

2.1 INNOVATION OF NON-FUNCTIONAL AND FUNCTIONAL DIMENSION SHEET

One educator has written, " The children soon learn the shape of words and group of words and later recognize them as a whole words". Another say that " Most blind children rather quickly recognize words as a whole by their shapes". Braille published the first Braille book, *Method of Writing Words,Plain songs by means of Dots, Music, for use by the Blind and Arranged for Them*, in 1829 at age of 20. Haptics is also called active touch and it involve sensors of skin, muscle, tendon, and joints. Importance of hand is known by everyone and it has biological and physical role. Both haptics and vision can feel edges separating 3D surfaces, locate object in relation to observer in near space, can perceive the size of object that are not too large, perceive the texture of surface. There are some tasks that are performed only by active touch or haptics. Haptics can perceive the weight of object, can perceive the hardness of surfaces, perceive the temperature of surfaces. For the education of blind, hand movement and haptic shape information plays an important role. Active touch is important in identifying Braille dot configuration so important in Braille character recognition. Braille character are derive from 1 to 6 dots arranged in 2 column and 3 rows called Braille cell.

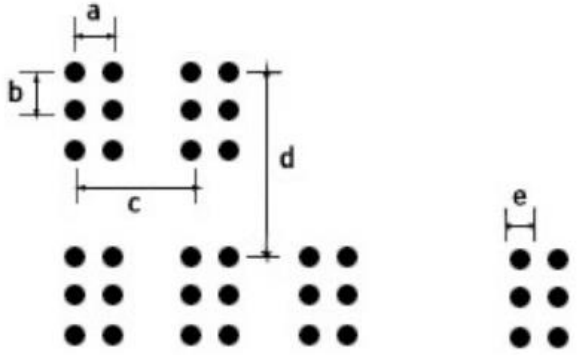

Figure2.1. - Braille Cell Dimension

Table.2.1. Braille Cell Dimension (According to American National Library for the Blind)

Horizontal dot to dot	2.28 mm
Vertical dot to dot	2.28 mm
Cell to cell	6.09 mm
Line to line	10.16 mm
Dot base diameter	
Dot height	0.5 mm

2.2. BRAILLE READING AND ACCURACY

The time taken for tactual perception of words is positively related to number of character it contains. Sum of times require to recognize the Braille character is compared with the time taken to recognize words, it was found that time taken to recognize individual Braille character is shorter. This show that perceptual unit in recognition of Braille word is individual Braille character but not the whole words. If the individual Braille character is perceptual unit in Braille recognition, then the associative burden of the Braille reading process can be assumed to be far greater than that for print. Ecclesiastes tells us that there is," a time to every purpose under the heaven." There has been many study that concern with the determination of relative efficiency of learning by reading and listening in Braille. In comparison to print reading which involve the perception of large wholes, the Braille reading involves the sequential integrative synthesis of the dots (Nolan, Morris and Kederis,1965). The roughness discrimination test has been has been the predictive validity for beginning Braille readers (Nolan,1960; Nolan and Morris,1965). Repeated

reading is most widely researched reading intervention that is successful in improving reading ability for student with and without disability. Braille reading rates are influenced by age, intelligence, number of hours used in studying Braille.

2.3.APPROPRIATE EMBOSSED BRAILLE DOT HEIGHT IN DIMENSION SHEET

The Braille character is composed of single Braille pattern or combination of Braille pattern and two or more character together form a Braille word.

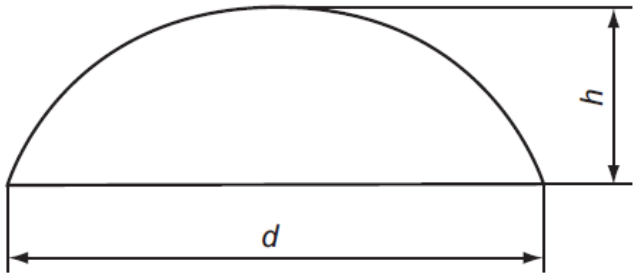

Figure 2.2.- Braille Dot Height

Where *h* is the perpendicular height of Braille dot centre

And *d* is the diameter of base

Height tolerance is the range of height in a given condition. Braille cell height measured using micrometer is significantly lower than microscope, this show that micrometer pressure distort the Braille reduces its height. The Braille dot height of American National Library for the Blind is 0.5mm, Sweden is 0.25mm, England (Interline/ Interpoint) is 0.46mm, France is 0.8mm to 1mm, German greater than or equal to 0.5mm, Australia sign is 0.46 to 0.53mm.

2.4. ROLE OF BRAILLE DOT CONFIGURATION IN CHARACTER RECOGNITION

Braille is a raised dot , punctiform , system of reading and writing employed by the blind. Braille system have literacy code and a special code for writing of music, mathematics and scientific formulae. There are three grade level in literacy code-grade 1, grade 2 and grade 3.

Braille dots are grouped in rectangular cells with three column and two rows.

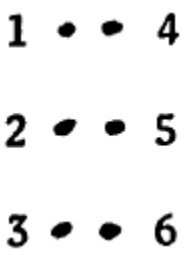

Figure 2.3– Arrangement of dot in Braille cell in row and column

Dots arranged in three column and two rows are numbered 1, 2, 3 in left column and 4, 5, 6 in second column. Braille configuration plays an important role in character recognition. Character is made by single dot or combinations of dot within cell. So there is formation of different configuration of dot for single character. Configuration is made up of a uniform pattern of dots which remain the same in regard to alignment and extension. Braille dot configuration is important factor in Braille reading rate. Burklin (1932) found that vertical arrangement of six dot is the best possible arrangement of dot for Braille reading. He also found that first and second finger of both hand is best preferred for Braille reading but all the finger in Braille reading can be used. Braille dot configuration is important factor in Braille reading rate and Braille recognition. In Braille reading, stimuli encountered are tactual in nature so development of ability of utilize the tactual receptors and hands in coordinated fashion is critical to the Braille reading.

