INTERACTIVE MODULE FOR DYSLEXIC CHILDREN

Dissertation submitted in partial fulfillment of the requirement for the degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

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ABSTRACT

One of the key factors about learning is that learning is a process. This process can be described as dynamic one. This means that different parts of the brain interact with other parts and each relies on and interacts with the other. For example the various parts of the brain that deal with visual/auditory/memory/understanding/co-ordination may all be used simultaneously to tackle a task. It is often this simultaneous use of learning skills that is challenging for children with dyslexia. For that reason tasks need to be structured, clarified and preferably focused towards the student's stronger areas of learning.

The aim of the project is to design a module for dyslexic students to improve their auditory and visual skills by the use of interactive multimedia elements. The methodology uses rotary encoders for taking input from dyslexic students, which are further, processed to make valid combination of useful words. The valid combination of words are accompanied by both image and audio of the corresponding word interpreted thereby improving the visual perception and auditory perception of the child respectively and thus making learning a fun filling and a more gradual process for these children with disabilities. Significantly, this research will also contribute to the body of knowledge in providing guidelines for future similar developments.

This project also aims at getting empirically based knowledge about the characteristic features of their study situation and about their perception of their personal dyslectic difficulties. The project has an exploring character and focuses on how students with dyslexia experience and manage their situation.

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DECLARATION BY SCHOLAR

We hereby declare that the work reported in the B-Tech thesis entitled **"INTERACTIVE MODULE FOR DYSLEXIC CHILDREN"** submitted at **Jaypee University of Information Technology,Waknaghat India,** is an authentic record of my work carried out under the supervision of **Dr. Meenakshi Sood**. I have not submitted this work elsewhere for any other degree or diploma.

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CERTIFICATE

This is to certify that the work reported in the B-Tech. thesis entitled **"INTERACTIVE MODULE FOR DYSLEXIC CHILDREN"** which is being submitted by **Basudha (121044), Pushp Bajaj (121056) and Arjun Chauhan (121066)** in fulfillment for the award of degree of Bachelor of Technologyin Electronics and Communication Engineering by the Jaypee University of Information Technology, is the record of their own work carried out by them under my supervision. This work is original and has not been submitted partially or fully anywhere else for any other degree or diploma.

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LIST OF ABBREVIATIONS

LD	Learning Disability
APD	Auditory Processing Disorder
LPD	Language Processing Disorder
NVLD	Non Verbal Learning Disability
ADHD	Attention Deficit Hyperactivity Disorder
RD	Reading Disabilities
FMRI	Functional Magnetic Resonance Imaging
DSM	Diagnostic and Statistical Manual of Mental Disorders

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CHAPTER -1

INTRODUCTION

1.1 LEARNING DISABILITY

A learning disability is a neurological disorder. In simple terms, a learning disability results from a difference in the way a person's brain is "wired."

A learning disability cannot be cured or fixed; it is a lifelong challenge. However, with appropriate support and intervention, people with learning disabilities can achieve success in school, at work, in relationships, and in the community. Parents can help children with learning disabilities achieve such success by encouraging their strengths, knowing their weaknesses, understanding the educational system, working with professionals and learning about strategies for dealing with specific difficulties.

1.1.1 Facts about learning disabilities

a) Fifteen percent of the U.S. population, or one in seven Americans, has some type of learning disability, according to the National Institutes of Health.
b) Difficulty with basic reading and language skills are the most common learning disabilities. As many as 80% of students with learning disabilities have reading problems.
c) Learning disabilities often run in families.
d) Learning disabilities should not be confused with other disabilities such as autism, intellectual disability, deafness, blindness, and behavioral disorders. None of these conditions are learning disabilities. In addition, they should not be confused with lack of educational opportunities like frequent changes of schools or attendance problems. Also, children who are learning English do not necessarily have a learning disability.
e) Attention disorders, such as Attention Deficit/Hyperactivity Disorder (ADHD) and learning disabilities often occur at the same time, but the two disorders are not the same.

1.1.2 Common learning disabilities

a) Auditory Processing Disorder

Also known as Central Auditory Processing Disorder, this is a condition that adversely affects how sound that travels unimpeded through the ear is processed or interpreted by the brain. Individuals with APD do not recognize subtle differences between sounds in words, even when the sounds are loud and clear enough to be heard. They can also find it difficult to tell where sounds are coming from, to make sense of the order of sounds, or to block out competing background noises.

b) Dyscalculia

Dyscalculia is a brain-based condition that makes it hard to make sense of numbers and math concepts. Some kids with dyscalculia can't grasp basic number concepts. They work hard to learn and memorize basic number facts. They may know what to do in math class but don't understand why they're doing it. In other words, they miss the logic behind it.

c) Dysgraphia

Dysgraphia is a deficiency in the ability to write, primarily handwriting, but also coherence. Dysgraphia is a transcription disability, meaning that it is a writing disorder associated with impaired handwriting, orthographic coding (orthography, the storing process of written words and processing the letters in those words), and finger sequencing (the movement of muscles required to write). It often overlaps with other learning disabilities such as speech impairment, attention deficit disorder, or developmental coordination disorder. In the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV), dysgraphia is characterized as a learning disability in the category of written expression when one's writing skills are below those expected given a person's age measured through intelligence and age appropriate education. The DSM is not clear in whether or not writing refers only to the motor skills involved in writing, or if it also includes orthographic skills and spelling.

d) Dyslexia

Dyslexia, also known as reading disorder, is characterized by trouble with reading despite normal intelligence. Different people are affected to varying degrees. Problems may include difficulties in spelling words, reading quickly, writing words, "sounding out" words in the head, pronouncing words when reading aloud and understanding what one reads. Often these difficulties are first noticed at school. When someone who previously could read loses their ability, it is known as alexia. The difficulties are involuntary and people with this disorder have a normal desire to learn.

e) Language Processing Disorder

A specific type of Auditory Processing Disorder While an APD affects the interpretation of all sounds coming into the brain (e.g., processing sound in noisy backgrounds or the sequence of sounds or where they come from), a Language Processing Disorder (LPD) relates only to the processing of language. LPD can affect expressive language (what you say) and/or receptive language (how you understand what others say).

f) Non-Verbal Learning Disabilities

Non-Verbal Learning Disabilities affects a child's social skills, but not his speech or writing skills. Typically, an individual with NLD (or NVLD) has trouble interpreting nonverbal cues like facial expressions or body language, and may have poor coordination.

g) Visual Perceptual/Visual Motor Deficit

A disorder that affects the understanding of information that a person sees, or the ability to draw or copy.A characteristic seen in people with learning disabilities such as Dysgraphia or Non-verbal LD, it can result in missing subtle differences in shapes or printed letters, losing place frequently, struggles with cutting, holding pencil too tightly, or poor eye/hand coordination.

h) ADHD

A disorder that includes difficulty in staying focused and paying attention, difficulty in controlling behavior and hyperactivity. Although ADHD is not considered a learning disability, research indicates that from 30-50 percent of children with ADHD also have a specific learning disability, and that the two conditions can interact to make learning extremely challenging.

i) Dyspraxia

A disorder that is characterized by difficulty in muscle control, which causes problems with movement and coordination, language and speech, and can affect learning.Although not a learning disability, dyspraxia often exists along with dyslexia, dyscalculia or ADHD.

j) Executive Functioning

Executive functioning issues aren't considered a disability on their own. They're weaknesses in a key set of mental skills. And they often appear in kids with learning and attention issues. Executive functions consist of several mental skills that help the brain organize and act on information. These skills enable people to plan, organize, remember things, prioritize, pay attention and get started on tasks. They also help people use information and experiences from the past to solve current problems.

k) Memory

Three types of memory are important to learning. Working memory, short-term memory and long-term memory are used in the processing of both verbal and non-verbal information. If there are deficits in any or all of these types of memory, the ability to store and retrieve information required to carry out tasks can be impaired.

1.2 UNDERSTANDING DYSLEXIA

The word dyslexia is derived from two Greek words: “dys” which means “difficulty” and “lexia” which means “words”. Dyslexia therefore stands for impairment in the ability to read.

One of the most complete definitions of dyslexia comes from over 20 years of research:

“Dyslexia is a specific learning disability that is neurobiological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction.”[1]

Figure 1.1: Understanding Dyslexia

“No other disabling condition affects so many people and yet has such a low public profile and low level of understanding as LD”. Lokerson [2] defined dyslexia as a severe difficulty in understanding or using one or more areas of language, including listening, speaking, reading, writing and spelling. Joffe [3] found that dyslexic students would not only have trouble in reading, writing and spelling, but also in mathematics. According to world research figures, 1 in 5 people suffer from dyslexia. According to the International Dyslexia Association [4], 10%-15% of the world population is suffering from dyslexia, but only 5% of people with dyslexia are ever properly diagnosed and given proper treatment and conditioned.

Dyslexia is not a sign of low intelligence or laziness. It's also not due to poor vision. It's a common condition that affects the way the brain processes written and spoken language. Dyslexia is an enigmatic mix of distinctive strengths and creativeness as well as a cluster of difficulties.

Dyslexic children are having abnormal difficulties in reading, spelling and writing. Therefore, the way these children think is always different from the normal ones. Different people are affected to varying degrees. Problems may include difficulties in spelling words, reading quickly, writing words, "sounding out" words in the head, pronouncing words when reading aloud and understanding what one reads.

Dyslexics can be extraordinarily talented, multidimensional thinkers, highly creative and produce magnificent ideas. People with dyslexia are often very creative. It's unclear whether such creativity comes from thinking outside the box or from having a brain that's "wired" a bit differently. This can be proven by taking the historic personalities as examples as Thomas Edison, John F. Kennedy, Leornado Da Vinci, Albert Einstein, and many others [5, 6]). Albert Einstein was a dyslexic and genius that justifies that dyslexia has nothing to do with intelligence.

1.2.1 TYPES OF DYSLEXIA

a) Primary Dyslexia

"Primary Dyslexia" is a genetic form. It is the most common form of Dyslexia. Dyslexics in this group typically experience problems with letter and number identification, spelling, reading, arithmetic, measurement, time, instructions and other skill sets that are normally performed by the left hemisphere. These Dyslexics are right brain dominant thinkers.

The majority of the world's population processes information primarily from the left which is linear and sequential by nature. They learn best with a step-by-step approach.

Right brain thinkers however respond well to learning with the "big picture" or overview of everything, whole images of words rather than phonics and relating all learning to real things or concepts. They see the "forest before the trees". In other words, they have to see the conclusion of anything before they can see the parts, sequences or meaning of a subject. The problem for these Dyslexics is that general teaching methods in many schools worldwide are organized primarily for the left brain student.

b) Secondary Dyslexia

Developmental Dyslexia **or** Secondary Dyslexia is caused by problems with brain development in a fetus that causes impaired neurological abilities in word recognition and spelling. The difficulties and severity of this condition generally improves with age. The child may experience Dyslexic symptoms throughout childhood but can perform well in college if they receive proper instruction. These children generally respond well to phonics.

c) Trauma Dyslexia

"Trauma Dyslexia" is caused by a serious illness or brain injury. Dyslexic symptoms can develop due to damage to the hearing from continuous flu, cold or ear infections in young children, the child cannot hear sounds in words or "phonemes" so they have a difficult time with sounding words out, spelling and learning to read.

1.2.2 SYMPTOMS OF DYSLEXIA

A. Preschool

A preschool-age child may:

a) Talk later than most children.

b) Have more difficulty than other children pronouncing words. For example, the child may read aloud "maw lower" instead of "lawn mower."

c) Be slow to add new vocabulary words and be unable to recall the right word.

d) Have trouble learning the alphabet, numbers, days of the week, colors, shapes, how to spell, and how to write his or her name.

e) Have difficulty reciting common nursery rhymes or rhyming words. For example, the child may not be able to think of words that rhyme with the word "boy," such as "joy" or "toy."

f) Be slow to develop fine motor skills. For example, your child may take longer than others of the same age to learn how to hold a pencil in the writing position, use buttons and zippers, and brush his or her teeth.

g) Have difficulty separating sounds in words and blending sounds to make words.

