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A Survey on Digitization of Handwritten Notes in Kannada

K Amulya, Lakshmi Reddy, M Chandara Kumar, Rachana D

Abstract: ***Recognition of handwritten text is still an unresolved research problem in the field of optical character recognition. This article suggests an efficient method for creating handwritten text recognition systems. This is a challenging subject that has received a lot of attention recently. A discipline known as optical character recognition makes it possible to convert many kinds of texts or photos into editable, searchable, and analyzable data. Researchers have been using artificial intelligence and machine learning methods to automatically evaluate printed and handwritten documents during the past ten years in order to digitize them. This review paper's goals are to present research directions and a summary of previous studies on character recognition in handwritten texts. Since different people have different handwriting styles, handwritten characters might be challenging to read. Our "Digitization of handwritten notes" research and effort is to categorize and identify characters in the south Indian language of Kannada. The characters are extracted from printed texts and pre-processed using NumPy and OpenCV before being fed through a CNN.***

Keywords: ***C-NN (Convoluted Neural Networks), Image Processing, Segmentation***

I. INTRODUCTION

Digitization refers to the conversion of text, pictures, or sound into a digital form that can be processed by a computer. A Dravidian language with literature that dates back to the ninth century, Kannada is mostly spoken in the state of Karnataka in South India. In addition to the Karnataka, neighbouring states of Andhra Pradesh, Tamil Nadu, and Maharashtra, also speak in Kannada. There are around 44 million speakers of Kannada. The alphabet of the language has 47 characters, including 13 vowels and 34 consonants. These writings are incredibly difficult for individuals to read and understand, especially those who are not familiar with the language, thus trying to copy and recreate them would be a tedious and time-consuming operation. As a result, a computerized system that serves as a conduit between machines and humans becomes necessary.

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By graphically combining the symbols for consonants, consonant modifiers, and vowel modifiers according to established principles of combination, the characters known as aksharas are created.34*15=544 are potential consonant-vowel combinations and 34*34*16 = 18511 different consonant-consonant-vowel combinations are allowed. The training dataset is the Chars74K dataset. The data set includes 25 handwritten Kannada alphabets, vowels, and consonants that are divided into 657 groups.

II. BACKGROUND AND OBJECTIVES

Currently, tangible copies of documents are the norm in government agencies. The ability to digitize this will boost these offices' productivity and simplify data transfer across networks. The complexity is tremendous due to the enormous number of classes that letters, numbers, kagunitas, and ottaksharas form. As we all know, a large number of people in Karnataka today are from different parts of the nation and struggle to read and write Kannada. Such people would find it challenging to do even basic tasks in government organizations.

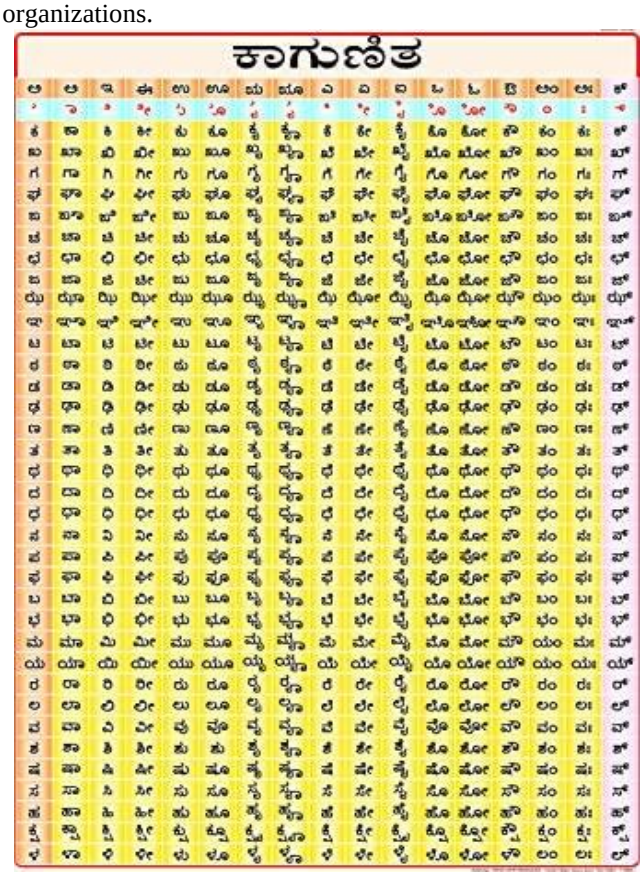

Fig-1: List of Kannada Kagunitas [2]

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Deep learning in particular has gained importance in artificial intelligence and computer vision during the past few years. Learning-based techniques have been investigated for natural language processing, plant detection, human action recognition, picture segmentation, and image classification In this study and project, we employed a deep learning technique to categorize handwritten characters.