2.5.OPTIMUM EXCLUSION ZONE (LENGTH) FOR DIMENSION SHEET EXPERIMENTS

Exclusion zone is the area where nothing is placed around a Braille cell or cells.

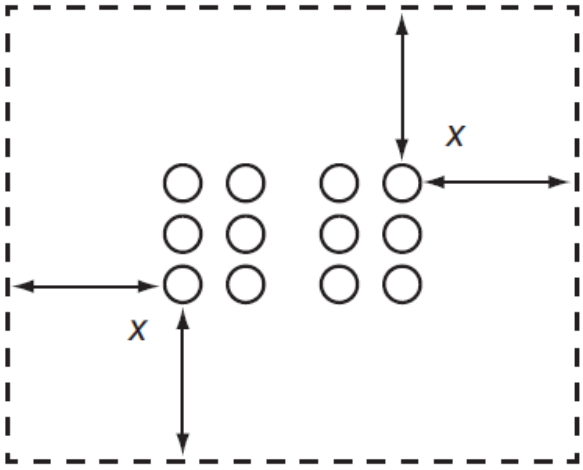

Figure 2.4.Exclusion Zone Length of Braille Cell

Where X is the exclusion zone length.

2.6.HAND MOVEMENT AND HAND MOVEMENT PATTERN

Hand dominance refers to whether an individual is right handed or left handed. The method in which hands are moved in Braille character recognition is important factor in Braille reading (Davidson, Wiles-Kettenmann, Haber & Apelle,1980; Eatman,1942; Gray and Todd,1968; Kusajima,1974; Mangold,1978; Millar,1997; Wormsley,1979). Correlation between pattern of hand movement in Braille reading and faster Braille reading ability suggest that there are some pattern of hand movement are more efficient than other (Bertelson, Mousty& Alimonte,1985; Davidson, Appelle& Haber,1992; Eatman,1942; Gray and Todd,1968; Kusajima,1974; Mangold,1978; Millar,1997; Mousty& Bertelson,1985). Hand movement pattern is divided into two main categories-right handed pattern and left handed pattern based on which hand is used for reading. The other non-reading hand sometimes touches the book but does not read. There are further four grouping of two handed readers- left marks, parallel, split and scissors. In left mark pattern, left hand is static at the beginning of the line while right hand read each line. In parallel pattern, both hands move at all times while reading each line. In split pattern, both hands move together up to the end of each line but at the end the left hand move to the next line while right hand continue to read the previous line. In scissor pattern, both hand are involved in reading but they move independently of each other while reading (Kusajima 1974; Wormsley,1979).

2.7.LANDMARKS IN HISTORY OF EDUCATION FOR BLIND

Landmarks in the history of education of the visually handicapped in India have been

1.) State level decision to establish a Braille press in 1929 to produce books in Braille. Due to non-existence of a uniform Braille code in Indian languages this is not implemented.

2.) Government of India set committee in 1941 to develop a uniform Braille code for Indian languages.

3.) Submission of the Report on Blindness in India (1944) for the service of blind which form the basis for the most of service for blind today.

4.) Ministry of Education in 1946 set up a cell to promote education, training and rehabilitation for the blind.

5.) Development and acceptance of " Bharthi Braille", a common Braille code for Indian languages finalized in November 1950, replacing the earlier codes in the light of certain recommendations made by UNESCO.

6.) Setting up of the first Braille press at Dehradun in 1951.

7.) Establishment of National Association for the Blind in 1952 marking the beginning of concerted voluntary action in the field.

8.) Setting up of first vocational Training Centre for the Adult Blind Women in 1957 at Dehradun.

9.) Establishment of first school for the Blind in 1959 at Rajpur Dehradun by central government.

10.) Institution of first light Engineering course in 1961 at Dehradun.

11.) Establishment of the first National Library for the Blind by the central government in 1962.

12.) Government of India establish National Centre for the Blind Dehradun which brought all the activities of education, training and rehabilitation of blind under one umbrella.

13.) Establishment of the National Institute for the visually Handicapped (NIVH) on 2nd july 1979.