B. Kindergarten through grade 4

Children in kindergarten through fourth grade may:

a) Have difficulty reading single words that are not surrounded by other words.

b) Be slow to learn the connection between letters and sounds.

c) Confuse small words such as "at" and "to," or "does" and "goes."

d) Make consistent reading and spelling errors, including:

e) Letter reversals such as "d" for "b."

f) Word reversals such as "tip" for "pit."

g) Inversions such as "m" and "w" and "u" and "n."

h) Transpositions such as "felt" and "left."

i) Substitutions such as "house" and "home."

C. Grades 5 through 8

Children in fifth through eighth grade may:

a) Read at a lower level than expected.

b) Reverse letter sequence such as "soiled" for "solid," "left" for "felt."

c) Be slow to recognize and learn prefixes, suffixes, root words, and other reading and spelling strategies.

d) Have difficulty spelling, and he or she may spell the same word differently on the same page.

e) Avoid reading aloud.

f) Have trouble with word problems in math.

g) Write with difficulty or have illegible handwriting. His or her pencil grip may be awkward, fistlike, or tight.

h) Avoid writing.

i) Have slow or poor recall of facts.

1.2.3 SKILLS AFFECTED BY DYSLEXIA

Dyslexia doesn't just affect reading and writing. Here are some everyday skills and activities your child may be struggling with because of this learning issue:

a) **Social skills:** There are several ways dyslexia can affect your child's social life. Struggling in school can make your child feel inferior around other kids. Your child may stop trying to make new friends or may avoid group activities. Your child may also have trouble understanding jokes or sarcasm. You can help your child decode humor and also try different strategies to improve self-esteem.

b) **Listening comprehension:** People with dyslexia tend to be better listeners than readers. But dyslexia can make it hard to filter out background noise. This means your child could have trouble following what the teacher is saying in a noisy classroom. Sitting near the teacher can help reduce distractions.

c) **Memory:** Kids with dyslexia can take so long to read a sentence that they may not remember the sentence that came before it. This makes it tough to grasp the meaning of the text. Listening to an audio version or using other kinds of technology can help.

d) **Navigation:** Children with dyslexia may struggle with spatial concepts such as "left" and "right." This can lead to fears about getting lost in school hallways and other familiar places. Using a buddy system can help with transitioning from class to class.

e) **Time management:** Dyslexia can make it hard to tell time or stick to a schedule. A cell phone alarm, picture schedule and other prompts can help keep kids (and adults) on track.

1.2.4 COMMON MISUNDERSTANDINGS ABOUT DYSLEXICS

a) **Writing letters and words backwards are symptoms of dyslexia.**

Writing letters and words backwards are common in the early stages of learning to read and write among average and dyslexic children alike. It is a sign that orthographic representations (i.e., letter forms and spellings of words) have not been firmly established, not that a child necessarily has a reading disability [7]

b) **Reading disabilities are caused by visual perception problems.**

The current consensus based on a large body of research [8] is that dyslexia is best characterized as a problem with language processing at the phoneme level, not a problem with visual processing.

c) **If you just give them enough time, children will outgrow dyslexia.**

There is no evidence that dyslexia is a problem that can be outgrown. There is, however, strong evidence that children with reading problems show a continuing persistent deficit in their reading rather than just developing later than average children [9]. More strong evidence shows that children with dyslexia continue to experience reading problems into adolescence and adulthood [10]

d) **More boys than girls have dyslexia.**

Longitudinal research shows that as many girls as boys are affected by dyslexia [11]. There are many possible reasons for the over identification of males by schools, including greater behavioral acting out and a smaller ability to compensate among boys. More research is needed to determine why.

e) **Dyslexia only affects people who speak English.**

Dyslexia appears in all cultures and languages in the world with written language, including those that do not use an alphabetic script such as Korean and Hebrew. In English, the primary difficulty is accurate decoding of unknown words. In consistent orthographies such as German or Italian, dyslexia appears more often as a problem with fluent reading – readers may be accurate, but very slow [12]

f) **People with dyslexia will benefit from colored text overlays or lenses.**

There is no strong research evidence that intervention using colored overlays or special lenses has any effect on the word reading or comprehension of children with dyslexia [13].

g) **A person with dyslexia can never learn to read.**

This is simply not true. The earlier children who struggle are identified and provided systematic, intense instruction, the less severe their problems are likely to be [14]. With adequately intensive instruction, however, even older children with dyslexia can become accurate, albeit slow readers.

1.3 MOTIVATION

Education is both the means as well as the end to a better life. It is a movement from darkness to light. Without education, people get caught in the inter-generational cycles of poverty and backwardness. Seven decades have passed after independence but still, India struggles to achieve a literacy rate of over 90 percent. Providing quality education to all children of India should be the top priority of all.

One of the key factors about learning is that learning is a process. This process can be described as dynamic one. This means that different parts of the brain interact with other parts and each relies on and interacts with the other. For example the various parts of the brain that deal with visual/auditory/memory/understanding/co-ordination may all be used simultaneously to tackle a task. It is often this simultaneous use of learning skills that is challenging for children with dyslexia. For that reason tasks need to be structured, clarified and preferably focused towards the student’s stronger areas of learning.

The intention of the project is to make children grasp more by experimenting and building. Children with dyslexia are known to learn better through interactive objects and self-learning. Our project will help such children learn to spell properly with an intuitive interface. All we aim for children in age group of 4-10 years is to play with interactive alphabets of the English library and ultimately display the dictionary meaning for those valid words that they accidentally made.

1.4 OBJECTIVES

The main aim of the project is to help dyslexic children learn words and improve their vocabulary without dealing with a much more complex interface. It is also much more fun to use this project to help children of lower age groups that are not mentally challenged, to learn words as they prefer a physical interface instead of a software or book.

To make the whole module more interactive instead of having a predefined database of images, the module will load real time images from the web. A special algorithm will be designed that will always load the best possible images out of all the available options from the goggle image search engine.

Also the valid words generated will also be accompanied by their respective dictionary meanings. Thus enhancing the vocabulary of the child in best possible way

Apart from taking the character input using rotary encoders, 3D printed prototype is also used to make the module more interactive. It can be given to the children as an educational toy.

Figure 1.2: Proposing Solution for Dyslexic Children.

Children will set the respective characters on the dial in the same way as a combination is set in case of cycle locks. And after finalizing the word the software part will boot up, taking the input of characters from this module rather than using rotary encoders. The intention of the project is to make children grasp more by experimenting and building. All we aim for children in age group of 4-10 years is to play with interactive alphabets of the English library and ultimately display the dictionary meaning for those valid words that they accidentally made.

CHAPTER 2

NEUROBIOLOGICAL FACTORS

2.1 AREAS OF THE BRAIN RELATED TO LANGUAGE AND READING

The human brain is a complex organ that has many different functions. It controls the body and receives, analyzes, and stores information.

The brain can be divided down the middle lengthwise into a right and a left hemisphere. Most of the areas responsible for speech, language processing, and reading are in the left hemisphere, and for this reason we will focus all of our descriptions and figures on the left side of the brain. Within each hemisphere, we find the following four brain lobes as shown in figure 2.1:

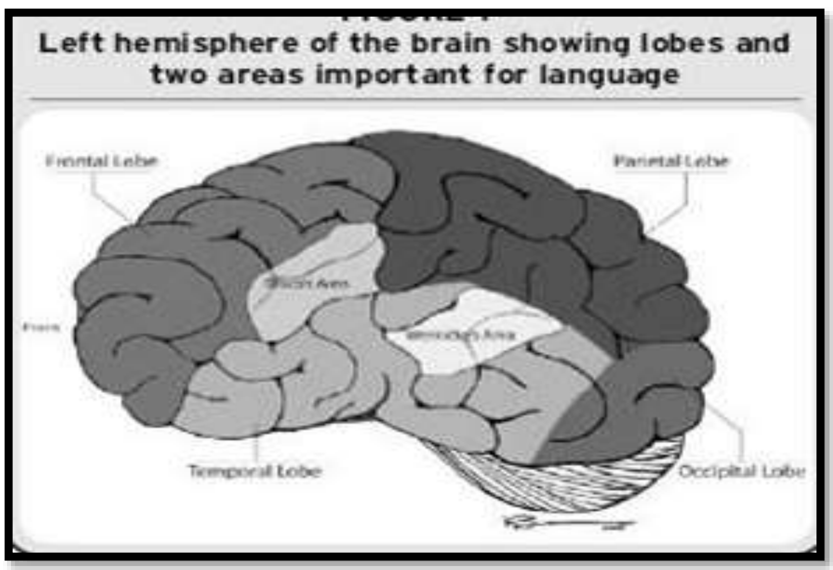

Figure 2.1: BrainLobes

a) The **frontal lobe** is the largest and responsible for controlling speech, reasoning, planning, regulating emotions, and consciousness.

   In the 19th century, Paul Broca was exploring areas of the brain used for language and noticed a particular part of the brain that was impaired in a man whose speech became limited after a stroke. This area received more and more attention, and today we know that Broca's area, located here in the frontal lobe, is important for the organization, production, and manipulation of language and speech [15] Areas of the frontal lobe are also important for silent reading proficiency [16].

b) The **parietal lobe** is located farther back in the brain and controls sensory perceptions as well as linking spoken and written language to memory to give it meaning so we can understand what we hear and read.
c) The **occipital lobe**, found at the back of the head, is where the primary visual cortex is located. Among other types of visual perception, the visual cortex is important in the identification of letters.
d) The **temporal lobe** is located in the lower part of the brain, parallel with the ears, and is involved in verbal memory.

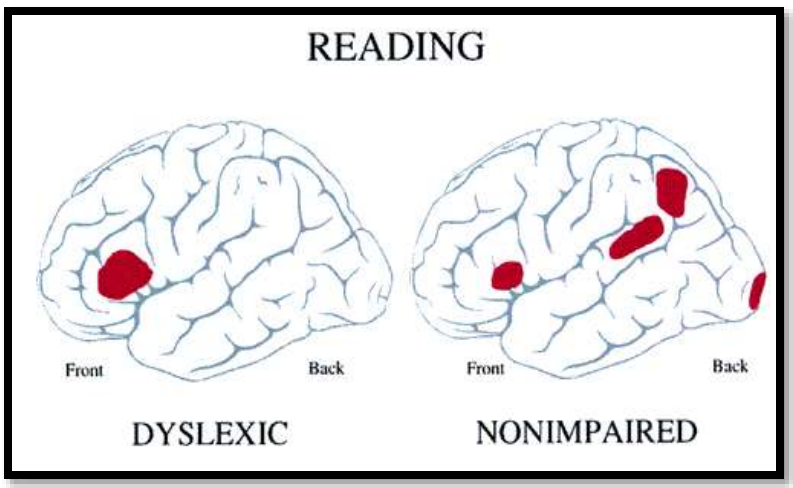

Figure 2.2: Dyslexic v/s Normal Brain

Figure 2.2 shows the difference between a dyslexic and a non dyslexic brain. It is clearly visible from the figure that the brain of a non dyslexic person has all the four lobes present in it. But in case of a dyslexic person's brain three of the lobes are missing which creates problem for them.

In addition, converging evidence suggests that two other systems, which process language within and between lobes, are important for reading as shown in figure 2.3 below.

The first is the **left parietotemporal system** that appears to be involved in word analysis – the conscious, effortful decoding of words. This region is critical in the process of mapping letters and written words onto their sound correspondences – letter sounds and spoken words [17]. This area is also important for comprehending written and spoken language.

The second system that is important for reading is the **left occipitotemporal area**. This system seems to be involved in automatic, rapid access to whole words and is a critical area for skilled, fluent reading.

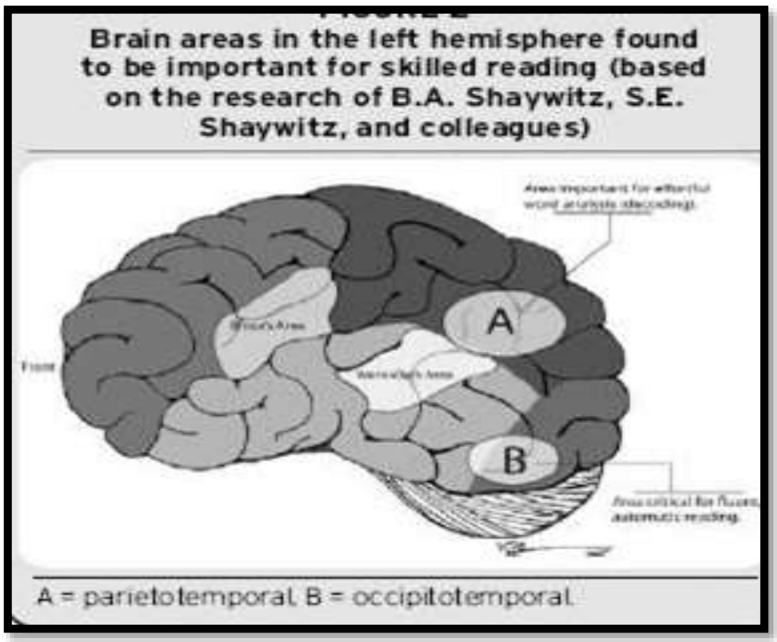

Figure 2.3: Brain Areas Important For Reading

2.2 BRAIN IMAGING RESEARCH AND DYSLEXIA

2.2.1 STRUCTURAL BRAIN DIFFERENCES

Studies of structural differences in the brains of people of all ages show differences between people with and without reading disabilities.

