

Real-Time Communication System Powered by AI for Specially Abled

Submitted By

TEAM MEMBERS

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1. INTRODUCTION

1.1 Overview

People get to know one another by sharing their ideas, thoughts, and experiences with those around them. There are numerous ways to accomplish this, the best of which is the gift of "Speech." Everyone can very convincingly transfer their thoughts and understand each other through speech. It will be unjust if we overlook those who are denied this priceless gift: the deaf and dumb. In such cases, the human hand has remained the preferred method of communication.

1.2 Purpose

The project's purpose is to create a system that translates sign language into a human-understandable language so that ordinary people may understand it.

2. LITERATURE SURVEY

2.1 Existing problem

Some of the existing solutions for solving this problem are:

Technology

One of the easiest ways to communicate is through technology such as a smart phone or laptop. A deaf person can type out what they want to say and a person who is blind or has low vision can use a screen reader to read the text out loud. A blind person can also use voice recognition software to convert what they are saying in to text so that a person who is Deaf can then read it.

Interpreter

If a sign language interpreter is available, this facilitates easy communication if the person who is deaf is fluent in sign language. The deaf person and person who is blind can communicate with each other via the interpreter. The deaf person can use sign language and the interpreter can speak what has been said to the person who is blind and then translate anything spoken by the blind person into sign language for the deaf person.

Just Speaking

Depending on the deaf person's level of hearing loss, they may be able to communicate with a blind person who is using speech. For example, a deaf person may have enough residual hearing (with or without the use of an assistive hearing device such as a hearing aid) to be able to decipher the speech of the person who is blind or has low vision. However, this is often not the most effective form of communication, as it is very dependent on the individual circumstances of both people and their environment (for example, some places may have too much background noise).

2.2 Proposed solution

This paper describes the system that overcomes the problem faced by the speech and hearing impaired. The objectives of the research are as follow:

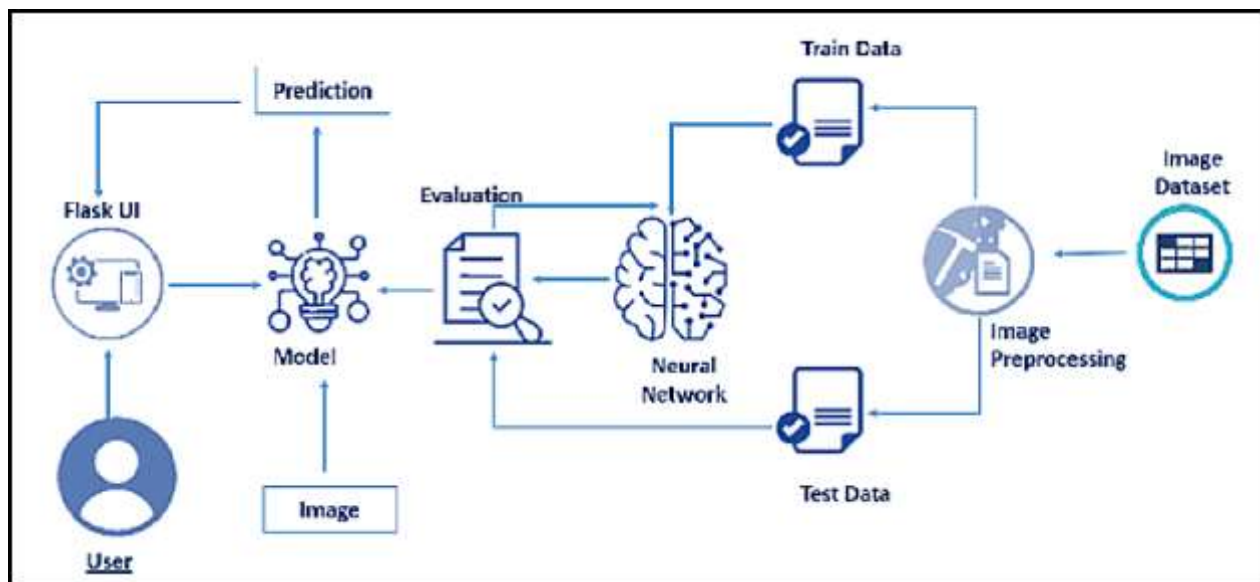
1. To design and develop a system which lowers the communication gap between speech-hearing impaired and normal world.