2.8. BRAILLE WRITING DEVICES

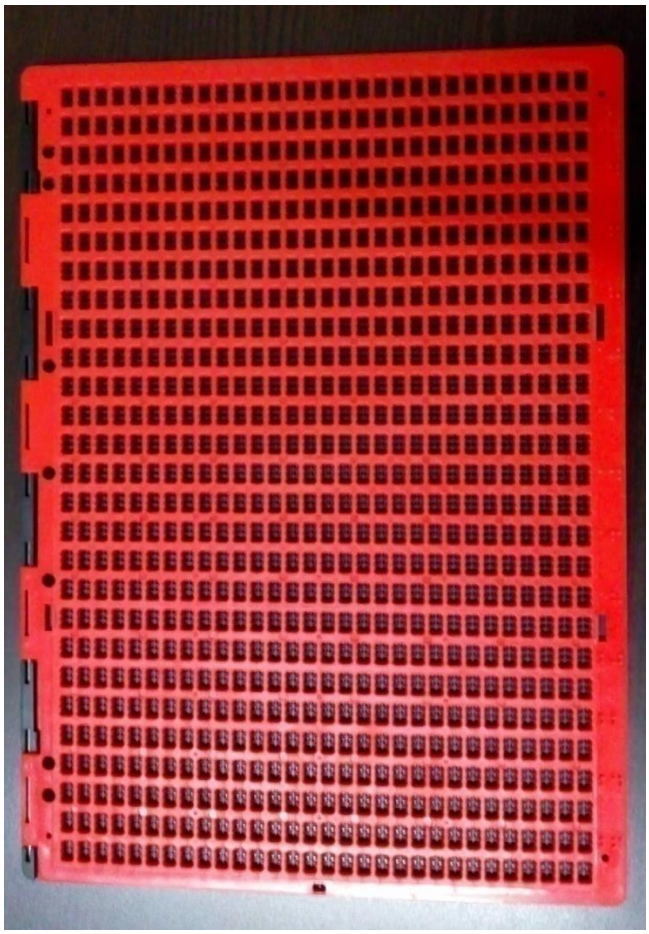

Figure 2.5.Braille Writing Slate

Slate is used to make emboss dots on a Braille paper by the blind person like a pen or pencil is used to write on paper by sighted people. Slate provides the guide for stylus and also it has depressions of six dots in the form two column and three rows by which Braille is written. The dimension of slate is about an average piece of paper which is made up of either metal or plastic. Slate is made up of two flat piece which is hinged and open like a book. The uppermost part of slate has rectangular opening which guide the stylus to write on Braille paper and the lowermost part has depressions of six dots to write Braille character. The slate holds the Braille paper between them and the person writing Braille put forces in the depression which is guided by rectangular opening of uppermost part of slate.

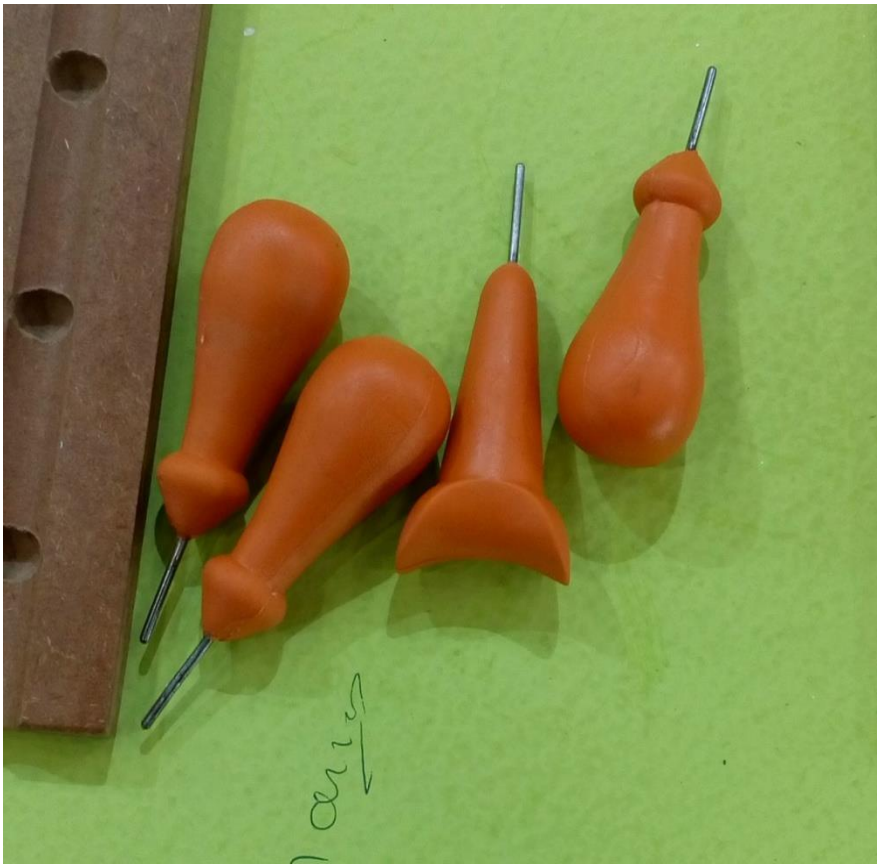

Figure 2.6 - Stylus

The stylus is composed of a pointed metal with a wooden handle. The stylus is used to write Braille by pressing the pointed metal in rectangular opening of slate which contain Braille paper inserted between them. Stylus is very similar to pen or pencil (used by sighted people) and it used to emboss (make a raised design) on Braille paper. Stylus should be emboss dots into the Braille paper from right to left since Braille is read from left to right. Stylus is about two inches long in which one to one and a half is composed of wooden handle with a rounded knob to comfortable held by hand and half inch pointed metal to make emboss dots into the paper.

Figure 2.7-Braille Learning Frame

Braille learning frame is used to learn Braille character of given language. It is also used to verify his answer of Braille character where he makes mistakes in writing or learning Braille. The Braille alphabet, Braille numbers, Braille punctuations and special symbol characters are constructed from six dots. Braille character is the unit of perception in Braille reading. The individual Braille character differs from one other with respect to configuration and number of dots. Braille learning frame is used for training and improvement of individual Braille character. Recognition of Braille character is done by moving the finger on the Braille learning frame and search for the appropriate Braille character.

Figure 2.8. Stylus

Figure 2.9.- Signature Guide Frame

Signature guide frame is a plate which has window to make signature.

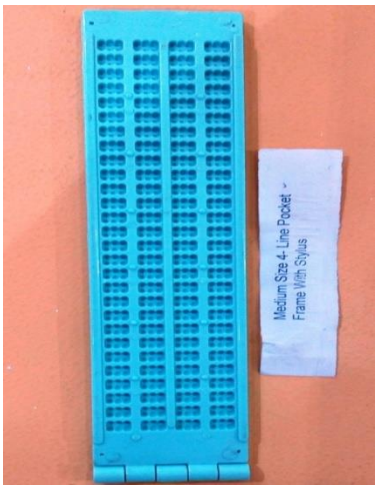

Figure 2.10.-Braille Writing Frame

Pocket Braille frame is used for writing Braille in small character.