The brain is chiefly made up of two types of material: gray matter and white matter. Gray matter is what we see when we look at a brain and is mostly composed of nerve cells. Its primary function is processing information.

White matter is found within the deeper parts of the brain, and is composed of connective fibers covered in myelin, the coating designed to facilitate communication between nerves. White matter is primarily responsible for information transfer around the brain.

Booth and Burman (2001) found that people with dyslexia have less gray matter in the left parietotemporal area than no dyslexic individuals. Having less gray matter in this region of the brain could lead to problems processing the sound structure of language (phonological awareness).

Many people with dyslexia also have less white matter in this same area than average readers, which is important because more white matter is correlated with increased reading skill [18]. Having less white matter could lessen the ability or efficiency of the regions of the brain to communicate with one another.

Other structural analyses of the brains of people with and without RD have found differences in hemispherical asymmetry. Specifically, most brains of right-handed, nondyslexic people are asymmetrical with the left hemisphere being larger than the same area on the right.

In contrast, Heim and Keil (2004) found that right-handed people with dyslexia show a pattern of symmetry (right equals left) or asymmetry in the other direction (right larger than left). The exact cause of these size differences is the subject of ongoing research, but they seem to be implicated in the reading and spelling problems of people with dyslexia.

2.2.2 FUNCTIONAL BRAIN DIFFERENCES

We lack space here for a detailed explanation of imaging techniques. For excellent descriptions of several techniques, readers are directed to Papanicolaou, Pugh, Simos, and Mencl (2004) and Richards (2001).

One commonly used method for imaging brain function is functional magnetic resonance imaging (FMRI), a noninvasive, relatively new method that measures physiological signs of neural activation using a strong magnet to pinpoint blood flow. This technique is called "functional" because participants perform tasks while in (or under) the magnet, allowing measurement of the functioning brain rather than the activity of the brain at rest.

Several studies using functional imaging techniques that compared the brain activation patterns of readers with and without dyslexia show potentially important patterns of differences. We might expect that readers with RD would show under activation in areas where they are weaker and over activation in other areas in order to compensate, and that is exactly what many researchers have found .

This type of functional imaging research has just begun to be used with children. This is in part because of the challenges involved in imaging children, including the absolute need for the participant's head to remain motionless during the scanning.

We will present the largest, best-specified study as an example of these new findings with children. Shaywitz et al. (2002) studied 144 right-handed children with and without RD on a variety of in- and out-of-magnet tasks. They compared brain activation between the two groups of children on tasks designed to tap several component processes of reading:

a) identifying the names or sounds of letters
b) sounding out nonsense words
c) sounding out and comparing meanings of real words

The nonimpaired readers had more activation in all of the areas known to be important for reading than the children with dyslexia.

Shaywitz et al. (2002) also found that the children who were good decoders had more activation in the areas important for reading in the left hemisphere and less in the right hemisphere than the children with RD.

They suggested that for children with RD, disruption in the rear reading systems in the left hemisphere that are critical for skilled, fluent reading leads the children to try and compensate by using other, less efficient systems .

This finding could explain the common experience in school that even as children with dyslexia develop into accurate readers, their reading in grade-level text is often still slow and labored without any fluency [19].

In summary, the brain of a person with dyslexia has a different distribution of metabolic activation than the brain of a person without reading problems when accomplishing the same language task. There is a failure of the left hemisphere rear brain systems to function properly during reading.

Furthermore, many people with dyslexia often show greater activation in the lower frontal areas of the brain. This leads to the conclusion that neural systems in frontal regions may compensate for the disruption in the posterior area .This information often leads educators to wonder whether brain imaging can be used as a diagnostic tool to identify children with reading disabilities in school.

CHAPTER 3

TECHNOLOGIES EMPLOYED

A rotary encoder, also called a shaft encoder, is an electro-mechanical device that converts the angular position or motion of a shaft or axle to an analog or digital code.

There are two main types: absolute and incremental (relative). The output of absolute encoders indicates the current position of the shaft, making them angle transducers. The output of incremental encoders provides information about the motion of the shaft, which is typically further processed elsewhere into information such as speed, distance and position.

Rotary encoders are used in many applications that require precise shaft unlimited rotation—including industrial controls, robotics, special purpose photographic lenses, computer input devices (such as optomechanical mice and trackballs), controlled stress rheometers, and rotating radar platforms.

3.1 HARDWARE IMPLEMENTATION

3.1.1 ENCODER TECHNOLOGIES

a) **Conductive**: A series of circumferential copper tracks etched onto a PCB is used to encode the information. Contact brushes sense the conductive areas. This form of encoder is now rarely seen except as a user input in digital millimeters.
b) **Optical**: This uses a light shining onto a photodiode through slits in a metal or glass disc. Reflective versions also exist. This is one of the most common technologies. Optical encoders are very sensitive to dust.
c) **On Axis Magnetic**: This technology typically uses a specially magnetized 2 pole neodymium magnet the same size as the motor shaft that typically requires a custom motor shaft be used. The accuracy is very bad and does not allow many resolution options. This technology does not typically offer UVW or Z pulse outputs. Due to the 2 pole magnet there is lots of jitter on the output due to the internal interpolation.

d) **Off Axis Magnetic**: This technology typically employs the use of rubber bonded ferrite magnets attached to a metal hub. This offers flexibility in design and low cost for custom applications. Due to the flexibility in many off axis encoder chips they can be programmed to accept any number of pole widths so the chip can be placed in any position required for the application. Magnetic encoders operate in harsh environments where optical encoders would fail to work.

3.1.2 ABSOLUTE AND INCREMENTAL ENCODERS

An "absolute" encoder maintains position information when power is removed from the system. The position of the encoder is available immediately on applying power. The relationship between the encoder value and the physical position of the controlled machinery is set at assembly; the system does not need to return to a calibration point to maintain position accuracy. An "incremental" encoder accurately records changes in position, but does not power up with a fixed relation between encoder state and physical position. Devices controlled by incremental encoders may have to "go home" to a fixed reference point to initialize the position measurement. A multi-turn absolute rotary encoder includes additional code wheels and gears. A high-resolution wheel measures the fractional rotation, and lower-resolution geared code wheels record the number of whole revolutions of the shaft.

An absolute encoder has multiple code rings with various binary weightings which provide a data word representing the absolute position of the encoder within one revolution. This type of encoder is often referred to as a parallel absolute encoder.

An incremental encoder works differently by providing an A and a B pulse output that provide no usable count information in their own right. Rather, the counting is done in the external electronics. The point where the counting begins depends on the counter in the external electronics and not on the position of the encoder. To provide useful position information, the encoder position must be referenced to the device to which it is attached, generally using an index pulse. The distinguishing feature of the incremental encoder is that it reports an incremental change in position of the encoder to the counting electronics.

3.1.2.1 ABSOLUTE ENCODER

a) Construction

Digital absolute encoders produce a unique digital code for each distinct angle of the shaft. They come in two basic types: optical and mechanical.

b) Mechanical absolute encoders

A metal disc containing a set of concentric rings of openings is fixed to an insulating disc, which is rigidly fixed to the shaft. A row of sliding contacts is fixed to a stationary object so that each contact wipes against the metal disc at a different distance from the shaft. As the disc rotates with the shaft, some of the contacts touch metal, while others fall in the gaps where the metal has been cut out. The metal sheet is connected to a source of electric current, and each contact is connected to a separate electrical sensor. The metal pattern is designed so that each possible position of the axle creates a unique binary code in which some of the contacts are connected to the current source (i.e. switched on) and others are not (i.e. switched off).

Because brush-type contacts are susceptible to wear, encoders using contacts are not common; they can be found in low-speed applications such as manual volume or tuning controls in a radio receiver.

c) Optical absolute encoders

The optical encoder's disc is made of glass or plastic with transparent and opaque areas. A light source and photo detector array reads the optical pattern that results from the disc's position at any one time.

This code can be read by a controlling device, such as a microprocessor or microcontroller to determine the angle of the shaft.

The absolute analog type produces a unique dual analog code that can be translated into an absolute angle of the shaft.

d) Magnetic absolute encoders

The magnetic encoder uses a series of magnetic poles (2 or more) to represent the encoder position to a magnetic sensor (typically magneto-resistive or Hall Effect). The magnetic sensor reads the magnetic pole positions.

This code can be read by a controlling device, such as a microprocessor or microcontroller to determine the angle of the shaft, similar to an optical encoder.

The absolute analog type produces a unique dual analog code that can be translated into an absolute angle of the shaft (by using a special algorithm.

e) Capacitive absolute encoders

An asymmetrical shaped disc is rotated within the encoder. This disc will change the Capacitance between two electrodes which can be measured and calculated back to an angular value.

3.1.2.2 INCREMENTAL ROTARY ENCODER

An incremental rotary encoder provides cyclical outputs (only) when the encoder is rotated. They can be mechanical, optical or magnetic. The mechanical type requires denouncing and is typically used as digital potentiometers on equipment including consumer devices. Most modern ncoderhome and car stereos use mechanical rotary encoders for volume control. Due to the fact the mechanical switches require denouncing, the mechanical type are limited in the rotational speeds they can handle. The incremental rotary encoder is the most widely used of all rotary encoders due to its low cost and ability to provide signals that can be easily interpreted to provide motion related information such as velocity.

The fact that incremental encoders use only two sensors does not compromise their resolution. One can find in the market incremental encoders with up to 10,000 counts per revolution, or more.

There can be an optional third output: reference or "index", which happens once every turn. This is used when there is the need of an absolute reference, such as positioning systems. The index output is usually labeled Z.

The optical type is used when higher speeds are encountered or a higher degree of precision is required.

Incremental encoders are used to track motion and can be used to determine position and velocity. This can be either linear or rotary motion. Because the direction can be determined, very accurate measurements can be made.

They employ two outputs called A & B, which are called quadrature outputs, as they are 90 degrees out of phase.

PHASE	A	B
1	0	0
2	0	1
3	1	1
4	1	0

Table 3.1: Coding for Clockwise Rotation

PHASE	A	B
1	1	0
2	1	1
3	0	1
4	0	0

Table 3.2: Coding for Counter-Clockwise Rotation

On encoders with detents there are different ways to switch states. In some, both A and B are always open circuit at the detents, and an entire 00 → 00 switching cycle occurs while transitioning from one detent to the next. Others have detents of alternating 00 and 11 value, with staggered switching times during the transition between detents.

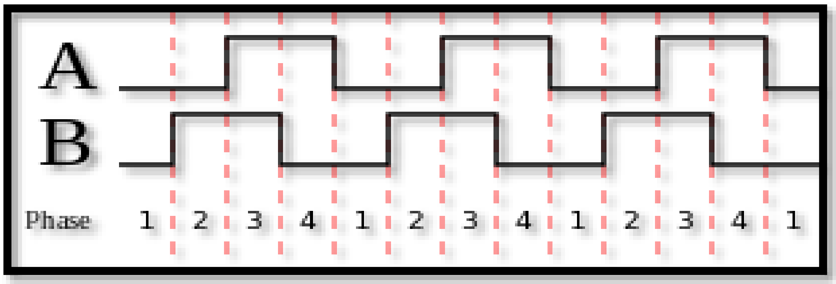

Figure 3.1: Switching States for Encoder

Additionally some incremental encoders output a "Z" signal. Once every rotation, this Z signal is rising for typically 90°, on exactly the same position. This can be used as an accurate reference point. Some incremental encoders also have additional differential signals, called "/A", "/B" and "/Z". These signals are inverted "A", "B" and "Z" signals. Controllers can compare each pair ("A" must be equal to inverted "/A") to ensure that there is no error during the transmission.[10]

An observer, such as a microprocessor, will read (sample) the output of the encoder. The observer needs to sample the encoder output often enough so it does not miss any code changes. If the encoder turns too fast, then the observer may miss an encoder output change, so the observer will see an invalid transition, such as 00 → 11, and be confused. For that transition, the observer does not know which way the encoder turned: it may have gone forward (00 → 01 → 11) or backward (00 → 10 → 11). If the encoder is turning even faster, then multiple output changes could be missed, and the observer may get the direction wrong. Consider the moving forward sequence 00 → 01 → 11 → 10 (3 steps forward). If the encoder is turning too fast, the observer may see only the first (00) and fourth (10) outputs and conclude the encode made a legal 00 → 10 transition (1 step backward).