Construction of an architecture is carried out using convolutional neural networks (CNN). Kannada characters have to be identified and categorized according to the proposed approach. Using convolutional neural networks, we have developed a system for character classification and recognition in a picture of predominantly handwritten Kannada text. With so many peculiar characters in a regional language like Kannada, it can be difficult to extract those characters from a scanned text. Character recognition is accomplished using three machine learning algorithms: segmentation, feature extraction, and classification. hand are considered. Before cutting and resizing each character image, we first cleaned up the scanned image by taking out the noise. The additional pixels in the image after preprocessing allowed us to train the CNN for precise classification into the appropriate classes. The Kannada vowels, consonants, and digits written by hand are considered. Despite some simple Kannada characters having structural similarities, the model can place them in the appropriate groups.

III. LITERATURE SURVEY

Due to its complex structure and variety of handwriting styles, [1] Gandharan M H and Dr. Lakshman Naik, Kannada Handwritten Characters are a challenge in the field of pattern recognition. In this study, they suggest a method for reading handwritten characters (vowels, consonants, and digits) in kannada that uses convolutional neural networks and transfer learning. The character can be placed in the proper class by the model. The newly developed CNN model had a validation accuracy of 86.92% after training. Two methods for identifying handwritten Kannada writing are suggested in [2] Sangeetha G and Dr. Lakshman Naika, both of which have a high degree of accuracy when compared to earlier attempts.

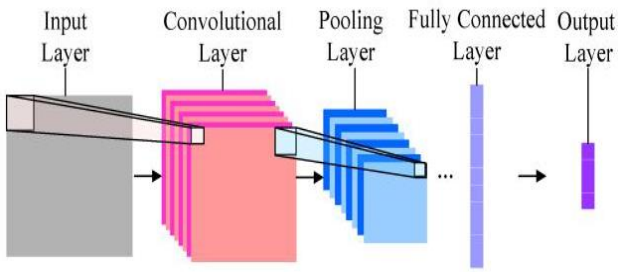

Fig-2: CNN Architecture [10]

The Tesseract tool is used in the first method, and the Convolution Neural Network is used in the second (CNN). The Convolution Neural Network offered 87 percent accuracy compared to the Tesseract tool's 86 percent.

They offer a segmentation-free OCR solution in [3] Ms. Roopa Tonashyal and Mr. Y. C. Kiran, that combines deep learning techniques, synthetic training, data generation, and data augmentation methods. Both recurrent and convolutional neural networks are used to depict the interactions between input components. They contend that the suggested architectures outperform popular commercial and open-source engines. For handwriting detection, this study [4] Leena Ragha, M. Sasikumar, uses machine learning, deep learning, and transfer learning approaches. Results of model performance are significantly impacted by data augmentation. The best recognition rate on Dig-MNIST was achieved using the Inception model with data augmentation and transfer learning. How to recognise and categorise photographs is a significant computer-related subject. [5] Thingamajig M, Dr. Ramakant Kumar, P Keshava Prasanna, Shravani Krishna Rau, presents methods for handwriting recognition. Convolutional Neural Network Method, Semi Incremental Method, and other techniques for handwriting identification. The purpose of the study in [6] B.V. Dhandra, Gururaj Murakami, Mallikarjun Hangarage was to identify Arabic handwriting. Test set accuracy, precision, recall, and F1 score were all on average 97 percent, 96.78 percent, 96.73 percent, and 96.73 percent. In this study [7] Suresh Kumar D S, Ajay Kumar B R, K Srinivasa Kalyan, it was detailed how Telugu text is decoded using OCR, Deep Learning, and Segmentation, which are all parts of OCR. Different OCR approaches are compared, and surveys show how OCR develops into the model that performs better than other machine learning models. [8]Suggested for 99.09% accurate SVM Classifier-based handwritten character recognition in Kannada. K-NN and SVM classifiers can be used to recognise characters.

IV. METHODOLOGY

4.1 Data collection:

It is well known that there are no standard databases for handwritten Kannada text in this literature, making it difficult to validate the results of the alphabets. As a result, our own database is used to create and collect the datasets.