Figure 2.11.- Print Braille Writing Frame

Figure 2.12. Geometrical Device

Geometrical devices is used to learn geometry, mathematics and engineering by visually impaired persons. It has Spur Wheel Sets (three in number), a compass, a protractor with a swing arm, and divider. All these devices having dots emboss on the surface. Protractor is used to measure angle and draw angle in geometry. Protractor has the shape of semicircle and a wand is attached to its center of semicircle diameter.

Figure 2.13.Compass with Spur Wheel

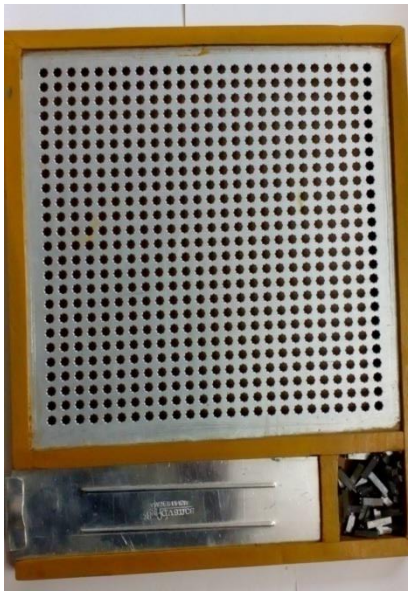

Figure 2.14. Arithmetic and Algebra Frame

Arithmetic frame is used for doing arithmetic by visually impaired people. The surface of frame is made up of aluminum and it is star shaped to place metal type to place according to set system.

Figure 2.15. Arithmetic and Algebra Metal Type

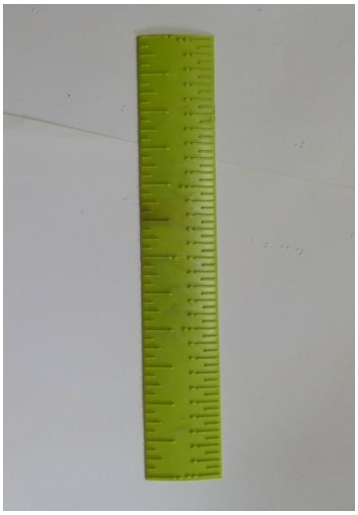

Figure 2.16.Plastic Foot Rule

Foot ruler is used embossed marking for geometrical purpose.

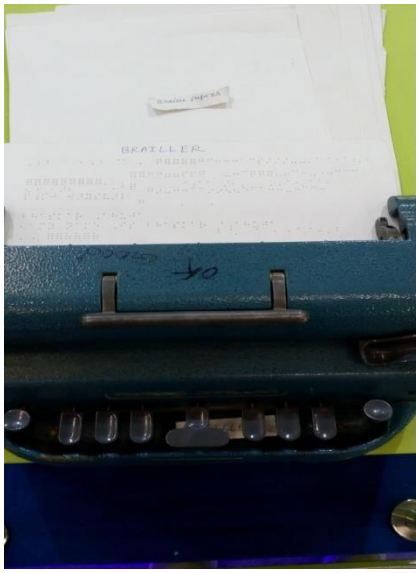

Figure 2.17. Brailler

The Brailler is used to write Braille by visually handicapped person. It has six keys for each dot in a Braille cell, a space bar, a backspace key, a line feed key and a carriage return. Brailler is used for fast writing in Braille having clear dots and it is easy to use.Brailler is equivalent to

typewriter but it contains less number of keys. On the brailler, standard position of keys correspond to dot position 3-2-1-4-5-6 from left to right.

Figure 2.18. Braille Writing Slate

Braille Slate is used for writing Braille. It has wooden board, a paper clamp, a stylus and a metal guide. The clamp is used for tightly holding the Braille paper.

Figure 2.19. Pocket Braille Frame

Figure 2.20.Spur Wheel

Spur wheel is made up of plated metal handle in which wheel having rough and sharp projections are revolving. It is used to draw embossed line which is continuous on the reverse side of Braille paper.

Chapter 3. DATA COLLECTION

3.1. BRAILLE READING AND ACCURACY

The study was conducted at National Association for the Blind, Delhi. Different age group student had participated in the study of Braille reading and accuracy for dimension sheet experiment. Dimension sheet is given to students and time taken to read the characters was determined. Braille character are in the form of numbers (X, Y) written in dimension sheet. Exclusion zone was 1.5 cm for dimension sheet and standard Braille height is used.

3.2.ROLE OF BRAILLE DOT CONFIGURATION IN CHARACTER RECOGNITION

The study was conducted at National Association for the blind, Delhi by the permission of NAB, DELHI and DTU, DELHI. Different age group student had participated for the Braille dot configuration study. Study of dot configuration is done with different Braille numbers written on the dimension sheet. The numbers are written in the form of (X, Y) where X and Y are numbers with regard to coordinate position X and Y respectively. There are different dimension sheet used in this study of size 3.5cm*3 cm, 3cm*3cm, 3cm*2cm, 3cm*2.5cm. Exclusion zone (length) was 1.5cm and standard Braille dot height is used in this study. Dimension sheet is given to students and different aspects of Braille study were done. For this study of role of dot configuration in recognition time, numbers from 0 to 9 were taken and time taken for every character recognition time was noted. After time taken to recognize Braille character was noted, statistical calculation for the correlation between Braille dot configuration and recognition time was done. Also graph of Braille dot character at X axis and character recognition time at Y axis was described. Correlation coefficient calculation was done to find out if there is any effect of dot configuration on Braille recognition time.