This same principle is used in ball mice to track whether the mouse is moving to the right/left or forward/backward.

Rotary encoders with a single output cannot be used to sense direction of motion. They are well-suited for systems that measure rate-of-movement variables. In certain applications they may be used to measure distance of motion (e.g. feet of movement).

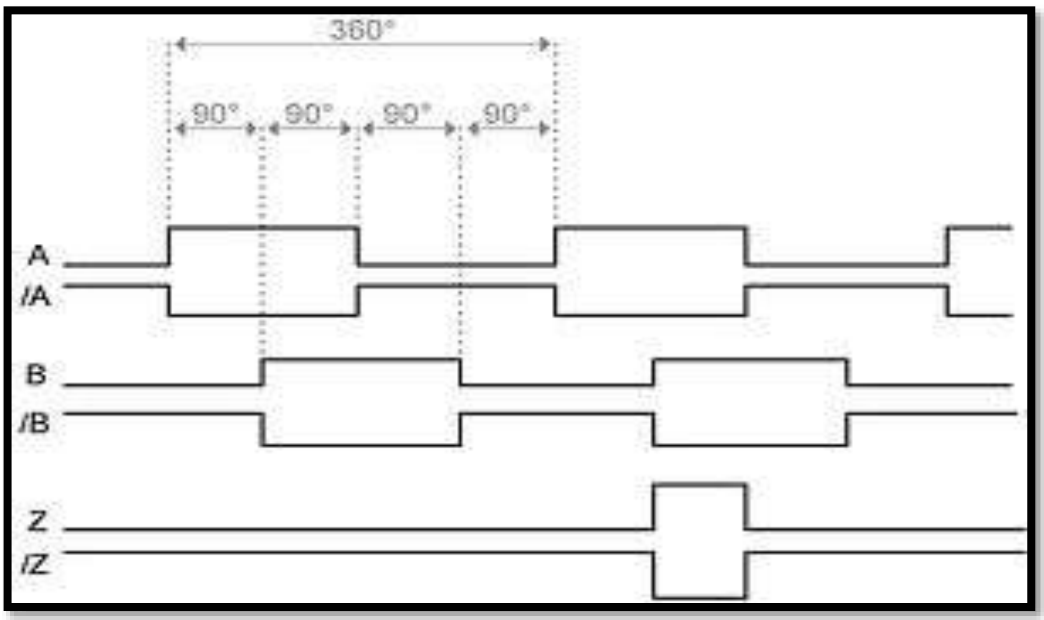

Figure 3.2: Incremental Pulse Diagram

3.1.3 RASPBERRY PI 2

The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It's capable of doing everything you'd expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games. The Raspberry Pi 2 Model B features a quad-core ARM Cortex A7 running at 1GHz with 1GB of RAM. This chip uses the ARMv7 architecture instead of the ARMv6 of the original Raspi. When playing around with it, it was noticeably zippier than my months-old Raspi Model B in web browsing tasks. Very, very cool, and something that opens up a few doors for CPU-intensive applications.

Although the CPU has been updated, there isn't much else on the Pi that has changed. USB and Ethernet are still handled by the LAN9514 USB/Ethernet controller. If you're looking for Gigabit Ethernet, sorry that's not going to happen. We're not going to get eMMC Flash, SATA ports, or anything groundbreaking other than the CPU with this hardware update. It's pretty much just a CPU and RAM upgrade.

All the original ports found on the Raspberry Pi Model B+ are found on the Raspi 2; HDMI, audio, analog video, Ethernet, USB, CSI, the as-for-now unused DSI, and GPIO ports haven't changed. Again, we're looking at a CPU and RAM upgrade with this hardware release.

3.1.3.1 Technical Specifications:

a) Broadcom BCM2836 Arm7 Quad Core Processor powered Single Board Computer running at 900MHz
b) 1GB RAM
c) 40pin extended GPIO
d) 4 x USB 2 ports

e) 4 pole Stereo output and Composite video port

f) Full size HDMI

g) CSI camera port for connecting the Raspberry Pi camera

h) DSI display port for connecting the Raspberry Pi touch screen display

i) Micro SD port for loading your operating system and storing data

j) Micro USB power source

3.1.3.2 Raspberry Pi 2 Model B Features:

a) Broadcom BCM2836 Arm7 Quad Core Processor powered Single Board Computer running at 900MHz
b) 1GB RAM so you can now run bigger and more powerful applications
c) Identical board layout and footprint as the Model B+, so all cases and 3rd party add-on boards designed for the Model B+ will be fully compatible.
d) Fully HAT compatible
e) 40pin extended GPIO to enhance your "real world" projects. GPIO is 100% compatible with the Model B+ and A+ boards. First 26 pins are identical to the Model A and Model B boards to provide full backward compatibility across all boards.
f) Connect a Raspberry Pi camera and touch screen display (each sold separately)
g) Stream and watch Hi-definition video output at 1080P
h) Micro SD slot for storing information and loading your operating systems.
i) Advanced power management:
j) You can now provide up to 1.2 AMP to the USB port – enabling you to connect more power hungry USB devices directly to the Raspberry PI. (This feature requires a 2Amp micro USB Power Supply)
k) 10/100 Ethernet Port to quickly connect the Raspberry Pi to the Internet
l) Combined 4-pole jack for connecting your stereo audio out and composite video out

Figure 3.3: Raspberry Pi 2

3.1.3.3 POWER SPECIFICATIONS

The device is powered by a 5V micro USB supply. Exactly how much current (mA) the Raspberry Pi requires is dependent on what you connect to it. We have found that purchasing a 1.2A (1200mA) power supply from a reputable retailer will provide you with ample power to run your Raspberry Pi. Typically, the model B uses between 700-1000mA depending on what peripherals are connected; the model A can use as little as 500mA with no peripherals attached. The maximum power the Raspberry Pi can use is 1 Amp. If you need to connect a USB device that will take the power requirements above 1 Amp, then you must connect it to an externally-powered USB hub.

The power requirements of the Raspberry Pi increase as you make use of the various interfaces on the Raspberry Pi. The GPIO pins can draw 50mA safely, distributed across all the pins; an individual GPIO pin can only safely draw 16mA. The HDMI port uses 50mA, the camera module requires 250mA, and keyboards and mice can take as little as 100mA or over 1000mA! Check the power rating of the devices you plan to connect to the Pi and purchase a power supply accordingly.

3.2 SOFTARE IMPLEMENTATION

3.2.1 PYTHON 2.7

Python is a widely used high-level, general-purpose, interpreted, dynamic programming language. Its design philosophy emphasizes code readability, and its syntax allows programmers to express concepts in fewer lines of code than would be possible in languages such as C++ or Java. The language provides constructs intended to enable clear programs on both a small and large scale.

Python supports multiple programming paradigms, including object-oriented, imperative and functional programming or procedural styles. It features a dynamic type system and automatic memory management and has a large and comprehensive standard library.

Python interpreters are available for many operating systems, allowing Python code to run on a wide variety of systems. Using third-party tools, such as Py2exe or Pyinstaller, Python code can be packaged into stand-alone executable programs for some of the most popular operating systems, so Python-based software can be distributed to, and used on, those environments with no need to install a Python interpreter.

3.2.2 KIVY 1.9.1

Kivy is an open source, cross-platform Python framework for the development of applications that make use of innovative, multi-touch user interfaces. The aim is to allow for quick and easy interaction design and rapid prototyping whilst making your code reusable and deployable. It is a software library for rapid development of hardware-accelerated multitouch applications.

Kivy is written in Python and Cython, based on OpenGL ES 2, supports various input devices and has an extensive widget library. With the same codebase, you can target Windows, OS X, Linux, Android and iOS. All Kivy widgets are built with multitouchsuppor

CHAPTER 4

PROPOSED ARCHITECTURE

4.1 ALGORITHM USED

Following steps were used in this project:

a) Interfacing of rotary encoder with the microcontroller i.e. Raspberry Pi 2.
b) Mapping of rotation (both in clockwise and anticlockwise direction) with English Alphabets.
c) Repeating the same procedure for n number of rotary encoders.
d) Writing the input letters received into a text file.
e) Uploading the input file on the local server.
f) Downloading and reading the file for providing the received alphabets as input into a python file.
g) Making valid combinations out of the received input using the python script that checks from an already existing dictionary of words.
h) Downloading the corresponding image for the text received and also implementing text to speech
i) A GUI implementation of the above functionalities using Kivy (cross platform python framework).

We use KY040 rotary encoder and interface it with Raspberry Pi 2 microcontroller. The working of KY040 rotary encoder is explained below. Then we map the rotation of rotary encoder with English alphabets in both directions that is, clockwise and anticlockwise. Input from the hardware is then fed to the python code. The code generates all the possible permutations of the received characters. These words are then compared with the already downloaded database of dictionary words. Finally a main list is created which contains all the valid words.

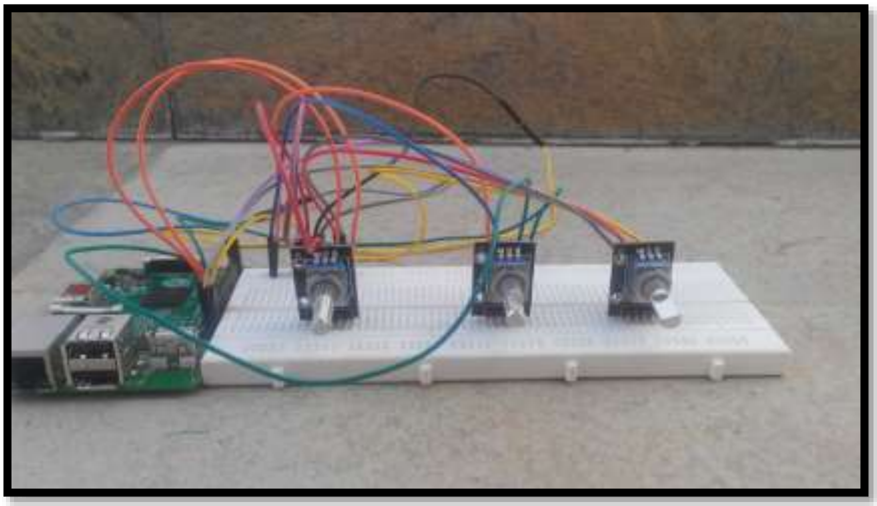

Figure 4.1: Interfacing of Rotary Encoders with Microcontroller

Simultaneously images for the valid words are downloaded from the internet using libraries like mechanizer, urllib and beautifulsoup.

Mechanizer helps to connect to the internet; urllib gives the html page of the provided URL. It also helps to download the image and beautifulsoup helps to find the link of the images in html page.

Now GUI is included to make the module more interactive. In GUI representation there are always three columns and the number of rows will vary according to the input. There will be a row for each valid word.

