

systems [4], yet still smartphones suffer from computational power [5]. Proposal is a client-server approach, which is much better in terms of computational power of smartphones.

In this paper we propose a client-server system, which addresses these drawbacks using CNN classifier which has shown better performance [6][7]. Focus of this study is on Persian Sign Language (PSL) recognition system on a smartphone platform that can recognize Persian Sign language and create a word and translate the word to English.

Gesture recognition applications include different stages such as: segmentation, feature extraction and classification. The aim of segmentation is to eliminate the noise in the background, leaving only Region of Interest (ROI), which is the main useful data in the picture. In feature extraction stage, ROI is the focused area to extract from image. These highlights can be edges, shapes, flows, corners, colors, surfaces, etc. The highlight of pictures basically is personality of each communication via gestures motion. In the next stage, the features experience classification is completed, which is used to train the system, and decide to which group of gestures, the new sign belongs. [8]

There is much work done on sign language system with computer platform; however, very limited research has been done on cell phones platforms. The past research on cell phones have shown big disadvantage in computation and resource limitation. [9]

In the following sections, the existing literature is referenced, and subsequently, the proposed method, evaluation, conclusion, and future work.

II. EXISTING LITERATURE

Sign language has been part of communication medium in human life. The usage of signs or movements of body are not fixed to age, ethnicity, or sexual orientation [10]. Many researchers proposed different approaches in sign language recognition.

Paper [11], introduces a system that uses mobile phone to recognize sign gesture for skin detection it use three color space RGB, YCbCr, and HSI. For recognizing process it has step it use histogram matching, and out of that go to ORB algorithm and achieve 69.41% accuracy.

In paper [12], an Android system translating sign language is developed, for hand detection using OpenCV. For classification K-NN is used, the system detected up to 50cm away from palm of a hand for recognition of gesture.

S. M. Halawani [10] has proposed Arabic Sign Language Translation System (ArSL-TS). His model uses a smartphone to translate Arabic text into Arabic Sign language.

In paper [8], a method for better segmentation can recognize 32 Persian static sign gestures. Their method is used YCbCr color space, sign Gaussian model and Bayes rule. In order to recognize the sign gestures by help of radial distance and Fourier Transform sign gesture extraction, and by help of Euclidean distance to find similarity between hand gesture and training database. The accuracy of the system is 95.62%.

Cheok Ming Jin [4], proposed a smartphone platform for ASL (American Sign Language) recognition. He implements Canny edge detection plus seeded region growing in order to segment hand gesture in the picture, for extraction of feature Speeded Up Robust Features (SURF) algorithm and SVM

(Support Vector Machine) is used for classification. The accuracy of the system for 16 class of ASL is 97.13%.

In paper [13], static Persian Sign Language gesture for recognizing some word is presented. It uses a digital camera for taking pictures as an input. The system uses Discrete Wavelet Transform and Neural Network for feature extraction and classification. The classification accuracy is 98.75%.

[14] This paper presents a system to recognize Persian static sign gesture. A digital camera is used for taking input pictures, feature extraction and classification uses Wavelet Transform and Neural Network. The accuracy of the system is 94.06%.

Sakshi Lahoti [4], proposed a smartphone approach in order to recognize the American Sign Language (ASL), YCbCr system used for segmentation of skin in pictures captured by smartphone, for feature extraction they use HOG, and finally for classification SVM is used, the accuracy of system is 89.54%.

Promila Haque [15], proposed two-Hand Bangla Sign Language Recognition system, the system has three phases' formation, training and classification that can recognize 26 sign gestures. Principal Component Analysis (PCA) is used to extract image principle component and for classification K-Nearest Neighbors is used. He used 104 images for testing and achieved Precision 98.11%, Recall 98.11% and F-Measure 90.46%

In [6], a comparison classification between CNN and SVM show, CNN has better performance compared to SVM. The accuracy of CNN is 90%.

In [7], as shown in the research experiment the CNN improves the performance of classification.