3.3. OPTIMUM EXCLUSION ZONE (LENGTH) FOR DIMENSION SHEET EXPERIMENT

The study of exclusion zone experiment was conducted at National Association for the Blind, Delhi. Different age of student had participated in this study by the permission of NAB, DELHI and DTU,DELHI. The students were given different Braille dimension sheets in which numbers was written in the form of (X, Y). The size of dimension sheets were 3cm*3cm, 3.5cm*3cm, 3cm*2cm, 3cm* 2.5cm etc. The numbers written are in uniform distance from the edges and boundary. Dimension sheets of different exclusion zone was given to each students and time taken in every experiments was noted. The exclusion length of 0.5cm, 0.7cm, 1cm, 1.2cm, 1.5cm, 1.8cm and 2cm for different dimension sheets are used in this experiment. Time taken for every different dimension sheets was measured.

3.4. HAND MOVEMENT AND BRAILLE READING EFFICIENCY

The study was conducted at National Association for the Blind, Delhi. Different ages of student was participated in this study by the permission of NAB, DELHI and DTU, DELHI. The student was given different Braille numbers written on the non-functional dimension sheet. The numbers written on the sheet are in the form of (X, Y) on the Braille size of 3.5 cm * 3cm, 3cm* 3cm, 3cm*2cm, 3cm*2.5cm. Exclusion zone for the given sheet is 1.5cm and standard Braille dot height is used. Dimension sheet is given to students of age below 15 years old and time taken was noted during each experiments. Ten students was participated in role of hand dominance in Braille reading efficiency. The ranking of reading efficiency was categorized into poor, average and superior based on the number of error done in reading Braille. Two or less than two error for ten dimension sheet is categorized in superior, three to five errors are categorized in average and greater than five errors are categorized in poor. Twenty students was participated in experiment of hand movement pattern and the effect of hand movement pattern on reading rates are noted.

Chapter 4. EXPERIMENTS

4.1.INNOVATION OF DIMENSION SHEET

Figure 4.1. Non-Functional Dimension Sheet

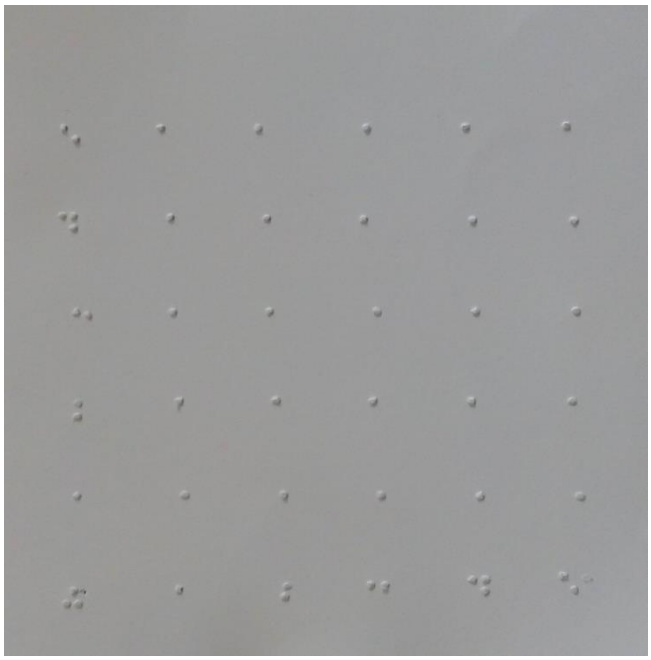

Figure 4.2. Functional Dimension Sheet

Table 4.1. Baseline Performance of Functional Dimension Sheet

Number of Individuals	Non-functional dimension sheet (numbers in the form of x,y)	Individual perform above in functional dimension sheet (number of individuals)
20	(1,1)	18
20	(2,1)	18
20	(3,1)	18
20	(1,2)	18
20	(2,2)	18
20	(3,2)	18
20	(1,3)	18

Table. 4. 2 Average time taken for Functional Dimension Sheet

Number of Individuals	Average time taken to read Non-functional Dimension sheet (in seconds)	Number of student perform above baseline in functional Dimension sheet	Average time taken for functional Dimension sheet (in seconds)
20	10	18	55

Table 4.3 - Average time taken for Functional and Non-functional Dimension Sheet for different (x, y).

Numbers in non-functional Dimension sheet	Average Braille reading time in non functional Dimension sheet (in seconds)	Average time taken to locate position in functional Dimension sheet (in seconds)
(1,1)	10	30
(2,1)	11	33
(3,1)	11	35
(4,1)	12	40
(1,2)	11	33
(2,2)	11	35
(3,2)	12	37
(4,2)	12	40
(1,3)	11	33
(2,3)	12	35
(3,3)	12	37
(4,3)	12	45
(1,4)	11	35
(2,4)	12	38