2. To build a communication system that enables communications between deaf-dumb person and a normal person.
3. A convolution neural network is being used to develop a model that is trained on various hand movements. This model is used to create an app. This programme allows deaf and hard of hearing persons to communicate using signs that are then translated into human-readable text.

3. THEORITICAL ANALYSIS

3.1 Block diagram

Architecture:



3.2 Hardware / Software designing

Hardware Requirements:

Operating System	Windows, Mac, Linux
CPU (for training)	Multi Core Processors (i3 or above/equivalent)
GPU (for training)	NVIDIA AI Capable / Google's TPU
WebCam	Integrated or External with FullHD Support

Software Requirements:

Python	v3.9.0 or Above
Python Packages	flask, tensorflow, opencv-python, keras, numpy, pandas, virtualenv, pillow
Web Browser	Mozilla Firefox, Google Chrome or any modern web browser
IBM Cloud (for training)	Watson Studio - Model Training & Deployment as Machine Learning Instance

4. EXPERIMENTAL INVESTIGATIONS

Training and Testing using Dataset Provided:

```
Model Training for Real Time Communication through AI for Specially Abled

Loading the Dataset & Image Data Generation

1. from tensorflow.keras.preprocessing.image import ImageDataGenerator

2. # Training Datasets
3. train_datagen = ImageDataGenerator(rescale=1/255, zoom_range=0.2, rotation=30, flip_mode='horizontal', fill_mode='nearest')
4. # Testing Dataset
5. test_datagen = ImageDataGenerator(rescale=1/255)

6. # Training Dataset
7. x_train_datagen = train_datagen.flow_from_directory('/K:/Projects/SmartBridge/ModelGen/dataset/training_set', target_size=(150,150), class_mode='categorical', batch_size=32)
8. # Testing Dataset
9. x_test_datagen = test_datagen.flow_from_directory('/K:/Projects/SmartBridge/ModelGen/dataset/test_set', target_size=(150,150), class_mode='categorical', batch_size=32)

Found 27000 images belonging to 8 classes.
Found 10727 images belonging to 8 classes.

1. print('len x-train : ', len(x_train))
2. print('len x-test : ', len(x_test))

len x-train : 30
len x-test : 29

3. # The Class Indices in Training Dataset
4. x_train.class_indices

{'A': 0, 'B': 1, 'C': 2, 'D': 3, 'E': 4, 'F': 5, 'G': 6, 'H': 7, 'I': 8}

Model Creation

5. # Importing Libraries
6. from tensorflow.keras.models import Sequential
7. from tensorflow.keras.layers import Convolution2D, MaxPooling2D, Flatten, Dense

8. # Creating Model
9. model = Sequential()

10. # Adding Layers
11. model.add(Convolution2D(32, 3, 3, activation='relu', kernel_initializer='he_normal'))
12. model.add(MaxPooling2D(pool_size=(2, 2)))
13. model.add(Flatten())
14. #
15. # Adding Hidden Layers
16. model.add(Dense(128, activation='relu'))
17. model.add(Dense(128, activation='relu'))
18. #
19. # Adding Output Layer
20. model.add(Dense(8, activation='softmax'))

21. # Compiling the Model:
22. model.compile(loss='categorical_crossentropy', optimizer='adam', metrics=['accuracy'])
```

```

1 # Fitting the Neural Generator
2 model_fit_generator(x_train, steps_per_epoch=len(x_train), epochs=10, validation_data=(x_test, validation_steps=len(x_test)))

C:\Users\Hishagra\AppData\Local\Temp\ipykernel_8892\394233990.py:2: UserWarning: "model_fit_generator" is deprecated and will be removed in a future version. Please use "ModelFit", which supports generators.
  model_fit_generator(x_train, steps_per_epoch=len(x_train), epochs=10, validation_data=(x_test, validation_steps=len(x_test)))

Epoch 1/10 [-----] - 252s 0s/step - loss: 2.1755 - accuracy: 0.1897 - val_loss: 1.9461 - val_accuracy: 0.3477
Epoch 2/10 [-----] - 41s 2s/step - loss: 1.9417 - accuracy: 0.4629 - val_loss: 1.6277 - val_accuracy: 0.4613
Epoch 3/10 [-----] - 47s 2s/step - loss: 1.3384 - accuracy: 0.5183 - val_loss: 1.1829 - val_accuracy: 0.6162
Epoch 4/10 [-----] - 48s 2s/step - loss: 1.0815 - accuracy: 0.6258 - val_loss: 0.8888 - val_accuracy: 0.6967
Epoch 5/10 [-----] - 47s 2s/step - loss: 0.8933 - accuracy: 0.6967 - val_loss: 0.7331 - val_accuracy: 0.7686
Epoch 6/10 [-----] - 47s 2s/step - loss: 0.7787 - accuracy: 0.7329 - val_loss: 0.6089 - val_accuracy: 0.8048
Epoch 7/10 [-----] - 47s 2s/step - loss: 0.6882 - accuracy: 0.7781 - val_loss: 0.5204 - val_accuracy: 0.8384
Epoch 8/10 [-----] - 47s 2s/step - loss: 0.6089 - accuracy: 0.7977 - val_loss: 0.4819 - val_accuracy: 0.8378
Epoch 9/10 [-----] - 47s 2s/step - loss: 0.5287 - accuracy: 0.8365 - val_loss: 0.4178 - val_accuracy: 0.8616
Epoch 10/10 [-----] - 47s 2s/step - loss: 0.4707 - accuracy: 0.8454 - val_loss: 0.3698 - val_accuracy: 0.8662

keras.callbacks.History at 0x18547335080

Saving the Model

1 model.save('cat_model_M4104.h5')
2 # Derived accuracy is 0.8664

