**Form 4: Results and conclusion**

**1. Team No :** 02

**2. Project Title :** LSTM based OCR

**3. Experiment Environment :**

● VS Code:

Visual Studio Code, also commonly referred to as VS Code, is a source-code editor developed by Microsoft for Windows, Linux and macOS. Features include support for debugging, syntax highlighting, intelligent code completion, snippets, code refactoring, and embedded Git. Users can change the theme, keyboard shortcuts, preferences, and install extensions that add functionality.

● Python Programming Language:

Python is a high-level, interpreted programming language known for its simplicity and readability. It supports multiple paradigms, including procedural, object-oriented, and functional programming. Python is widely used in machine learning, data science, artificial intelligence, and automation, making it a versatile and popular choice for programmers.

● Datasets:

We have collected the required datasets from IEEE Dataport, which contains 11,055 images of Telugu characters(achulu, guninthalu, hallulu, otthulu).

**4. a Experiment 1:**

**Experiment Finding 1:** Data Collection

The dataset consists of all the Telugu characters that contains Vowels, Consonants and combine characters such as Othulu (Consonant-Consonant) and Guninthamulu (Consonant-Volwels). The main objective of this dataset to recognize handwritten Telugu characters, from that convert handwritten document into editable electronic copy. There is a significant difference between Indian literature and English literature, i.e., if we see English literature only 26 Characters, but where in Telugu total number of characters are 1,924 (Achulu (Vowels)- 16, Hallulu (consonants)- 36, Othulu – 36 and Guninthamulu – 34\*16=544). Hence, problem of recognition of Telugu characters are complex in compared to English. Furthermore, no dataset of Telugu characters that covers all characters in Telugu literature and even the worldwide encoding standard “Unicode” have not covered all Alphabet in Telugu. The objective of this work is to present a Handwritten Telugu character dataset with all Telugu Alphabets, assigning unique label to each character from there assign ‘Unicode’ to each label. If we could bring all Telugu and other Indian language characters into ‘Unicode’, it will resolve compatibility issues of all major Operating Systems and Word Processors.

**Findings:**

* Unicode support
* Labelled Dataset

**4. b Experiment 2:**

**Experiment Finding 2:** Building a Text Recognition Model with TensorFlow and CTC network.

 Extracting text of different sizes, shapes, and orientations from images is a fundamental problem in many contexts, especially in augmented reality assistance systems, e-commerce, and content moderation on social media platforms. To solve this problem, we need to extract text from images accurately.

Method:

* CNN feature extraction
* CNN Features to LSTM layer
* CTC loss (Connectionist Temporal Classification)

**Findings:**

* **Text Detection** helps you identify the location of an image that contains the text. It takes an image as input and gives boxes with coordinates as output.
* **Text Recognition** extracts text from an input image using bounding boxes derived from a text detection model. It inputs an image with cropped image parts using the bounding boxes from the detector and outputs raw text.

**4. c Experiment 3:**

**Experiment Finding 3:** LSTM based OCR for Telugu

The above used method in experiment-2 are applied for the Telugu dataset collected in experiment-1.

**Method:**

CNN feature map is fed to LSTM layer and based on the CTC Loss we use a clever encoding scheme to solve the problem of blank and duplicate characters.

A graph with a line and number

Description automatically generated

Number of epochs------>

**Findings:**

* While training the model with the CTC loss function, we only need to know the exact word in the image. Therefore, we ignore both the position and the width of the symbols in the image.
* The project is designed with a user-friendly interface.

**5. Parameter comparison table**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Previous Methods** | **Proposed Method** |
| Model Accuracy | High but is based on the number of epochs trained using CNN. | High as LSTM works well with sequential data. CNN performs character recognition based on features and these identified features are fed to the LSTM layer which performs text recognition. |
| Speed | Very slow as model recognizes individual characters which later are combined. | Faster when compared to previous methods |
| Correctness | Very low as the image always may not be of desired quality so blank and duplicate characters are produced | CTC Loss function ensures no blank and duplicate characters based on loss values. |

**6. Conclusion Statements**

In summary, Telugu OCR research has made significant strides using deep learning techniques, particularly LSTM-based models. Obtaining high-quality training data was essential for achieving accurate results.

**Signature of Supervisor**

**Dr K Shailaja**