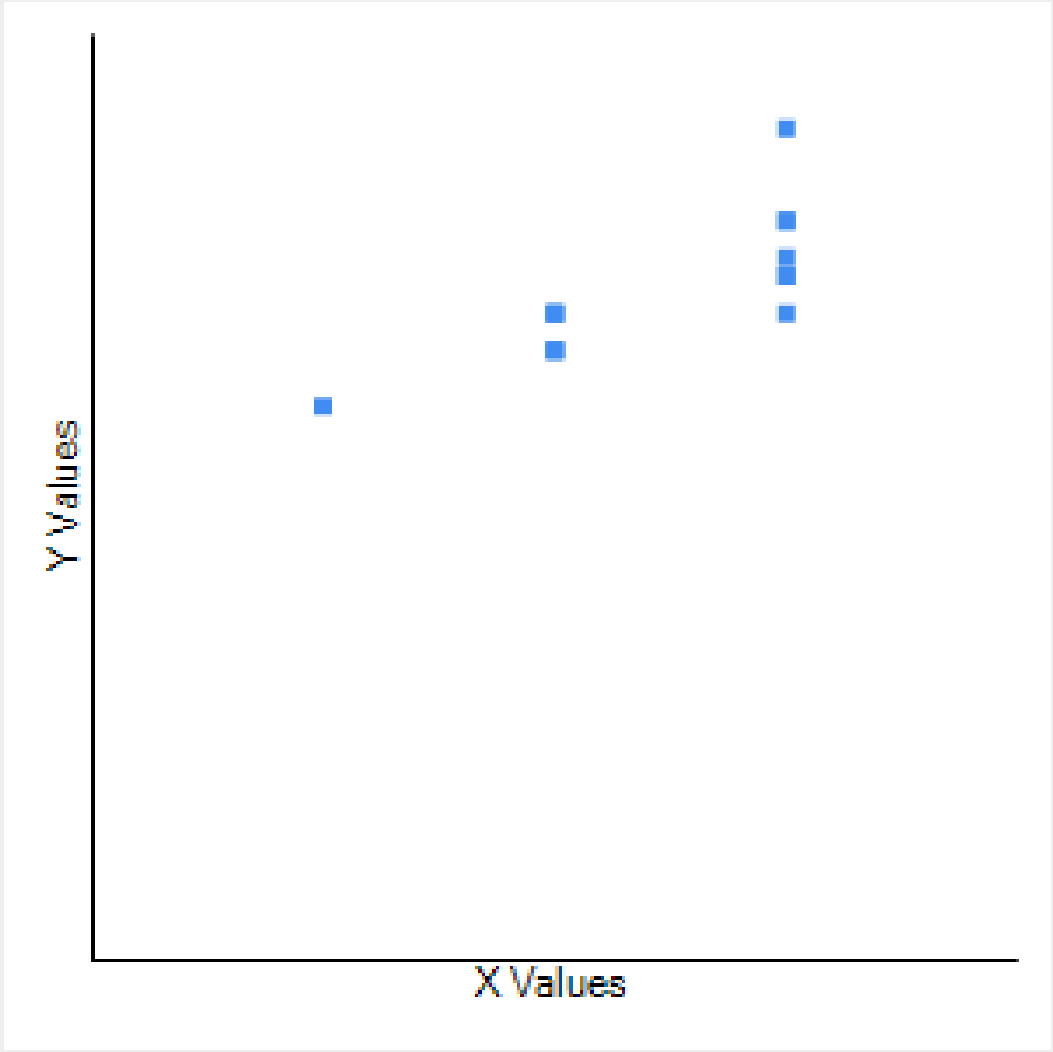

Figure 4.3.Graph showing correlation between numbersin Non-functional Dimension sheet(X) and time taken for Functional Dimension sheet (Y)

4.2BRAILLE READING AND ACCURACY

Table 4.4. Showing Braille Reading Accuracy

Number of students	Age	Male/Female	Class standards	Braille reading accuracy
2	10	MALE	3rd	SUPERIOR
3	10	FEMALE	3rd	SUPERIOR
4	12	MALE	5th	SUPERIOR
3	12	FEMALE	5th	SUPERIOR
1	7	MALE	1st	SUPERIOR

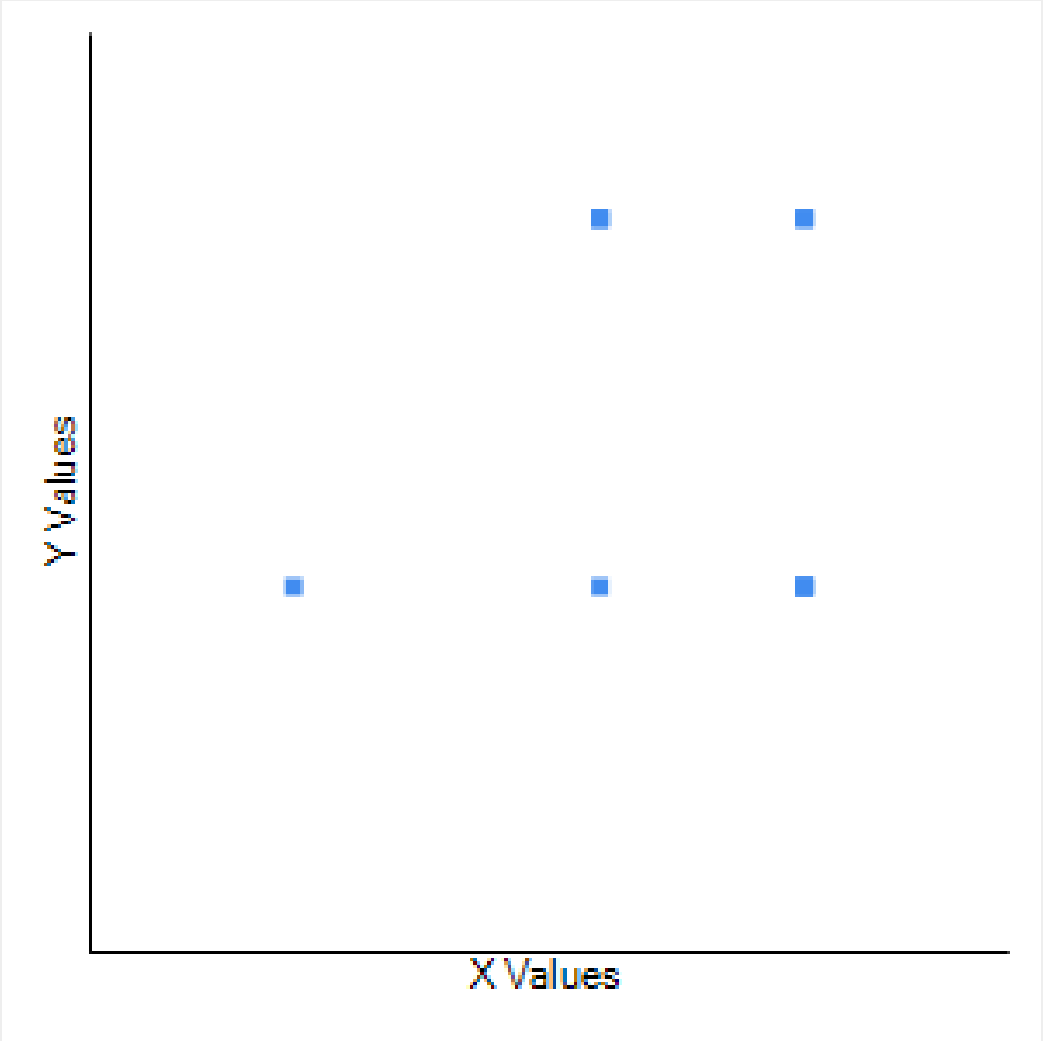

Figure 4.4. Graph showing correlation between age (X) numbers of error/s in Braille reading.