Each row contains three buttons – Left, Right and Middle one. The middle button contains the valid word whose font size will change on clicking. The left button display the image on clicking and if the internet is not connected it will not display the image but the code will not stop working. If that word is already searched then it will display the image even without internet connection as it was earlier stored in the memory. Right button is for the pronunciation of the word. Pyttsx inbuilt library of python is used for text to speech conversion

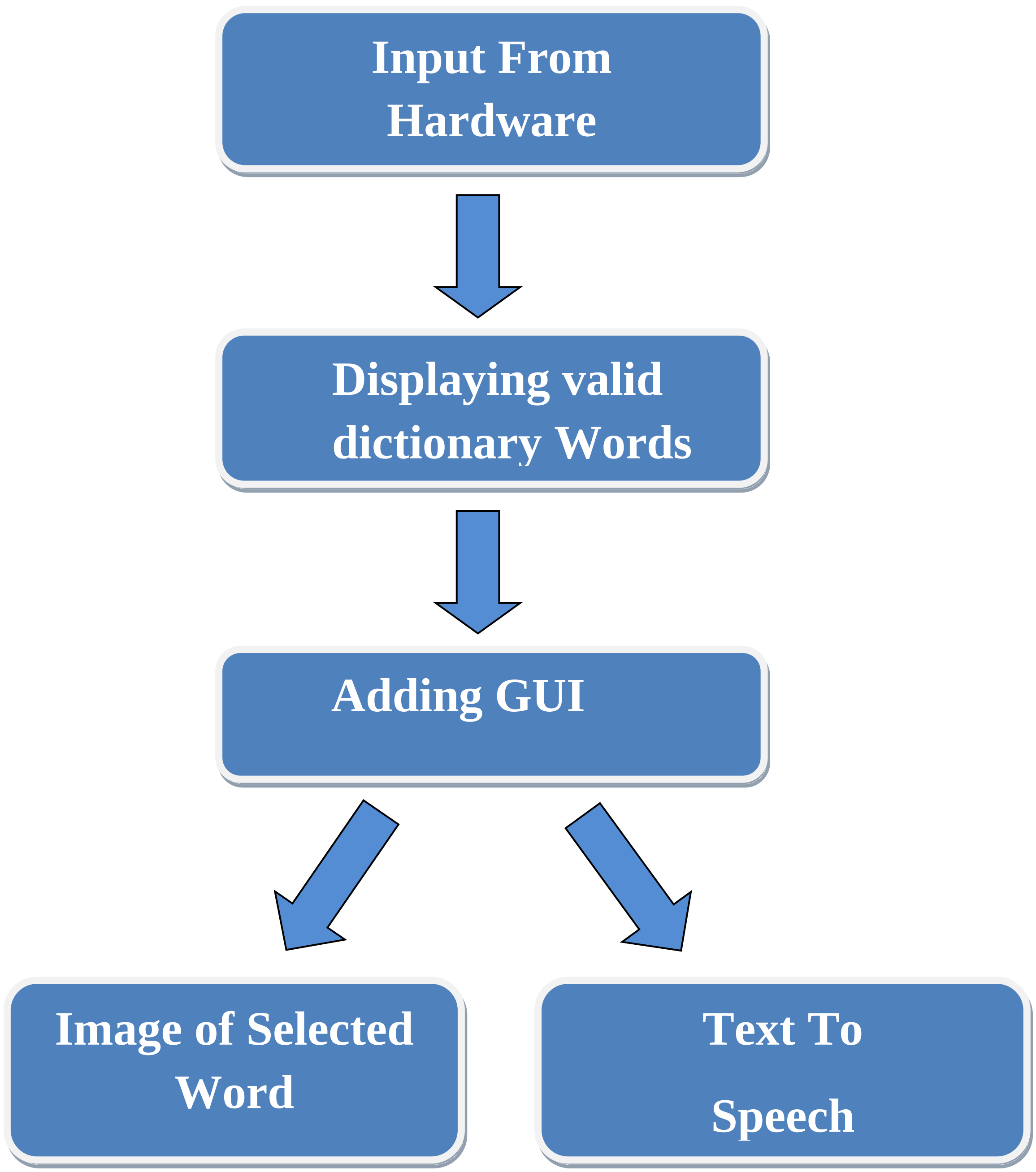

Figure 4.2: Flow Chart of proposed architecture

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4.2 KY040 ROTORY ENCODER

The Keyes KY-040 rotary encoder is a rotary input device (*as in knob*) that provides an indication of how much the knob has been rotated AND what direction it is rotating in.

It's a great device for stepper and servo motor control. You could also use it to control devices like digital potentiometers.

4.2.1 ROTARY ENCODER

A rotary encoder has a fixed number of positions per revolution. These positions are easily felt as small "clicks" you turn the encoder.
The Keyes module that I have has thirty of these positions.

On one side of the switch there are three pins. They are normally referred to as A, B and C. In the case of the KY-040, they are oriented as shown.

Inside the encoder there are two switches. Once switch connects pin A to pin C and the other switch connects pin B to C.

In each encoder position, both switches are either opened or closed. Each click causes these switches to change states as follows:

a) **If both switches are closed**, turning the encoder either clockwise or counterclockwise one position will cause both switches to open
b) **If both switches are open**, turning the encoder either clockwise or counterclockwise one position will cause both switches to close.

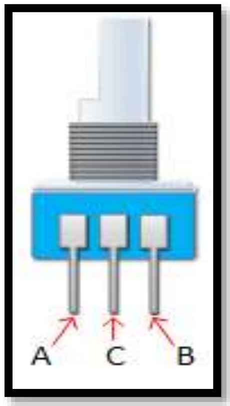


Figure 4.3:KY040 Rotary Encoder

The illustration below is representative of how the switch is constructed.

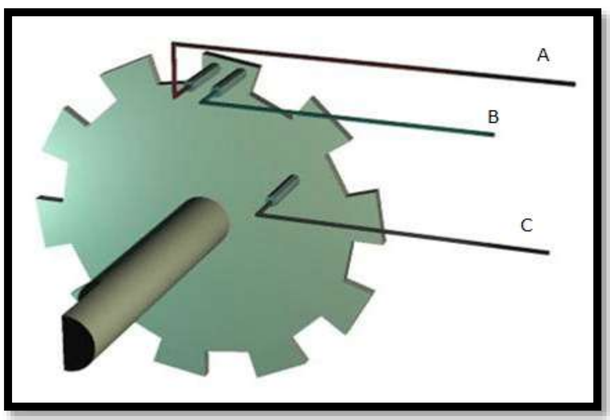


Figure 4.4: Construction of Switch

The angular position of the A terminal and the B terminal are such that:

a) **Rotating the switch clockwise** will cause the switch connecting A and C to change states first.
b) **Rotating the switch counterclockwise** will cause the switch connecting B and C to change states first.

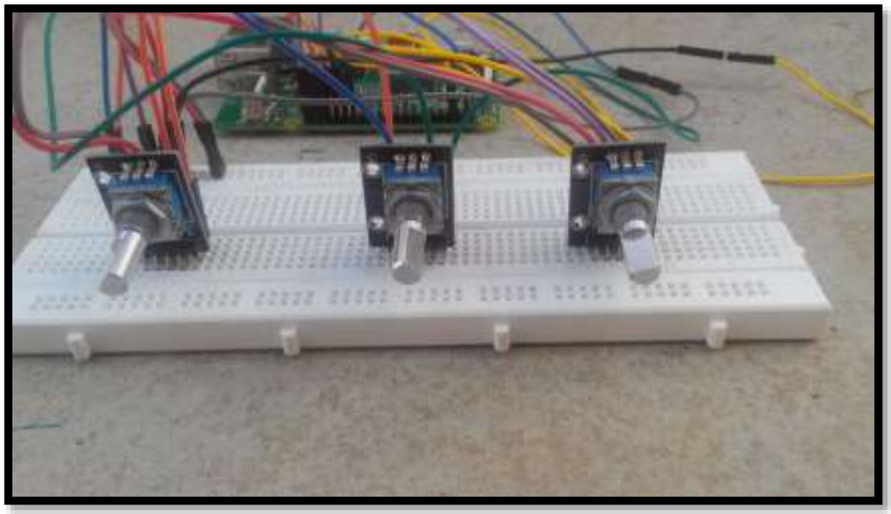


Figure 4.5: Three Rotary Encoders Being Used

Figure 4.4 shows three rotary encoders that are being used in our project. These three rotary encoders are used to give three character inputs to the python code. By interfacing more number of rotary encoders we can increase the number of inputs that are given to the code.

Essentially, determining which switch changed states first is how the direction of rotation is determined.

If A changed states first, the switch is rotating in a clockwise direction.

If B changed states first, the switch is rotating in a counter clockwise direction.

4.2.2 KY-040 PIN OUTS

The pin outs for this rotary encoder are identified in the illustration below.

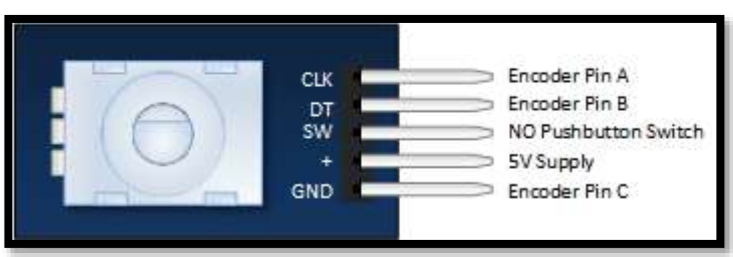


Figure 4.6: KY-040 Pin Out

The module is designed so that a low is output when the switches are closed and a high when the switches are open.

The low is generated by placing a ground at Pin C and passing it to the CLK and DT pins when switches are closed.

The high is generated with a 5V supply input and pull up resistors, such that CLK and DT are both high when switches are open.

Not previously mentioned is the existence of push button switch that is integral to the encoder. If you push on the shaft, a normally open switch will close. The feature is useful if you want to change switch function. For example, you may wish to have the ability to between coarse and fine adjustments.

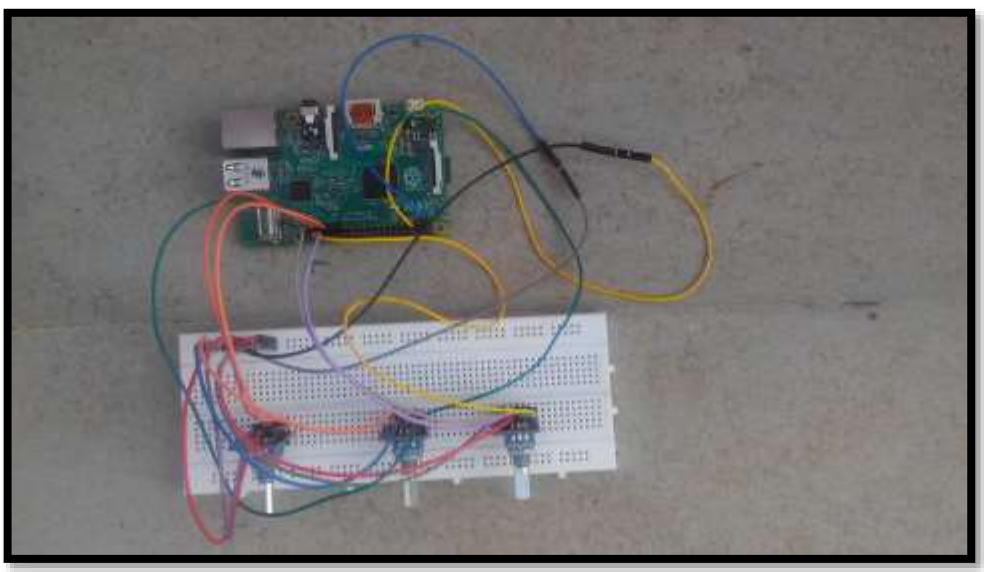


Figure 4.7: Hardware Implementation

4.2.3 KEYES ROTARY ENCODER SCHEMATIC

A schematic for this module is provided below. R2 and R3 in the schematic are pull up resistors.

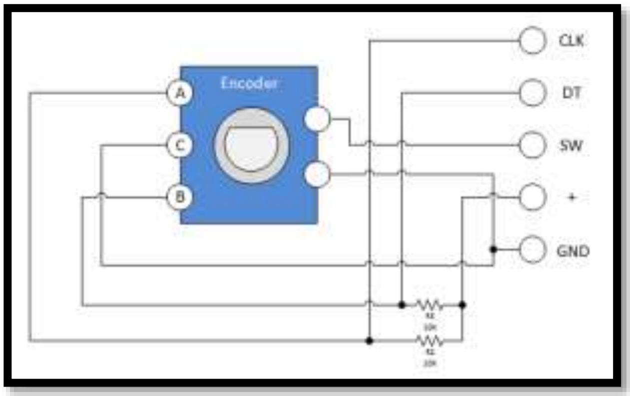


Figure 4.8: Encoder Schematic

4.3 DEVELOPING 3D PRINTED PROTOTYPE

3D printing, also known as additive manufacturing, refers to various processes used to synthesize a three-dimensional object. In 3D printing, successive layers of material are formed under computer control to create an object. These objects can be of almost any shape or geometry and are produced from a 3D model or other electronic data source. A 3D printer is a type of industrial robot.