In total, 6850 photographs of Kannada consonants and 2850 images of Kannada vowels were gathered from different groups of people in middle schools, high schools, colleges, and universities. This collection of data is digitised at 300 dpi using a flat-bed Cannon scanner, which typically produces minimal noise and high-quality images. The photos are cropped, then they are saved as grayscale pictures.

Natural hand movements and errors in the required input's digitization often cause variances in the digitised images. By using a median filter, the variations that are present in the photos are eliminated. The isolated character is then fitted using a minimal bounding box.

The cropped image is normalised to a 64x64 pixel size in order to create consistency between the character images. The handwritten Kannada vowels and consonants are displayed in a sample image [9].

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Table 1: Summary of Literature Survey

Source info	(IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 7, No. 1, 2016	(IRJET) International Research Journal of Engineering and Technology Volume: 09 Issue: 06 | Jun 2022	International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Published by, www.ijert.org ICESMART-2015	International Journal of Advanced Research in Computer and Communication Engineering Vol. 4, Issue 7, July 2015
Research topic/question	Segmentation and Recognition of Handwritten Kannada Text Using Relevance Feedback and Histogram of Oriented Gradients – A Novel Approach	ONLINE KANNADA HANDWRITTEN WORDS RECOGNITION USING DEEP LEARNING	A Comprehensive Survey on Kannada Handwritten Character Recognition and Dataset Preparation	Basic Kannada Handwritten Character Recognition System using Shape Based and Transform Domain Features
Methodology	→Segmentation method →Recognition Method	Data is collected using graphic tablets and then resized.Data is then segmented into 3 categories.CNN model is used where 80% of data is training and 20% for testing.Collected data is assigned a number and stored.Output is displayed using anaconda	• Preprocessing • Segmentation • Feature Extraction • Classification	DATA COLLECTION AND PREPROCESSING FEATURE EXTRACTION CHAIN CODE METHOD WAVELET DECOMPOSITION
Findings	→Four different category of kannada text →The data is collected from 51 individuals	Training accuracy is 99.23%, training loss is 0.0251%, testing accuracy is 97.09% and testing loss is 0.210% by Tensor Flow. As CNN classifier is used, it gives the more accuracy when compared to that of other methods.	• Offline handwritten character recognition and dataset collection. • provides better information about Kannada handwritten character recognition and dataset preparation.	An algorithm exhibited the average percentage of recognition accuracy as 90.09% with SVM classifier with 2-fold cross validation.
Limitations	→Data related to govt docs →Kannada Numerical digits	Works only when letters are written by stylus and tablet. Does not work on documents or physical paper.	• Not applicable on kannada numerical values • Characters should not touch outer-box.	The proposed work is to meet the objective of recognition of similar shaped Kannada characters.
Areas for future research	To address the segmentation of the touching characters in the document.	Words can be scanned from documents and then converted	To achieve more accuracy in subscripts(vattu).	To improve the recognition rate and test with other classifiers.

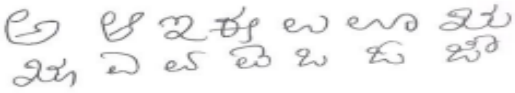

Fig-3: Vowels in Kannada

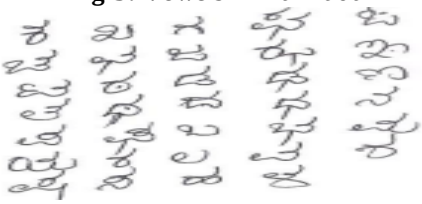

Fig-4: Consonants in Kannada

4.2 Linear Segmentation of Segments

The most important pre-processing step for document scanning is line segmentation. After the lines of handwritten text have been separated, word segmentation, word recognition, and other indexing procedures essential for document scanning can proceed. Line segmentation is greatly hampered by the presence of intersecting lines.

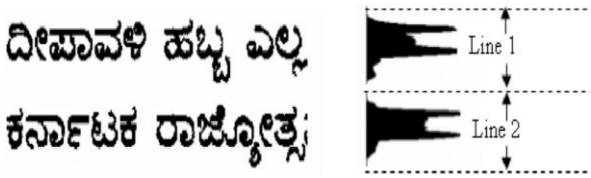

Fig-5: Line Segmentation [10]

4.3 Word segmentation:

Following line segmentation, words are segmented. The line segmented portion will be further separated into separate words during word segmentation. Based on the counters, every word will be recognised as an image. After then, it is kept in a distinct folder.