4.3.BRAILLE DOT HEIGHT

Table 4.5 Showing variation of Braille character recognition time with Braille height

Number of students	Age	Male/ Female	Braille Height (in mm)	Character recognition time (in seconds)
2	9	MALE	0.7	10
3	9	FEMALE	0.7	9
2	11	MALE	0.7	8
5	11	FEMALE	0.7	8
2	9	MALE	0.5	10
3	9	FEMALE	0.4	10
2	11	MALE	0.4	11
5	11	FEMALE	0.3	11

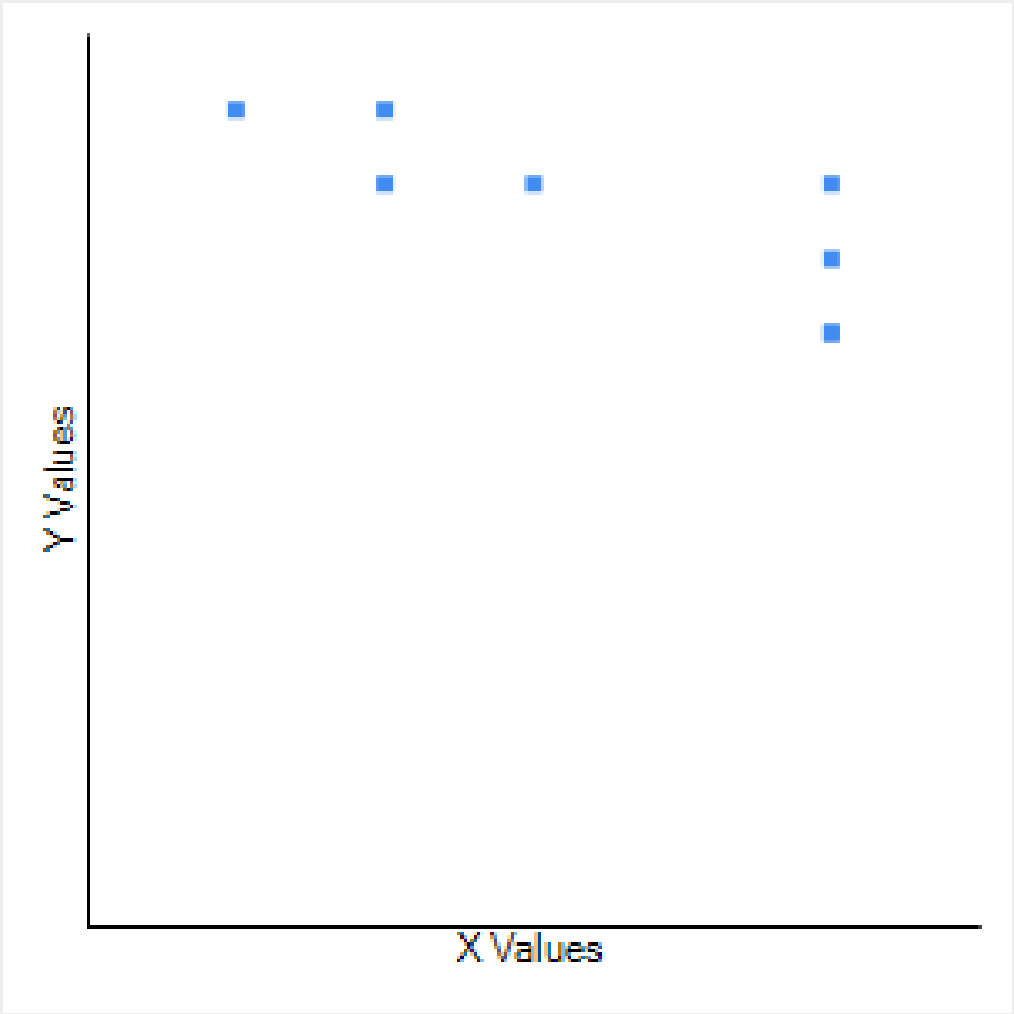

Figure 4.5. Graph showing correlation betweenBraille dot height (X) and Braille recognition time (Y)

4.4.BRAILLE DOT CONFIGURATION

Table 4.6 Role of Braille dot configuration in character recognition.

Braille number (character)	Character recognition time (in seconds)
0	5
1	3
2	4
3	4
4	5
5	8
6	5
7	7
8	6
9	8

4.5.BRAILLE EXCLUSION ZONE (LENGTH)

Table 4.7 Role of Exclusion zone length in Braille of Dimension sheet.