```

```

Testing the model

1 import cv2, os
2 from tensorflow.keras.models import load_model
3 from tensorflow.keras.preprocessing import image

1 model.load_model('cat_model_M4104.h5')
2 img = image.load_img('C:/Projects/learn/string/Paw/GenderDataset/test_set/001.png',
3 target_size=(64, 64))

1 img

1 image_img_to_array(img)

1 x_ndim

1 x.ndim

1 x.expand_dims([0, axis=0])

1 x_ndim

1 x.ndim

1 model.predict(x)

1 model.predict(x)

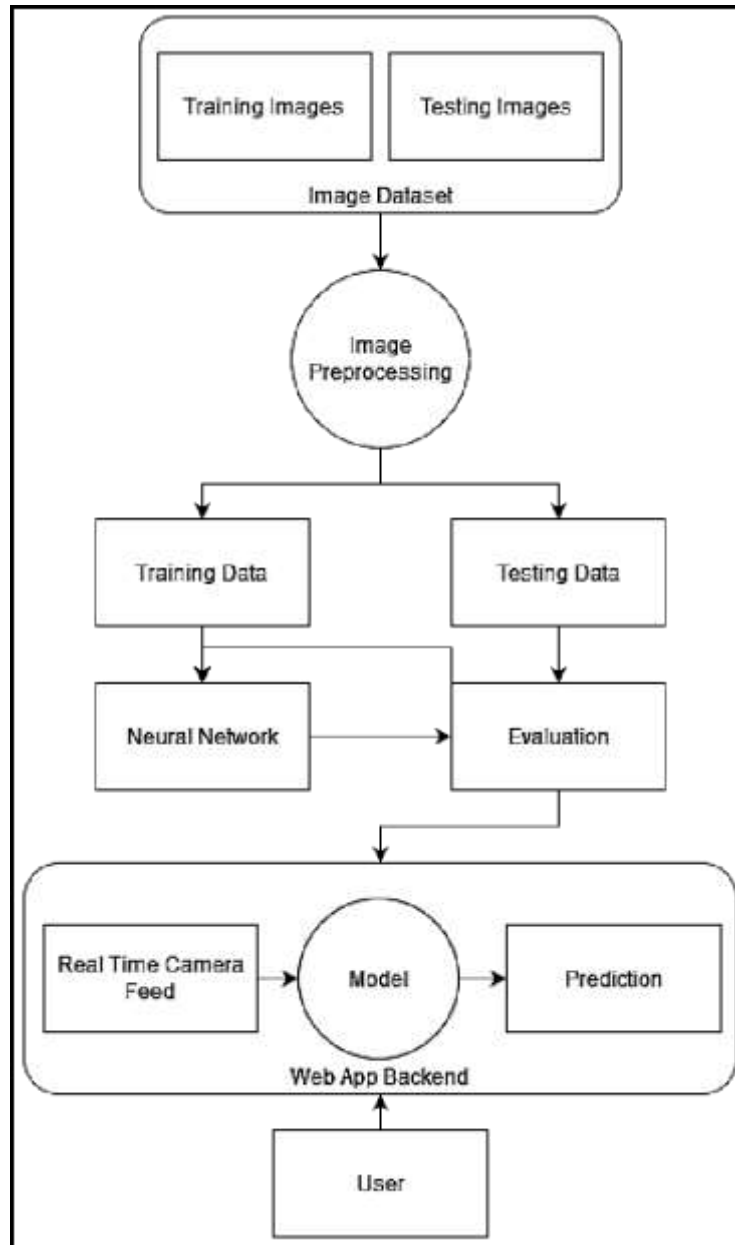
1 img

array([1], dtype=int64)

1 index=[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
2 index[indexes[0]]