Abbas Muhammad Zakariya, [5] proposed Arabic Sign Language (ArSL) recognition; based on client server approach which client is a smartphone. They use HSV color space for background elimination and SVM for classification and achieved accuracy of 92.5%.

III. PROPOSED METHOD

A client server recognition system is developed as shown in figure 2, as on the client side is a smartphone; user in client side could interact directly with smartphone application. The Android application catches sign gesture pictures as an input to the system, and sends it through Application Programming Interface (API) to server. On the other hand, on server side receives the picture from the client-server. After predicting and translating the text from sign gesture, server API sends it back to the client API responsible to show the text on the screen of smartphone

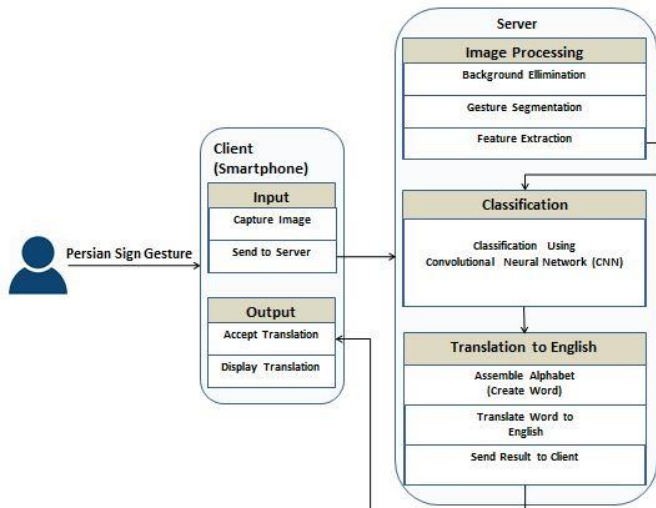


Figure 2 Machine Translation from Persian Sign to English on Smartphones

Client has two main responsibilities: first captures the sign gesture image as input for server and displays the prediction text on the screen of smartphone, while server has three main responsibilities: first preprocesses the input images, second, classifies and finally translates the predicted text to the target language.

A. Smartphone Application

A smartphone application is developed by android studio using Volley library as client to capture images and sent it over to sever for further processes. After that shows the result to user. The picture is saved in server directory and then the server reads these images from the directory. After processing and translating the images in to Persian word and translate it to English, the results are sent back to the client. Finally, the smartphone application displays the results to user. Some screenshots from the mobile application show in figure 5.

B. Background Elimination

The background of input picture which was sent from smartphone is detected and set to black. The picture transforms from one color space to another in this case from RGB to HSV, so the skin color is detected and series of dilation and erosion using elliptical kernel is made. The final frame is created by combining effect of two masks as shown in figure 3.

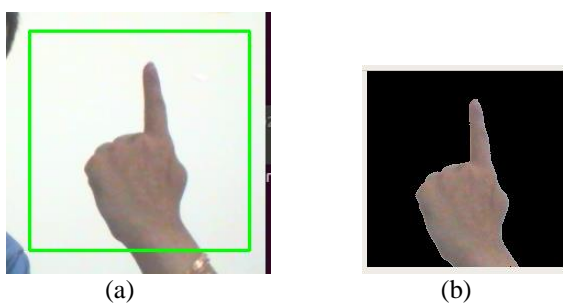


Figure 3 (a) Raw Picture, (b) Picture after background elimination

C. Background Elimination

The picture from previous process where the background was changed to black is first converted into grayscale, although the color of original picture is lost, this process increase the robustness of system to variety of lighting conditions, after that pixels which is non-black pixels change to white (binarize) and the rest of pixels remain black, then the segmentation of hand gesture is begun by removing all connected component in the picture and only allow the largest connected components that is the sign gesture, resizing the image into 64*64 pixels. The whole process is shown in figure 4.



Figure 4 (a) Binarize, (b) Segment hand gesture and resize

D. Feature Extraction

The sign language gesture images are normalized and scaled to 64*64px, binary pixels of the image are what we use as features. We found out that scaling to 64 pixels will contain good enough features to classify the Persian Sign Language (PSL) gestures efficiently. By using 64*64px we will be having 4096 number features.