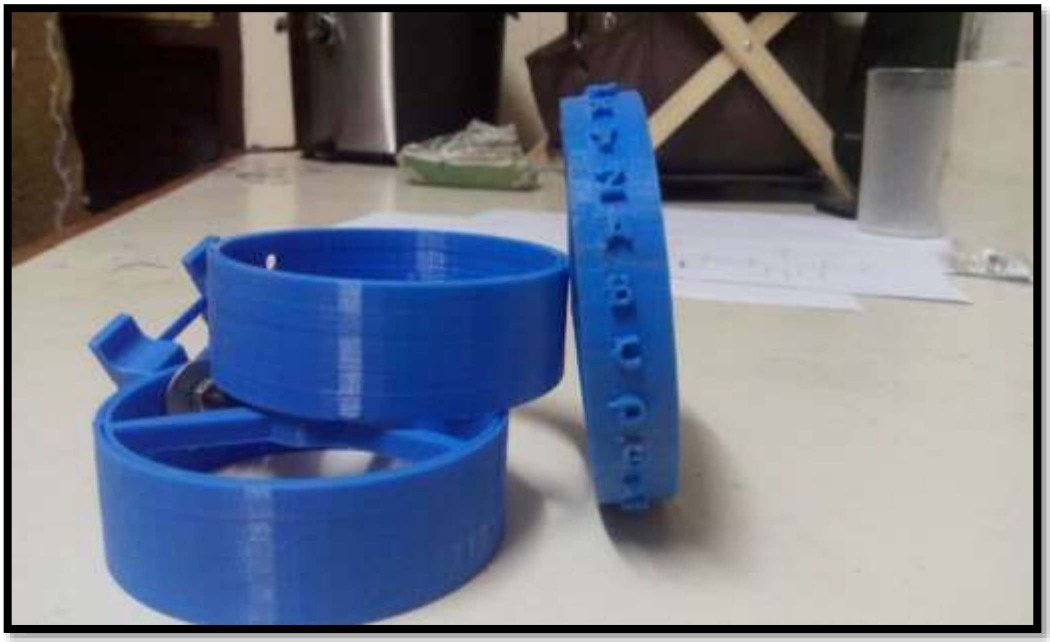


Figure 4.9: 3D Printed Ring with Alphabets on It

Developing 3D printed prototype will help children get the feel because one thing we can't get from a picture or virtual prototype on the computer screen is the way something feels in our hand. If you want to ensure that our product is just right, we must actually hold it and use it.

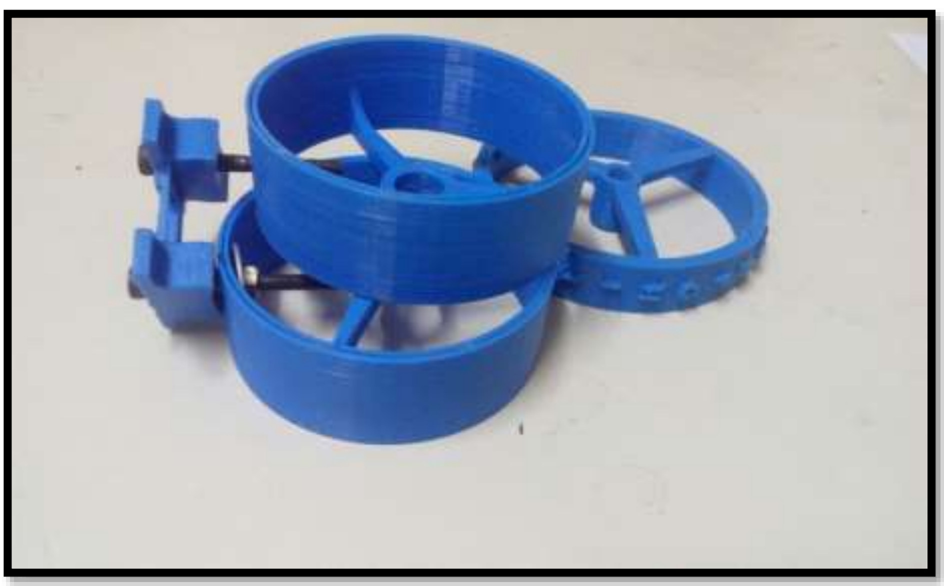


Figure 4.10: 3D Printed Model

CHAPTER 5

RESULT AND CONCLUSION

5.1 RESULTS OBTAINED

Figure 5.1 shows the console output for the case when there is only one possible combination of the entered characters. When we entered “nam” the code generates all the possible combinations using these three characters. These combinations are then compared with database dictionary. After the comparison valid words are displayed on the screen. In this case there is only one valid word i.e. “man” which is displayed.

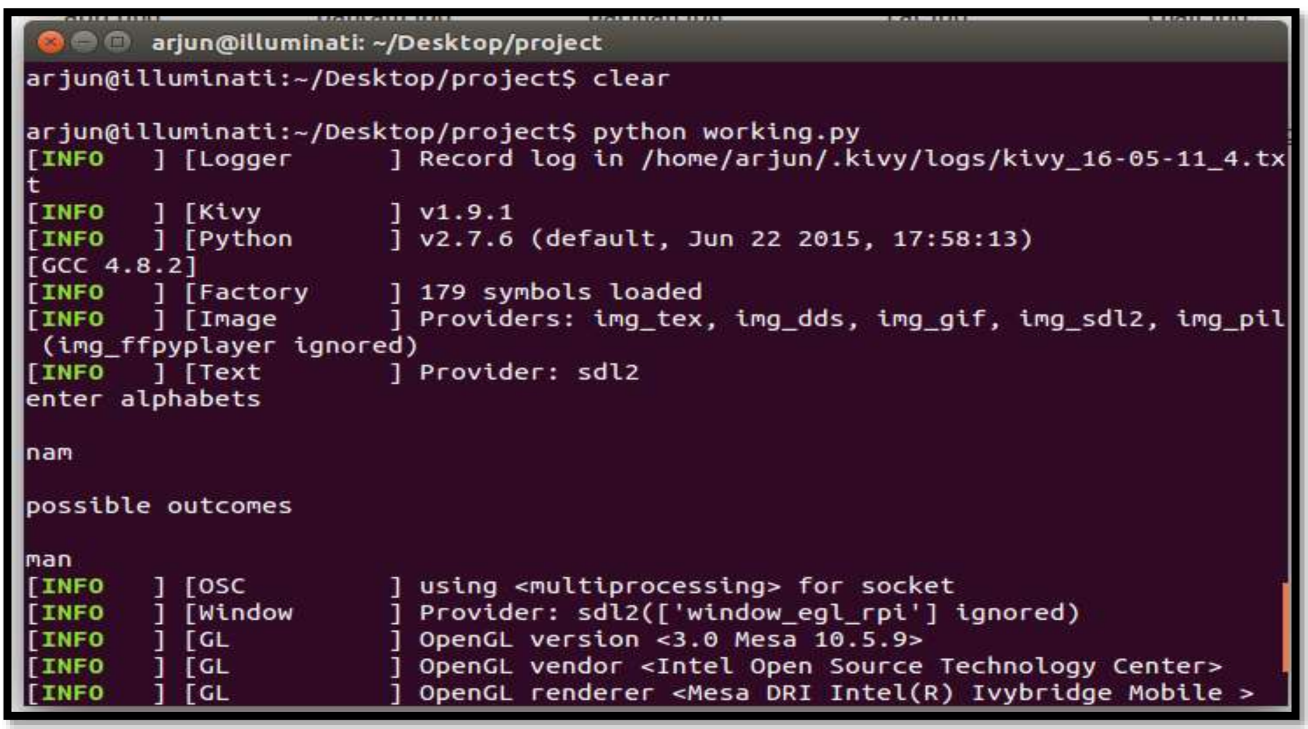


Figure 5.1: Console Output for One Possible Combination

Figure 5.2: GUI Output for One Possible Combination

Figure 5.3: GUI Output Displaying Image for Selected Word combination

Figure 5.2 shows the GUI output when only one valid combination is there. In GUI output, there are three buttons. Left button on clicking will display the image of the word as shown in figure 5.3. The middle button on clicking will change the font size of the displayed word and the right button on clicking will give the pronunciation of the word.

Figure 5.4 shows the console output for the case when there are two possible combinations of the entered characters. When we entered “chain” the code generates all the possible combinations using these four characters. These combinations are then compared with database dictionary. After the comparison valid words are displayed on the screen. In this case there are two valid words and they are “chain” and “china” which are displayed on the screen.

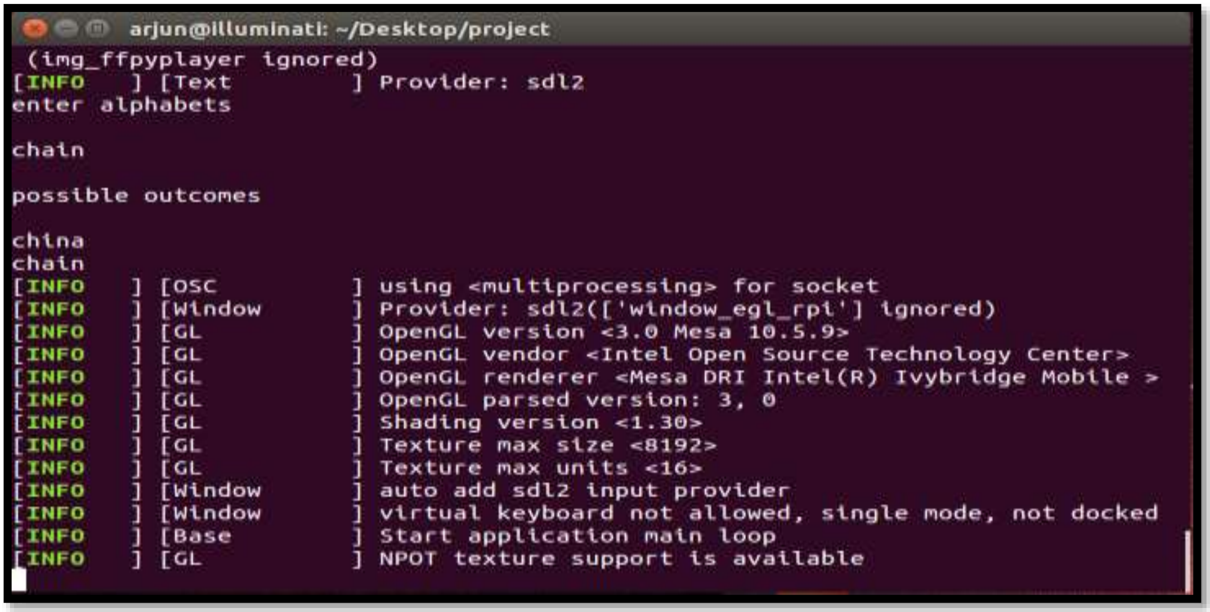


Figure 5.4: Console Output for Two Possible Combinations

Figures 5.5 shown below are the GUI output when there are two valid combinations. In GUI output, there are three columns and two rows i.e. there are six buttons in total. When we click on the first button it displays the image of word "china" which is downloaded from internet as shown in figure 5.7 and when we click on the next image button it displays the image of the word "chain". The middle button on clicking will change the font size of the displayed word and the right button on clicking will give the pronunciation of the word.

