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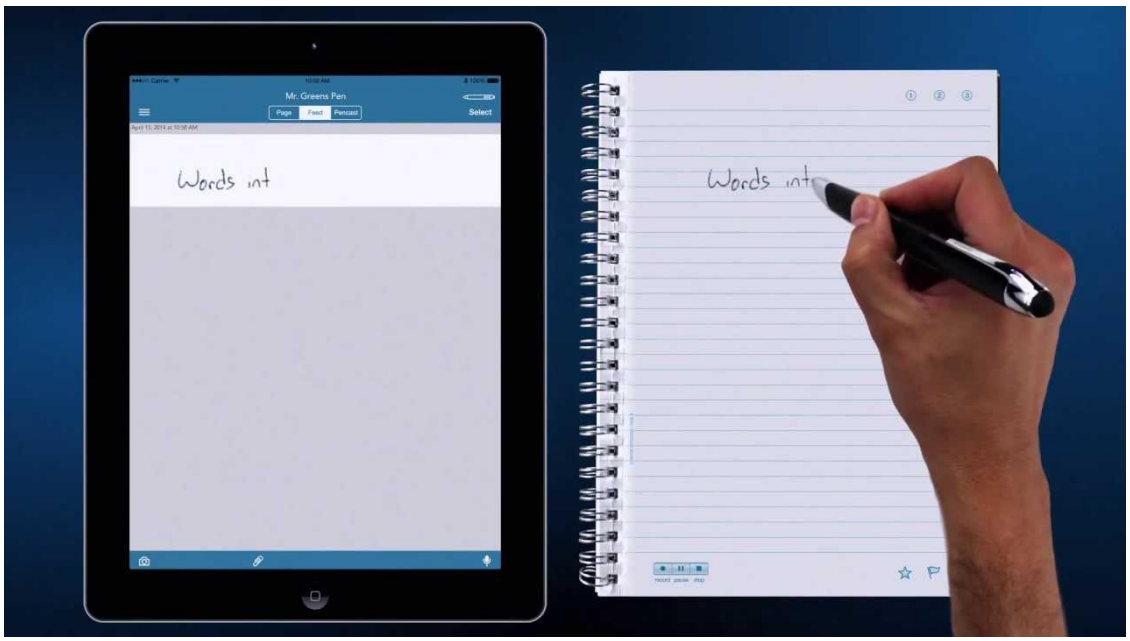


SUSTAINABLE DEVELOPMENT GOAL

This Project fulfils Sustainable Development Goal-4 (QUALITY EDUCATION) which mainly highlights and focusses on how the Quality of Education can be improved through various Inventions and Advancements in Technology in coming times.

PROBLEM STATEMENT

This Project focuses on "QUALITY EDUCATION" which helps in enhancing lives of handicapped people.

- People who are mute will get a voice to express their emotions through writing.
- People who are more interested in what someone is teaching him in school or college rather than making notes of the what he is teaching can help them to get those notes easily through Digi-pen.
- Audio commands will help the blind people to learn how to write alphabets in English instead of Braille.

INTRODUCTION

The Digi-pen is such a helpful product that satisfies the needs of the people in today's technologic and fast life. This product can be used in many ways. The Digi-pen provides taking fast and easy notes to people who are busy one's self with something. As we scribble on any paper, the movements will be recorded and sent to the wireless device connected to it. The recorded movements will be analysed and corresponding text will be displayed. An audio will also be played that corresponds to the text. This will save time and facilitate life.

The Digi-pen is good and helpful for blinds that think and write freely. It's also useful especially for instructors in presentations. The instructors may not want to present the lecture in front of the board. The drawn figure can be processed and directly sent to the server computer in the room. The server computer then can broadcast the drawn shape through network to all of the computers which are present in the room. By this way, the lectures are aimed to be more efficient and fun. This product will be simple but powerful.

There will be an additional feature of the product which will monitor the notes, which were taken before, on the application program used in the computer. This application program can be a word document or an image file. Then, the sensed figures that were drawn onto the air will be recognized and by the help of the software program we will write, the desired character will be printed in the word document. If the application program is a paint related program, then the most similar shape will be chosen by the program and then will be printed on the screen.