E. Classification

A Convolutional Neural Network (CNN) is what we use to classify our sign gesture datasets extracted from the pictures. CNN is a multilayered neural network; it has especial architecture in order to discover complex features in data. It's mostly used in image recognition, powering vision in robots and self-driving vehicles. CNN has three main steps: 1. Convolution, 2. ReLu, 3. Pooling, 4. Flattening, and 5. Full connection.

F. Translation to English

The words recognized by CNN classifier are placed in an array in order to construct a word, then by using a bilingual dictionary, in this case Google-translate, library of Python, translating a Persian word to an English word. The word that is translated is sent to the client (Smartphone), as shown in figure 5.

The word which is used to translate is combination of 10 Alphabetic letters A(ا), B(ب), C(س), D(د), Gh(غ), K(ك), N(ن), O(ا), T(ت), and Y(ی).

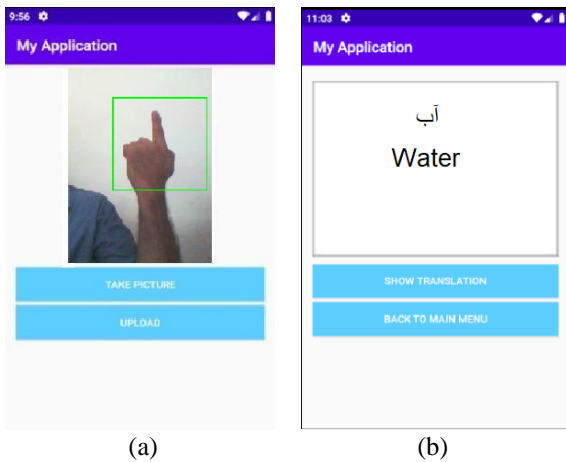


Figure 5 (a) input gesture sign, (b) Translation in English

IV. EVALUATION

For each of the 10 Persian Sign Language the model is evaluated, which have the following Alphabetic: A(آ), B(ب), C(س), D(د), Gh(غ), K(ک), N(ن), O(اُ), T(ت), and Y(ی). We have used a total of 2000 images to train the Convolutional Neural Network (CNN) classifier. For evaluation system performance, we split our training image to 20% testing and 80% training, and we have obtained an accuracy of 98% Table 1 shows detailed precision, recall and F-Measures for each class.

TABLE 1 PRECISION, RECALL, F-MEASURE

Letter	Precision	Recall	F-Measure	Support
A	0.98	1.00	0.99	40
B	1.00	1.00	1.00	40
C	1.00	1.00	1.00	40
D	1.00	1.00	1.00	40
GH	1.00	1.00	1.00	40
K	1.00	0.88	0.93	40
N	1.00	0.97	0.99	40
O	0.87	0.97	0.92	40
T	1.00	1.00	1.00	40
Y	1.00	1.00	1.00	40
Accuracy			0.98	400

V. CONCLUSION AND FUTURE WORK

There are many Computer base systems for sign language recognition as mentioned in this paper, but they are not, practical because not possible to carry around for sign gesture recognition, that is needed for any time at any point to communicate with others. The best way to address this gap is smartphones, which are portable, available, and easy to use.

In conclusion, this paper discusses methods of Persian Sign Language gestures translation to English text on smartphones. As stated earlier, the major problem with smartphones is computational power [5], which in this case a client-server system proposes to overcome this constraint. To improve the performance of system a CNN classifier is used, and to translate from Persian to English a bilingual dictionary is used.

Carrying out the research, I propose, to extract features from sign gesture images by normalizing and rescaling the image to 64*64 pixels and for robustness of system binary pixels used as features and using CNN for classification. We have used 10 Persian Sign language gestures only, achieving the accuracy of 98% which is better than any other work mentioned in this paper.

In future work will be on improve of model recognize more alphabetic features and to achieve higher accuracy.

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