4.4 Character division.

Because there is an Ott Akshara, character segmentation is applied after line and word segmentation for both axes. Each character is identified, after which it is placed in the character segment folders.

4.5 CNN (Convoluted neural networks)

Using the CNN model, we use the 80-20 split 80% of the data is used for training and 20% of the data for testing. Among the available neural network algorithms CNN is considered as one of the best.

It consists of three layers, namely

1. Input Layer
2. Hidden Layers
3. Output Layer

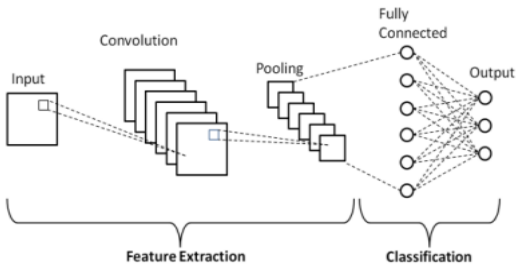

Fig-6: CNN Architecture [1]

Feature extraction & classification are done using convoluted neural networks. Hidden layers in CNN are:

Hidden layers in CNN are:

1.Convolution Layer
2.Pooling Layer
3.ReLU Correction Layer
4.Fully connected layer
5. Softmax layer.

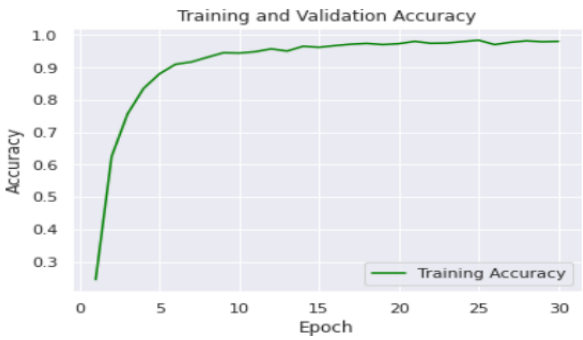

Fig-7: Training vs Validation Accuracy [1]

Result The output window is obtained here using the anaconda prompt.

The outcome is displayed in three windows. User input is accepted in the first window, and their output is shown in the same window. The window allows type alphabetic characters in addition to displaying kagunita combinations. The user may alter these settings in this output box. The user can access the standard Kannada text for letters, words, and lines via this window. As a result, this window is thought to be the best of all the windows. Huge data collecting is the key issue with this work. The user must understand how to hold the graphics tablet, how to hold the stylus pen, and where tobegin and stop writing.

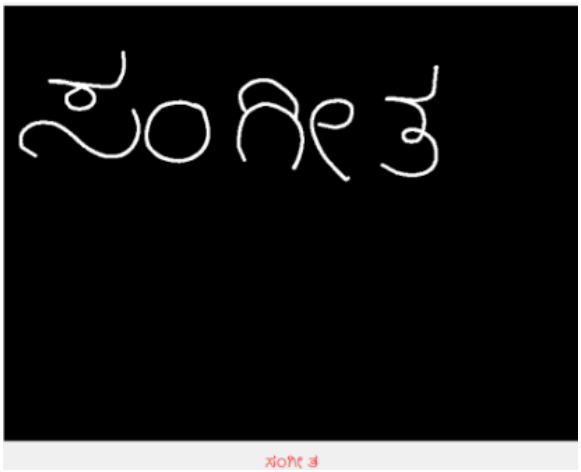

Fig-8: Output window on anaconda [2]

4.6 Augmentation:

Image augmentation is a method for changing already-existing photos to produce more data for the model-training procedure. It is the process of artificially expanding the dataset that can be used to train a deep learning model, to put it another way. For feature extraction CNN, the most appropriate relevant features for classification are chosen. Convolution layer, maximum pooling, flattening, and completely connected layers are included in this.

Fig-9: Augmented Image [11]

4.7 Image pre-processing:

It is essential for improving the image quality, which is crucial for computer vision. The input is an image, as may be seen below. The output would be the attributes linked with the image, which may be a scanned paper. When a CNN is trained using raw images, classification results could result. hence, imagine Pre-processing procedures are essential to understanding deep learning principles.

The steps are: grayscale image conversion, noise removal, contrast normalisation, binarization, and lastly segmentation.