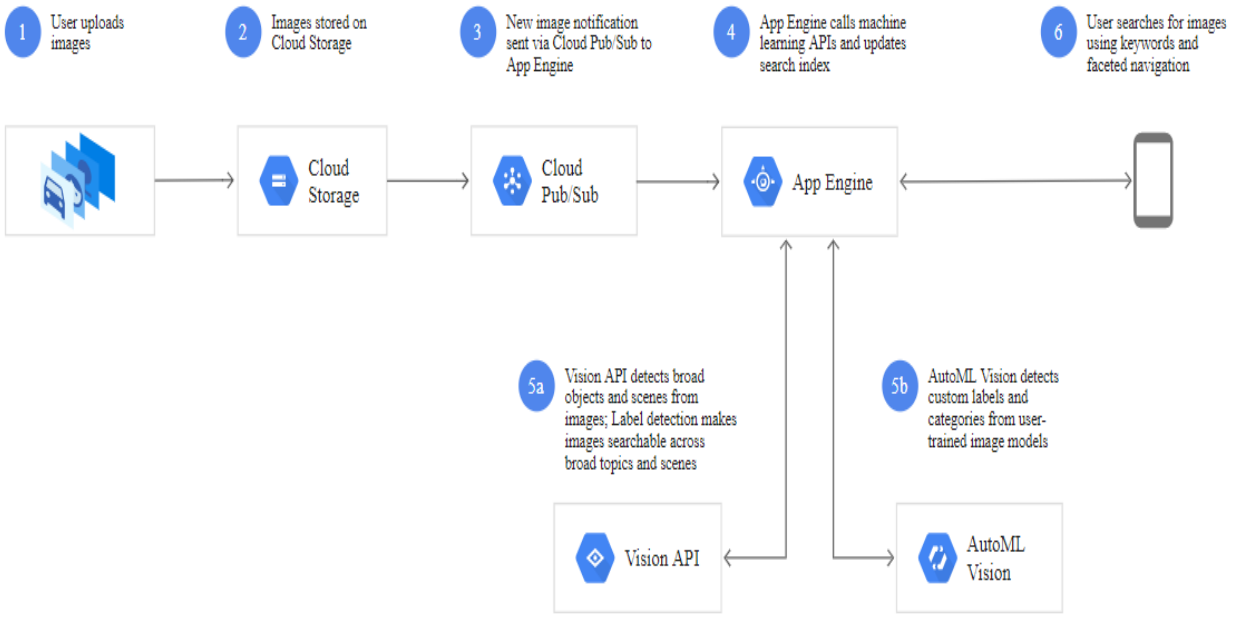
LITERATURE SURVEY

Paper Name	**Author & Publisher, Year**	**Algorithms used & How their modules work**	**Data Sets that the authors have used**	**Statistical measures / comparison criteria of their results**	**Merits of the methods that authors have proposed**	**Demerits / drawbacks /any further work**
Text Recognition from Images	Mr. Pratik MadhukarManwatkar (2015)	User will input a image and using preprocessing module, it will segment the images into different objects. These objects will then classified on the basis of shapes,curve using text recognition. Training is also done at this level so that it could able to figure difference between objects. Lastly text is stored in a proper format and can be used for reading.	Images of different characters	How accurately ocr is able to detect the text from variable aspects of images.	Text recognition technology may be apply throughout the entire spectrum of industries, revolutionizing the document management process. With the help of this technology, people no longer need to manually retype important documents when entering them into electronic databases.	Not efficient for handwritten documents. Letters need to be written properly for better accuracy. Limited document data can be converted to text at one time.