Figure 5.5: GUI Output for Two Possible Combinations

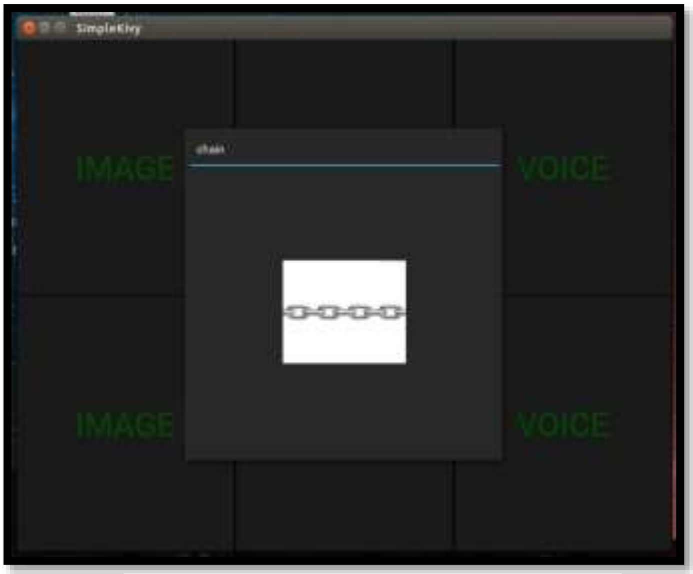


Figure 5.6: GUI Output Displaying Image for Selected Word

Figure 5.7: GUI Output Displaying Image for Selected Word

Figure 5.8 shows the console output for the case when there are three possible combinations of the entered characters. When we entered “stain” the code generates all the possible combinations using these five characters. These combinations are then compared with database dictionary. After the comparison valid words are displayed on the screen. In this case there are three valid words and they are “stain”, “satin” and “saint” which are displayed on the screen.

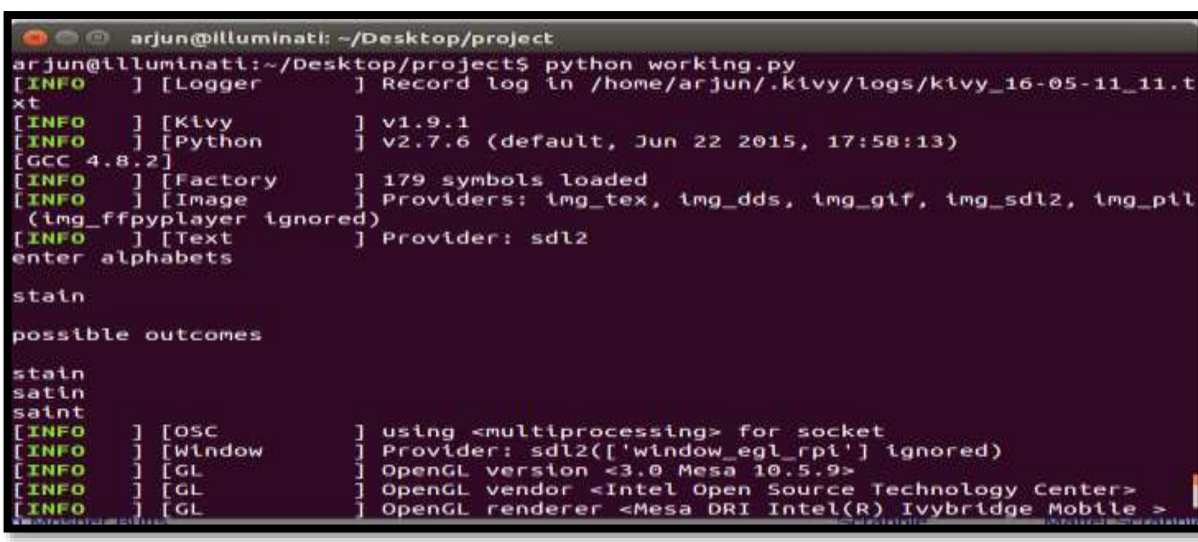


Figure 5.8: Console Output for Three Possible Combinations

Figures 5.9 shown below are the GUI output when there are three valid combinations. In GUI output, there are three columns and three rows i.e. there are nine buttons in total. When we click on the image button corresponding to word "saint" it displays the image of the word which is downloaded from internet as shown in figure 5.10. The middle button on clicking will change the font size of the displayed word as shown in figure 5.9.

Figure 5.9: GUI Output for Three Possible Combinations

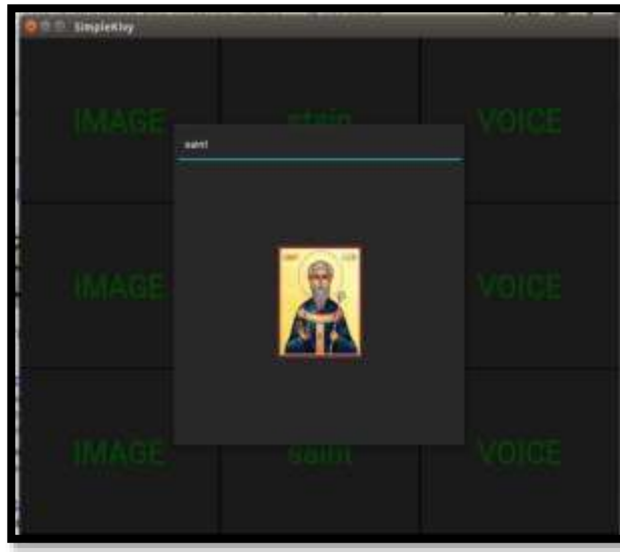
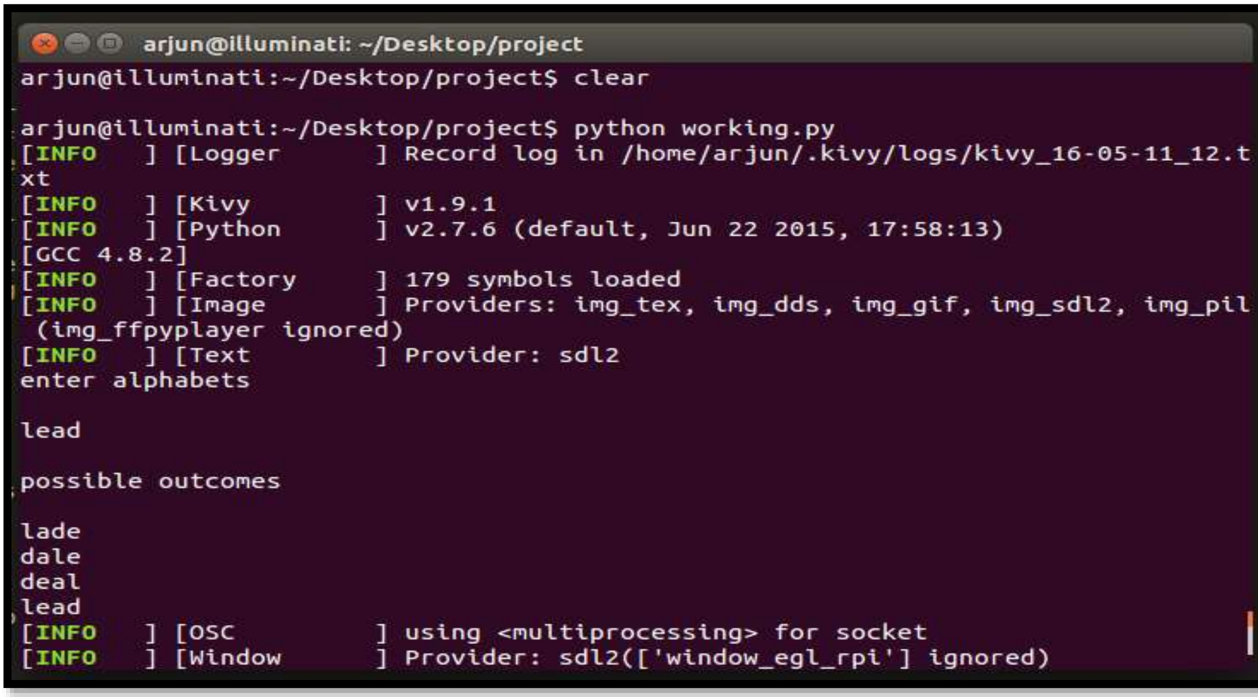


Figure 5.10: GUI Output Displaying Image for Selected Word

Figure 5.11 shows the console output for the case when there are four possible combinations of the entered characters. When we entered "lead" the code generates all the possible combinations using these four characters. These combinations are then compared with database dictionary. After the comparison valid words are displayed on the screen. In this case there are four valid words and they are "lade", "dale", "deal" and "lead" which are displayed on the screen.



```
arjun@illuminati: ~/Desktop/project
arjun@illuminati:~/Desktop/project$ clear

arjun@illuminati:~/Desktop/project$ python working.py
[INFO   ] [Logger      ] Record log in /home/arjun/.kivy/logs/kivy_16-05-11_12.t
xt
[INFO   ] [Kivy        ] v1.9.1
[INFO   ] [Python      ] v2.7.6 (default, Jun 22 2015, 17:58:13)
[GCC 4.8.2]
[INFO   ] [Factory     ] 179 symbols loaded
[INFO   ] [Image       ] Providers: img_tex, img_dds, img_gif, img_sdl2, img_pil
 (img_ffpyplayer ignored)
[INFO   ] [Text        ] Provider: sdl2
enter alphabets

lead

possible outcomes

lade
dale
deal
lead
[INFO   ] [OSC         ] using <multiprocessing> for socket
[INFO   ] [Window      ] Provider: sdl2(['window_egl_rpi'] ignored)
```

Figure 5.11: Console Output for Four Possible Combinations

Figures 5.12 shown below is the GUI output when there are four valid combinations. In GUI output, there are three columns and four rows i.e. there are twelve buttons in total. When we click on the image button corresponding to word "deal" it displays the image of the word which is downloaded from internet as shown in figure 5.13. The middle button on clicking will change the font size of the displayed word as shown in figure 5.12.

Figure 5.12: GUI Output for Four Possible Combinations

Figure 5.13: GUI Output Displaying Image for Selected Word

From the results obtained, it is clear that the proposed model is working well for input up to four characters. If for a particular input there in no valid combination found in the database dictionary, then the code will display the message "no valid word found". If there are more than four valid combinations then it will display the message "out of memory".

5.2 FUTURE SCOPE

It is generally reported that around 10 to 15 percent of the children across the world suffer from learning disability or what is known as Dyslexia. These children find difficulty in managing the academic works. They may also be slow learners. They would score poor marks. In most of the cases, these children are branded as 'useless', 'poor performers', etc. by the teachers and parents.

These children are not intellectually weak. They possess different skills like music, sports, art, acting, innovation, drawing, craft, driving, etc. Many eminent people like Winston Churchill, Einstein, Issac Newton, Thomas Alva Edison and many popular Hollywood actors were dyslexic during their childhood.

If these children are not identified and remedied, we will be guilty of losing great men of eminence for future. So as a part of future work, we can make our project model more handy and give it to the dyslexic students as an educational toy. We can collaborate with the NGOs working for the betterment of such children like **TAMANA and NIRMAN**.

We can also extend the scope of our project by not keeping it limited to only dyslexic children. It will be designed in such a way so that it could be given to any child of lower age group to help him improve his vocabulary.

Figure 5.14: Educational Toy for Kids

Figure 5.15: Interactive Real Time

5.3 CHALLENGES FACED

a) GUI was created on python framework Kivy. To install all the important libraries and configure them to work properly, it took us more than a week due to which our project completion got delayed.

b) Earlier we were using arduinouno to get the input of rotary encoders. To interface rotary encoders we need two interrupt pins per rotary encoder and but number of interrupt pins present in arduinouno is only two which meant we can interface only one rotary encoder. Therefore we have to drop the idea of using arduino mega and use a much better microcontroller that offered more interrupt pins.

c) We thought of using arduino mega instead of arduinouno which offered 6 interrupt pins but again we have to drop the idea because we couldn't find a way to send the input from arduino mega to computer. We ended up using Raspberry pi 2 which offered 30 pins thus allowing us to add up to 15 rotary encoders in future.

d) We have written the code in Python which is the default language of raspberry pi and the GUI is created using Kivy. Kivy was not working properly on raspberry pi, so we have to create the local server and run the Kivy file on another desktop.

e) We also thought of making 3D printed rings which had alphabets on them. These rings could be given as educational toy to the children of lower age group. But this design was not affordable.

5.4 CONCLUSION

Thus, winding up the description of the proposed model in a nutshell, the project seems viable enough to help dyslexic children learn words and improve their vocabulary without dealing with a much more complex interface. It is also much more fun to use this project to help children of lower age groups that are not mentally challenged, to learn words as they prefer a physical interface instead of a software or book.

To make the whole module more interactive instead of having a predefined database of images, the module will load real time images from the web. A special algorithm will be designed that will always load the best possible images out of all the available options from the goggle image search engine.

Also the valid words generated will also be accompanied by their respective dictionary meanings. Thus enhancing the vocabulary of the child in best possible way

Apart from taking the character input using rotary encoders, 3D printed prototype is also used to make the module more interactive. It can be given to the children as an educational toy.