Number of students	Exclusion zone length (in cm)	Average Braille reading time (in seconds)
4	0.5	13
3	0.7	13
4	1	13
5	1.2	11
4	1.5	10
5	1.8	13
4	2	13

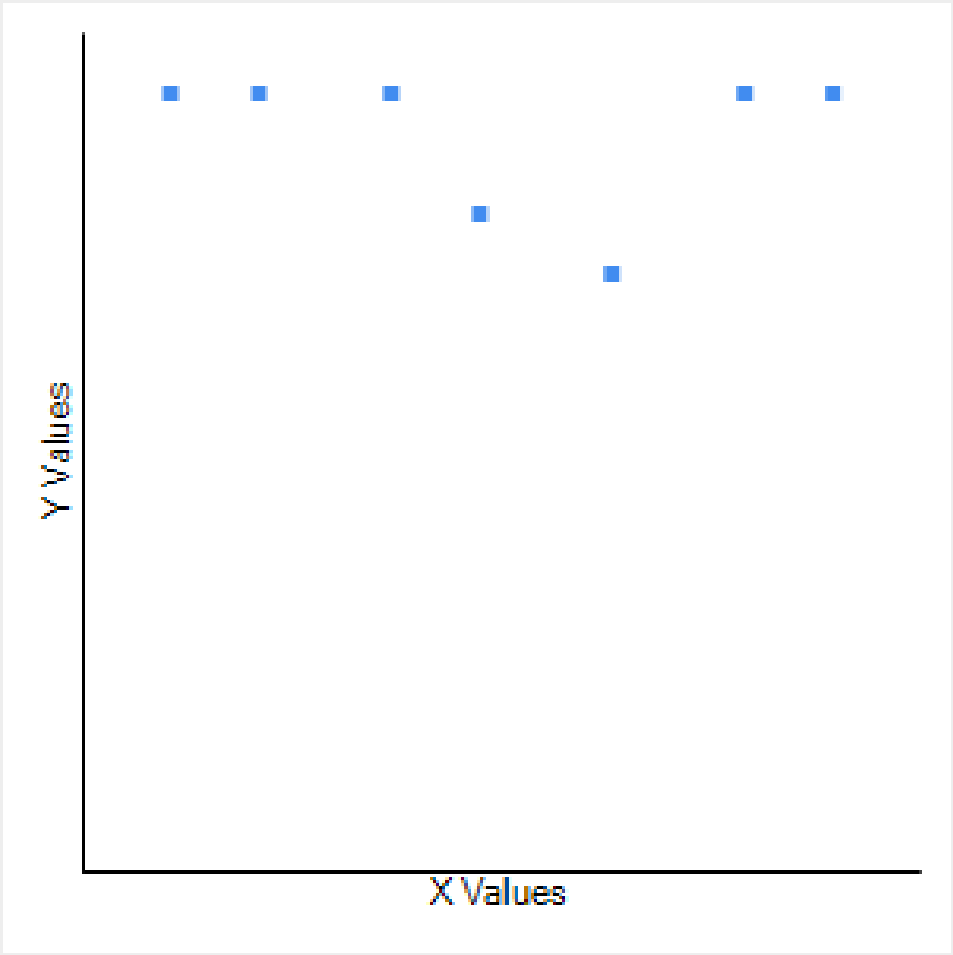

Figure 4.6. Graph showing correlation between Exclusion Zone length (X) and Braille recognition time (Y)

4.6. HAND DOMINANCE AND HAND MOVEMENT PATTERN

Table4.8 Role of Hand dominance in Braille reading efficiency

Number of students	Right handed or left handed (hand dominance)	Braille reading efficiency
10	Right handed	Average
10	left handed	Average
10	Right handed than uses both hand	Superior
10	Left handed than uses both hand	Superior

Table 4.9 Role of Hand movement pattern in Braille reading rate.

Number of students	Hand movement pattern	Reading rate of Braille character (in seconds)
20	Left marks pattern	10
20	Parallel	3
20	Split	7
20	Scissor	8

Chapter 5. DISCUSSION AND CONCLUSION

Braille is a system of raised dot which may be single or in combination to form a Braille character and Braille word is composed of one or more Braille character. Functional Braille readers are blind children or adults who have mastered the mechanics of Braille reading to the extent that they can derive meaningful information from it. Finding of coordinate position by active touch by blind individuals with functional and non-functional dimension sheet was done in this experiment. Functional and non-functional dimension sheet was my own innovation.18 out of 20 individuals have perform above baseline in functional dimension sheet experiment and average time taken was 55 seconds. With increasing numbers in non-functional dimension sheet (X, Y), the time taken for functional sheet increases. This may be due to searching the location by hand. The Pearson correlation coefficient value R is 0.7919 which is a strong positive correlation and it predict that with increase in number (X, Y) in non-functional dimension sheet, the time taken for functional dimension sheet increases. Braille reading and accuracy is determined by many factors like age, sex, hours spending for Braille study, environment etc. Braille is perceived through pressure receptors within the tips of finger so maximum should be utilized for Braille reading. Light pressure is good for tactual perception whereas heavier pressure is believed to spread the perception point and blur the image. Pearson correlation coefficient R for effect of age in Braille reading is 0.0081 which indicate that there is very small effect of age in Braille reading. Height of Braille dot is important in strong signal perception through hand. There is optimum height of Braille dot for which there is highest signal perception. There is high negative Pearson correlation coefficient value of -0.8183 which indicate that with increase in Braille height the time taken to recognize Braille character decreases. Confidence test for different Braille dimension sheet was studied which conclude that with increasing Braille dimension sheet number in non-functional dimension sheet, the confidence level decreases. Number of dots in Braille character is important in Braille reading rate. The correlation coefficient value R is 0.4651 which indicate that there is positive correlation between number of dots and Braille recognition time. Optimum exclusion is the area where nothing is placed around Braille cell or cells. The optimum exclusion zone is 1.5cm for which there is minimum time taken for Braille recognition. With increases in exclusion zone length the time taken is higher, it may be due to long searching time in Braille character. Braille dot

configuration is made by combination of different dot in a cell. Recognition time for different Braille dot configuration was studied which conclude that there is positive correlation between dot configuration and recognition time. It was found that Braille reading is highest when both hands are used in Braille reading. It was also found that minimum time is required in Parallel hand movement pattern.

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