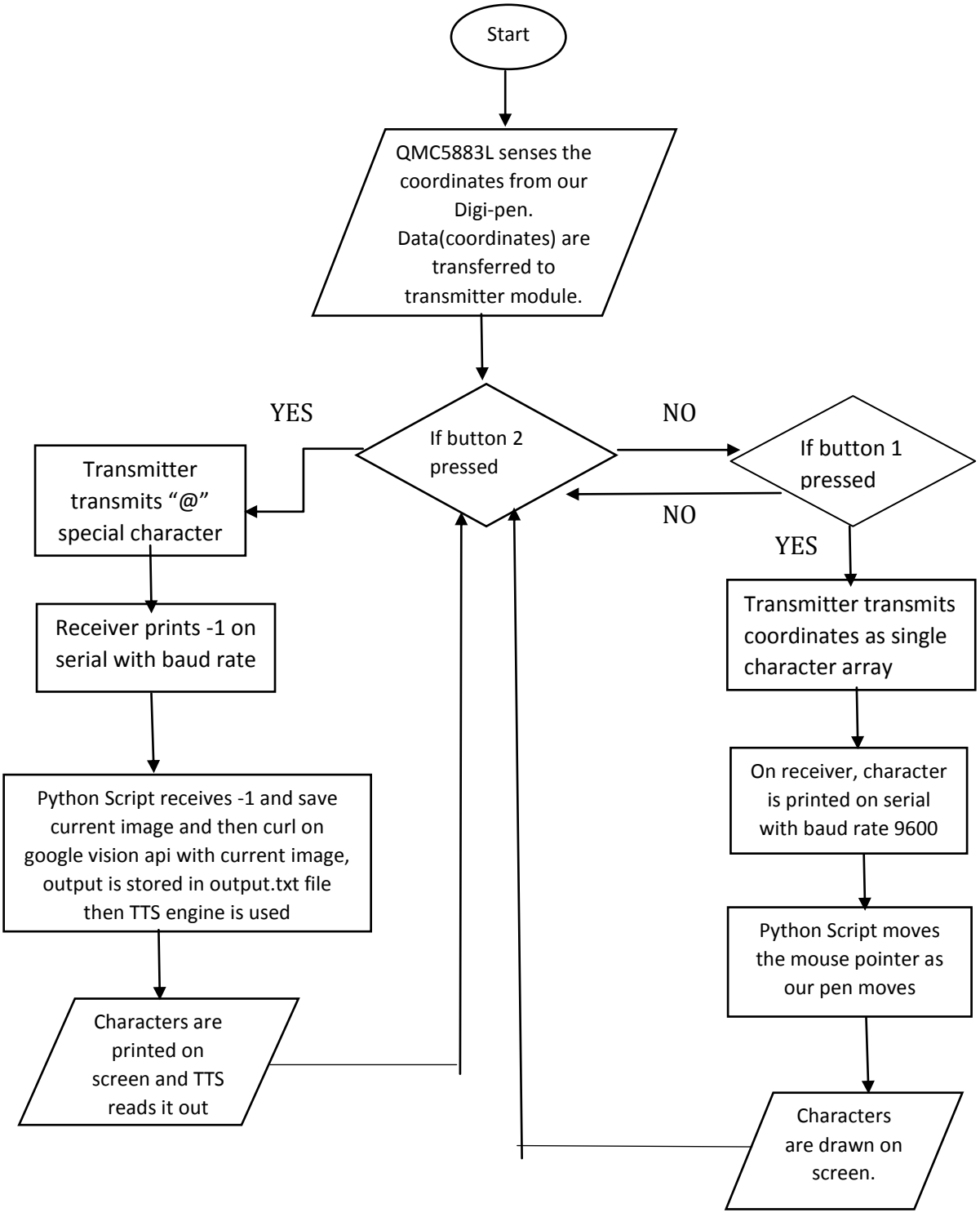
Paper Name	Author & Publisher, Year	Algorithms used & How their modules work	Data Sets that the authors have used	Statistical measures / comparison criteria of their results	Merits of the methods that authors have proposed	Demerits / drawbacks /any further work
An Overview of the Tesseract OCR Engine	Ray Smith (2007)	It is simple to detect inverse text and recognize it easily. Blobs are organized into text lines, and regions are analysed. Text lines are broken into words according to the kind of character spacing. Then recognition of words is done in 2 steps. In 1st step word is passed in adaptive classifier to recognise it. In second step adaptive classifier runs it again for words that are not recognised properly.	Input image is divided into small outlines on white on black text.	Comparison between recent version of Tesseract with original 1995 results. Percent Error rate of both versions.	Being included in 4th UNLV test of OCR help OCR to get more performance in character recognition.	Tesseract is now behind the leading commercial engines in terms of its accuracy. Its key weakness is probably its use of a polygonal approximation as input to the classifier instead of the raw outlines. Accuracy could probably be improved with the judicious addition of a Hidden-Markov-Model-based character n-gram model, and possibly an improved chopper.