Children will set the respective characters on the dial in the same way as a combination is set in case of cycle locks. And after finalizing the word the software part will boot up, taking the input of characters from this module rather than using rotary encoders.

5.5 PUBLICATION

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meeInteractive module for dyslexic children

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***Abstract* –An interactive module is being designed for dyslexic students to improve their auditory and visual skills by the use of interactive multimedia elements. The methodology uses character recognition as an input for the words written by the dyslexic students, which are further, processed to make valid combination of useful words. The valid combination of words are accompanied by both image and audio of the corresponding word interpreted thereby improving the visual perception and auditory perception of the child respectively and thus making learning a fun filling and a more gradual process for these children with disabilities. Significantly, this research will also contribute to the body of knowledge in providing guidelines for future similar developments.**

Keywords – Auditory Improvement; Dyslexia; Character Recognition; Visual Improvement; Vocabulary Builder

I. INTRODUCTION

The word dyslexia is derived from two Greek words: "dys" which means "difficulty" and "lexia" which means "words". Dyslexia therefore stands for impairment in the ability to read.
"No other disabling condition affects so many people and yet has such a low public profile and low level of understanding as LD". Lokerson [1] defined dyslexia as a severe difficulty in understanding or using one or more areas of language, including listening, speaking, reading, writing and spelling. Joffe [2] found that dyslexic students would not only have trouble in reading, writing and spelling, but also in mathematics. According to world research figures, 1 in 5 people suffer from dyslexia. According to the International Dyslexia Association [3], 10%-15% of the world population is suffering from dyslexia, but only 5% of people with dyslexia are ever properly diagnosed and given proper treatment and conditioned.

A. Background

Dyslexia is a disorder manifested by difficulty in learning to read despite conventional instruction, adequate intelligence, and socio-cultural opportunity [4].

Dyslexia is an enigmatic mix of distinctive strengths and creativeness as well as a cluster of difficulties.
Dyslexic children are having abnormal difficulties in reading, spelling and writing. Therefore, the way these children think is always different from the normal ones. Dyslexics can be extraordinarily talented, multidimensional thinkers, highly creative and produce magnificent ideas. This can be proven by taking the historic personalities as examples as Thomas Edison, John F. Kennedy, Leornado Da Vinci, Albert Einstein, and many others (Ryden, 1998[5]; Sheila. 2006[6]). Albert Einstein was a dyslexic and genius that justifies that dyslexia has nothing to do with intelligence. Difficulties faced by dyslexics vary in degree from one person to other and can be grouped into five broad categories:

i. Mixing up items that are similar like the letters "b" and "d".
ii. Short term memory problem.
iii. Coordination problem.
iv. Reading and writing problems.
v. Problem in decoding symbols and sounds.

People with dyslexia are not lazy or stupid, they just face difficulty in processing the information Most of them have average or above average intelligence.

B. Neurobiological factors

Dyslexia is neurological in origin, which means that the problem is located physically in the brain so it is a lifelong problem. Dyslexia is caused due to inherited traits or due to genes that control the development of brain.
The human brain is a complex organ that has many different functions. It controls the body and receives, analyzes and stores information. The brain can be divided into two halves: right and left hemisphere. Most of the areas, which are responsible for speech, language processing and reading, lie in the left hemisphere. Within each hemisphere, four brain lobes are found which are as follows:

- **Frontal lobe:** It is the lobe that is responsible for controlling speech, emotions, reasoning, consciousness planning, regulating and is the largest one amongst the all lobes.

- **Parietal lobe:** It controls sensory perceptions, and is instrumental in linking spoken and written language to memory giving the words meaning. It is located farther back in the brain

- **Occipital lobe:** Its importance lies in the identification of letters and is placed at the back of the head.

- **Temporal lobe:** This lobe plays an important role in verbal memory. It is located in the lower part of the brain.

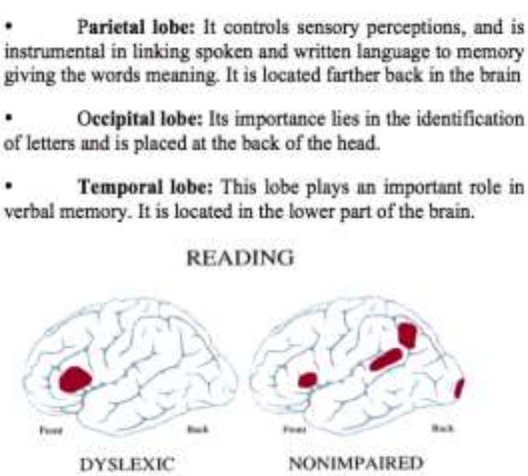

Fig. 1. Dyslexic v/s normal brain

It is well known fact that dyslexic's primarily use frontal lobe area for reading. This is different from the non-Dyslexic people who gather information from many different parts of the brain and use that information for reading. There exist structural differences in the brains of normal people and dyslexic people. Dyslexic people have problem in accessing some of the areas of the brain which leads to difficulties in reading, writing and spelling using conventional methods.
In this research work we intend to overcome the difficulties faced by dyslexics by developing an interactive module to improve their auditory and visual skills. The rest of the paper is organized as follows. Section II discusses the significance of the work. Section III discusses the proposed methodology. Section IV presents the results obtained so far followed by conclusion and future scope.

II. SIGNIFICANCE OF THE WORK

Lot of study and research work has been done and currently being undertaken for helping the children to cope up with their inabilities. Nor Hasnizam Parman (1997) [7] found that dyslexia children cannot pronounce the complete words and always face confusion among letters that are of the same shape. He concluded that the dyslexia children were retarded in their skills of making sounds of the letter, making errors in the arrangement of the letters and having confusion in identifying letters that look alike. Mercer (1997)[8] in his research proved that the dyslexia children had problems in discriminating different letters having similar shapes, for e.g. the children were not able to discriminate the letters 'b' from 'd' and 't' from 'l' or 'm' from 'w'. Even the numbers and the arrangements of the numbers as '69 to 96' and '17 to 71' and the words that look alike and sound alike as 'was' became 'saw'. Authors as N. H. Che Mat [9] in her study found from various readings and studies that the children affected form this problem are also affected in their speech and fluency.

The teaching and learning module are available in the market, but the materials are not suitable in terms of the ability, strength and interest of the dyslexic children. Neither these products are sufficient enough in overcoming the problems of mastering the skills; reading, spelling and writing. In the absence of the existence of the suitable learning module with the dyslexic children, an open research problem has open up to fill up the gap to the researcher to produce a learning module for the affected students. This research is a design process of the development of an interactive educational module developed with Interactive multimedia functions.

III. PROPOSED METHODOLOGY

This research paper is aimed at helping dyslexic children in age group of 4 to 10 years to learn to spell properly with an intuitive interface. The characters written by children are recognized using image processing techniques. These characters are given as input to a developed python code which generates all the possible combinations of the characters entered. These combinations are compared with a developed database and the valid words are displayed on the screen.
A GUI is added to make the module more user friendly, more appealing to the children and also to speed up the child's work. The image of the selected word is displayed along with its pronunciation. The block diagram of the proposed module is depicted in the Fig. 2

Fig. 2. Conceptual representation of proposed methodology

The following section includes a brief description of the modules incorporated in the design of proposed interactive module.

A. HANDWRITTEN CHARACTER RECOGNITION

Image processing techniques is being used to recognize the characters written by dyslexic students which are further processed using Matlab. Character recognition includes different phases which are:

1) Image Acquisition:

Image acquisition is the first stage of image processing which involves retrieving an image from some source, so that it can be processed afterwards. Image of the written word is captured using computer's track pad which is then exported to Matlab.

2) Preprocessing:

A series of operations are performed on the acquired image. First step is noise removal because noise can appear in images from a variety of sources and can corrupt the image completely. The noise can be a Gaussian noise, uniform noise or salt and pepper noise. The noise can be removed by using either mean filters or the order filters. The mean filters are used for the removal of Gaussian or uniform noise and the order filters are used for the removal of salt-and-pepper noise.

After that the image is converted to binary image .Binary image has only two possible values for each pixel, black and white. Conversion to binary image makes the further processing faster.

3) Segmentation:

In the segmentation stage, the image is decomposed into distinct non-overlapping regions. Regions with pixels of similar properties are found based on thresholding i.e. the intensity differences in the image. Pixels with intensity greater than threshold are put in one region and pixels with intensity less than threshold are put in other region.

4) Feature Extraction and classification:

Feature extraction is done to obtain the most relevant information from the original data. The information extracted is then represented in a lower dimensionality space. Zoning method is used for feature extraction. In this method the frame containing the character is divided into several overlapping or non-overlapping zones. For each zone densities of object pixels are calculated. To calculate density, number of object pixels in each zone is divided by total number of pixels.

This entire process is depicted in Fig.3

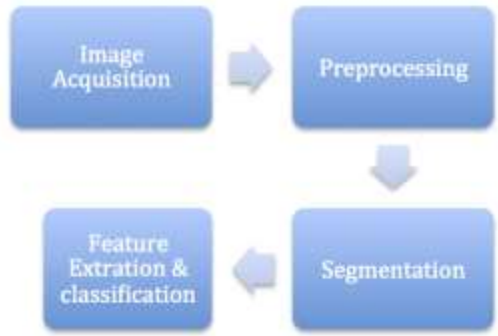

Fig. 3. Conceptual representation of Character recognition

B. DEVELOPING GUI

To make the module interactive a web based GUI is developed using "kivy". Kivy is an open source Python library which is used for developing mobile apps and other multi touch application software with a natural user interface (NUI).

GUI consists of two parts:

C. DISPLAYING VALID DICTIONARY WORDS

After character recognition the recognized characters are given as input to the python script. With the help of the combination method provided in math module of Python 2.7.5 all the possible combinations are generated .These are compared with a predesigned database dictionary and the valid words are displayed on the screen.

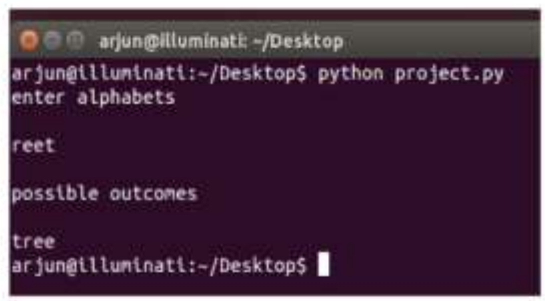

Fig. 4. Console output of Valid words

1) Image of the word:

The corresponding images are loaded over to the web based GUI for all the valid dictionary words decoded by the python script to help the child recognize the exact word he/she wanted to write.

2) Text to speech

A secondary option to get the pronunciation of the valid dictionary words is also provided as part of GUI, which is implemented using python text to speech module.

IV. RESULT AND DISCUSSION

Input is taken from the user and the output is displayed on both console and GUI. A database of 58000 words which is created initially is used to find the valid words out of all the possible combination. The database includes three letter words to seven letter words. Database of images and audio for three letter words is created for implementing GUI. In Fig. 5 Python code is run thrice. In the first run, user enters three characters ATC. The possible combinations are created which are then

compared with the database dictionary. The valid words which are displayed on the screen are CAT and ACT. GUI is also supported for three letter words. In Fig. 6 GUI is shown which is developed by using kivy (a python based platform for creating GUI based applications). There are 2 buttons in front of each word. After clicking on the image button we get the image of the word CAT and after clicking on audio button text to speech module deliver the pronunciation of the word CAT.
In the second run, user enters 4 characters REET. Only one valid combination is displayed on the screen which is TREE. In the third run, user enters 4 characters CHARI. Only one valid combination is displayed on the screen which is CHAIR.

V. CONCLUSION AND FUTURE SCOPE

The project seems viable enough to help dyslexic children learn words and improve their vocabulary without dealing with a much more complex interface. It is also much more fun to use this project to help children of lower age groups that are not mentally challenged, to learn words as they prefer a physical interface instead of a software or book.

To make the whole module more interactive instead of having a predefined database of images, the module will load real time images from the web. A special algorithm will be designed that will always load the best possible images out of all the available options from the goggle image search engine.

Also the valid words generated will also be accompanied by their respective dictionary meanings. Thus, enhancing the vocabulary of the child in best possible way.

Fig. 5. Console output for a test case.

Fig. 6. GUI representation of the interactive module

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