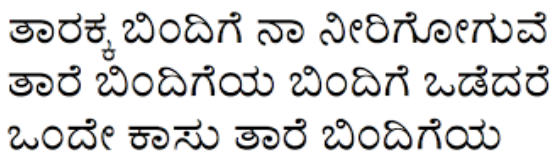

Fig-10: De-noised text [11]

The steps are: grayscale image conversion, noise removal, contrast normalisation, binarization, and lastly segmentation.

a. The grayscale conversion is the initial step in pre-processing. Grayscale images are created by transforming coloured images in this step.
b. Generally speaking, there are 256 different shades of grey in a gray-scale image. It must be transformed from grey to black and white. It is crucial in bringing down the intricacy of the image. This is accomplished by converting the image's 3D pixel value to its 1D value.
c. b. Denoising is the following step. The input documents may be subjected to several noises because they are a compilation of various sources (inconsistencies). De-noising will therefore help in further reducing noise from the image.
d. c. The process of binarization, which turns the gray-scale image into a binary image, is the next step. This would be the method for turning a grayscale image with 256 shades of grey into black and white, which is then transformed into a binary image.

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4.8 Pre-Processing

The CNN Algorithm is used for this application. Typically, a picture is taken as input from the input layer. CNN evaluates each component of the image, referred to as features, and matches them with components from other images in the dataset that have comparable characteristics. By integrating the output of neuron clusters at one layer into a single neuron at the next layer, Max-pooling lowers dimension, computation, and over-fitting. The maximum values are picked from the window in this method.

V. IMPLEMENTATION

All the samples are divided into training and testing data. Different programs are written for segmentation, pre-processing in python. For segmenting words Open Cv library of python is used which contains bounded rectangle functions in order to get the character from the document. The other python libraries we have used NumPy for array objects and pandas for manipulating table data, we store image names and their values in a table where each row represents a particular character of the kannada alphabet. The overall result is an application which accepts images of kannada characters and predicts output of the same.

VI. RESULTS

For straightforward Kannada text, the system has an accuracy rate of above 92%. Character recognition is quite accurate. The accuracy decreases when ottaksharas and dheergas are included as input.

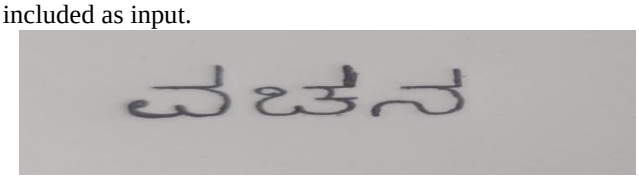

Fig-11: Written note [3]

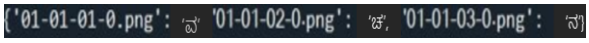

Fig-12: File stored [3]

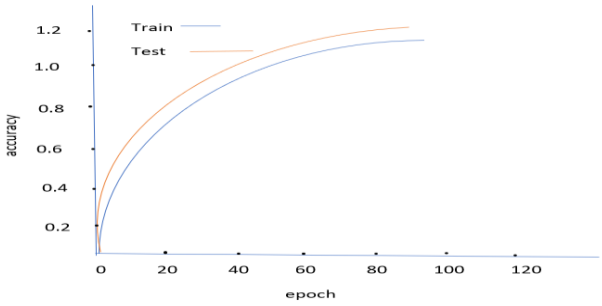

Fig-13: Model Accuracy [1]

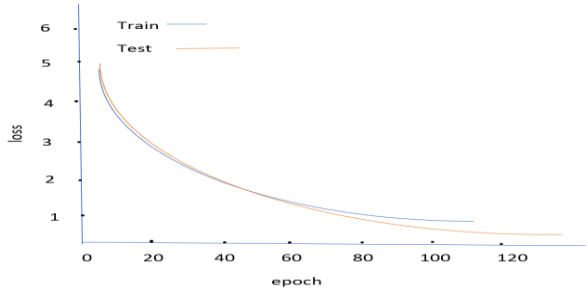

Fig-14: Model Loss [1]

VII. CONCLUSION

CNN is used in this model which gives an accuracy of 92 percent. The application only works for recognising words, further; it could be used for identifying sentences and paragraphs as well as capturing letters entered by users via a pen. To extract the character from the document, the Open Cv library of Python, which has bounded rectangle functions, is utilised for word segmentation.

We store image names and their values in a table with each row denoting a different character of the kannada alphabet, using the other Python tools NumPy for array objects and pandas for working with table data. The end result is a programme that predicts what will happen to images of Kannada characters. The system's accuracy rate for plain-vanilla Kannada text is over 92%. The accuracy of character recognition is high. When ottaksharas and dheergas are used as input, the accuracy suffers. Max-pooling reduces dimension, computation, and over-fitting by integrating the output of neuron clusters at one layer into a single neuron at the following layer. This method selects the maximum values from the window.