Software Used	Platform	Open Source	Application
Arduino IDE	C	Yes	To record movements of the pen and for the wireless connection between pen and the computer
OpenCV	C	Yes	Image Processing
Google Vision	Window Power Shell (Curl)	Yes	Image to Text conversion (OCR)
Festival Engine	Python	Yes	Text-to-speech Conversion

METHODOLOGY



Flow Chart -


Start
QMC5883L senses the coordinates from our Digi-pen. Data(coordinates) are transferred to transmitter module.
If button 2 pressed
YES
NO
Transmitter transmits "@" special character
Receiver prints -1 on serial with baud rate
Python Script receives -1 and save current image and then curl on google vision api with current image, output is stored in output.txt file then TTS engine is used
Characters are printed on screen and TTS reads it out
If button 1 pressed
NO
YES
Transmitter transmits coordinates as single character array
On receiver, character is printed on serial with baud rate 9600
Python Script moves the mouse pointer as our pen moves
Characters are drawn on screen.

Module / Function Name	**Algorithm / Pseudocode**	**Description**
Digi-Pen	It outputs three axes (x,y,z) that describe its position with respect to earth's magnetic field.	A pen is attached with a magnetometer (GY273 qmc5883). It is used to record movements of the pen.
Transmitter	It combines three coordinates for a position in an array. When we press button1, array is sent to the receiver. And when we press button2, '@' special characters are sent to the receiver which will be handle at a receiver side.	It constitutes two modules – nRF (radio frequency module) and Arduino UNO(microcontroller board). It receives input (coordinates) of the pen and transmits a character array of coordinates to receiver.
Receiver	The received character array is analysed and if it receives array, it will print it in serial monitor and if @ is received, then -1 is printed on the serial monitor.	It constitutes two modules – nRF (radio frequency module) and Arduino UNO(microcontroller board). The data received is analysed and a letter is drawn in GIMP software .
Python Script	This program reads the coordinates from serial monitor and analyse them and decides the direction of movement of the pointer using various conditions to draw the alphabet. Then the alphabet's image is saved and processed through the google vision cloud. Then the received text is sent to text-to-speech engine.	This python file is the backbone of our project which runs every command.
OCR (optical Character Recognition)	User will upload the images which is stored on the Google Cloud Storage. New image notification is sent via Cloud Pub to the App engine which will later call machine learning APIs and updates the search index. User searches the image using keywords and faceted navigation.	OCR is performed with the help of Vision API and auto ML Vision.

Text-to-speech Conversion	It takes the converted text from google vision as input and convert it to speech.	The text is converted to speech using Festival Engine.

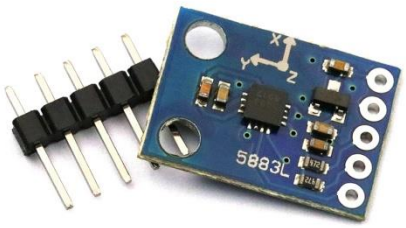
Results

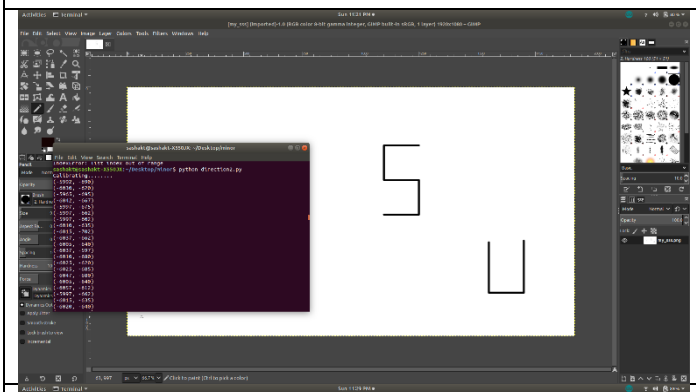
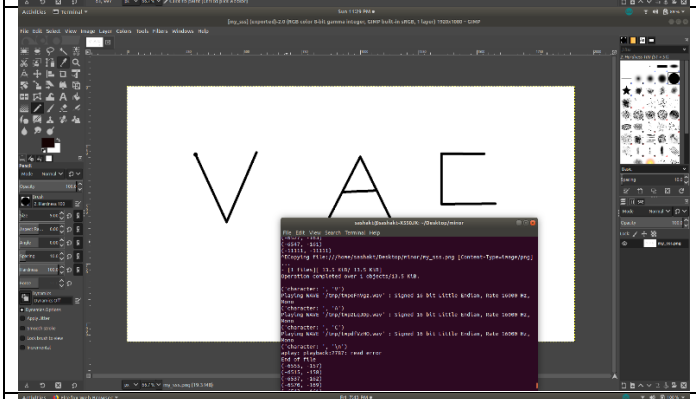
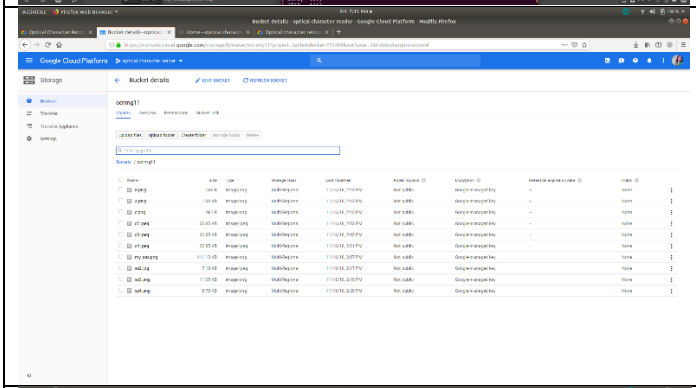
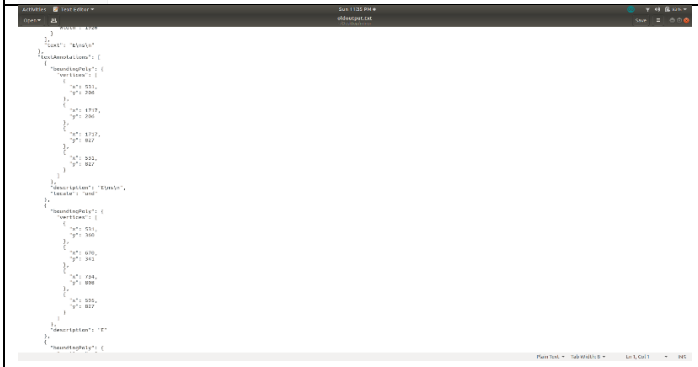
Hardware Requirements:

- Arduino Uno (microcontroller board)
- nRF 24L01 (radio frequency module)
- GY273 qmc5883l (magnetometer)

Software Requirements:

- Arduino IDE
- OpenCV
- Google Vision
- Pillow
- Talkey
- Festival Engine
- GNU Image Manipulation Program



Screen shot image	What does it do.	Any inputs that it takes & processing that it might perform	What is the output / where does the output values / variables go.
	It shows calibration of our Digi-pen.	Take coordinates as input and draw the letter according to them.	Output – F,S These letter's image is sent for text recognition.
	Image is analysed to retrieve the corresponding text	Image of the text	Output- V,A,C This image is sent for text recognition.
	It is the google cloud storage which contains input image and output text.	Image of the text	Output File is stored on the cloud.
	It is the format of the output received from the google cloud.		

Test Case Variables	Test Data Values	Output	How critical is the test case
	F,S,U	OCR recognising Letter 'F', 'S' and a voice saying the letter 'F', 'S'.	4 ('U' is not recognised)
	F,S	OCR recognising Letter 'L' and a voice saying the letter 'L'.	1
	V,A,C,H	OCR recognising Letter 'V','A','C' and a voice saying the letter 'V','A','C'.	3 ('H' is not recognised)

CONCLUSION AND FUTURE WORK

- The Digi-pen is highly helpful to convert handwritten notes into digital text.
- It is helpful for blinds to learn as when they write they could able to understand what they are writing.
- It is a cost-effective technology that can be integrated.
- If you are a student taking notes in classes or lectures, imagine how brilliant it would be to get back to your room, immediately upload all your notes to your computer and instantly print them out in neat typed form.

Future works-

1. With the help of this digital pen, people will be able to write notes on the air, while being busy with their work.
2. Till now, this product is not at its level best and require further improvisation to get better results.

References

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- https://github.com/opencv/opencv
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- https://github.com/usc-isi-i2/festival-text-to-speech-service
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- https://ieeexplore.ieee.org/document/7193210
- https://ieeexplore.ieee.org/abstract/document/4376991

Appendix – I

Sashakt Pathak	**Arushi Agarwal**	**Shubham Aggarwal**
Arduino IDE codes (Transmitter, Receiver and magnetometer)	Hardware Connections (Transmitter, Receiver and magnetometer)	Python Script
Python Script	Python Script	OpenCV
Google Vision(OCR)	Festival Engine(TTS)	Google Vision(OCR)