It is critical for enhancing image quality because computer vision depends on it. As seen in the figure below, the input is an image. The attributes associated with the image, which may be a scanned paper, would be the output. Results for classification may be obtained when a CNN is trained using raw images. Through this window, the user can access the standard Kannada text for letters, words, and lines. This window is considered to be the best of all windows as a result. The main problem with this endeavour is the massive data collection. The user must be aware of the proper grip for the stylus pen, graphics tablet, and where to start and stop writing. By saying this we would like to conclude.

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Without mentioning the individuals whose persistent assistance and encouragement made this Capstone Project possible, the satisfaction that comes with its successful completion would be lacking. We want to express our gratitude to our parents and friends for their unwavering support. We really appreciate **Dr. M. Shahina Parveen's** assistance and guidance throughout the process. She is the Chairperson of the department of Computer science and Technology. Our sincere appreciation and compliments go out to **Prof. Suparna H S**, Assistant Professor, Dept of CST, for her assistance with this project's execution and ongoing support.

SCOPE

The application can be used to make digitized text in kannada easily available to anyone who is willing to use it. Rather than typing long text in kannada one can just write the same on paper and then input it to the application which gives text in digitized form which can then easily be copied and pasted for various application.

The model can be prepared for scanning long documents which after conversion to the digitized text form can then be stored in a database making it easier to search and retrieve the data. Text summarization functionality can also be added such that long documents summaries are easily available if there a large number of documented text. OCR is a topic that is currently the subject of extensive research. Future research in this area will be made easier by this endeavour. Examples of the hyperparameter optimization techniques' extensive applicability could be presented

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11. https://github.com/ShandonType/Benne

AUTHORS PROFILE

K Amulya. Education: Is Pursuing B. Tech in Computer Science and Technology at Dayananda Sagar University Bengaluru, Karnataka, India. Her major area of interests are in the field of data analytics, machine-learning and knowing more about machine-learning models. Some of the programming languages frequently used by her in her research work are python, R-programming with visualization tools on both and SQL when required. As a researcher she is always keen on new research material published by the journal which helps her challenge herself and explore unknown territory. As her first publication it would not have been possible without the help of her guides and colleagues

Lakshmi Reddy is currently pursuing her B. Tech in Computer Technology Department at Dayananda Sagar University Bengaluru, Karnataka, India. Her major interests include Artificial Intelligence, Machine Learning, Web Development, Deep Learning, Data Engineering, Cyber Security, Image Processing, User Interface Design, User Experience, Business Intelligence, Algorithms ,Data Structures, Compiler Design, Project Management, Digital Electronics, Game Design, Human Computer Interaction, Natural Language Processing, System Software, Data Science, Automation, Testing, Database Management and Security, Programming languages and Computer Networks. She likes to work on projects in web development and has worked on projects with technologies like ReactJs, HTML, CSS. She has also worked on projects related to data analytics

Rachana D is currently pursuing her B. Tech degree in Computer Science and Technology at Dayananda Sagar University, Bangalore, Karnataka, India. Her areas of interests include Cyber security and cryptography, AI, ML. She derives a greater interest in achieving innovations and strive to always keep her updated with new technologies in market. She is awarded with "Saraswathi puraskar" state award for matriculation result of above 600 score in 2017.Her extra-curricular interests include sports where she represented her university DSU at Inter-university National athletic championship in 2020, also represented Team Bangalore(S) at several state-level tournaments during her pre-university college days in Kho-Kho, Cross-country and Athletics. She is also a state-level NSS volunteer.

M Chandara Kumar is currently pursuing his B.Tech degree in Computer Science and Technology at Dayananda Sagar University, Bangalore, Karnataka, India. His areas of interests include Data science, cloud computing, Java, AI,ML. My natural ability for logical thinking and problem solving has been strengthened through the study of these academic subjects and the constant challenge of applying new methods and concepts.He has successfully completed mini projects on web and software based applications that include some of the projects like library management system, e - commerce website, online fertilizers store etc. He has achieved an aggregate score of 82 % in SSLC 10 th ICSE Board and 80% in 12 th Puc Board. He also Participated in various programs conducted in the university such as workshops, webinars and seminars. He had been fascinated by technologies in general and computers in particular from the beginning. He as participated in various competitions for learning new skills. He has also won first prize and participation certificates in various art and competitions .