```

5. FLOWCHART



6. RESULT

The proposed procedure was implemented and tested with set of images. The set of 15750 images of Alphabets from “A” to “I” are used for training database and a set of 2250 images of Alphabets from “A” to “I” are used for testing database. Once the gesture is recognise the equivalent Alphabet is shown on the screen.

Some sample images of the output are provided below:



Click Reference - All Alphabets

About The Project

Artificial Intelligence has made it possible to handle our daily activities in new and simpler ways. With the ability to automate tasks that normally require human intelligence, such as speech and voice recognition, visual perception, predictive text functionality, decision-making, and a variety of other tasks, AI can assist people with disabilities by significantly improving their ability to get around and participate in daily activities.

Currently, Sign Recognition is available **only for alphabets A-I** and not for J-Z, where J-Z alphabets also require Gesture Recognition for them to be able to be predicted correctly to a certain degree of accuracy.

Developed By



Click Reference - All Alphabets

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Developed By



7. ADVANTAGES & DISADVANTAGES

Advantages:

1. It is possible to create a mobile application to bridge the communication gap between deaf and dumb persons and the general public.
2. As different sign language standards exist, their dataset can be added, and the user can choose which sign language to read.

Disadvantages:

1. The current model only works from alphabets A to I.
2. In absence of gesture recognition, alphabets from J cannot be identified as they require some kind of gesture input from the user.
3. As the quantity/quality of images in the dataset is low, the accuracy is not great, but that can easily be improved by change in dataset.

8. APPLICATIONS

1. It will contribute to the development of improved communication for the deafened. The majority of people are unable to communicate via sign language, which creates a barrier to communication.

2. As a result, others will be able to learn and comprehend sign language and communicate with the deaf and dumb via the web app.
3. According to scientific research, learning sign language improves cognitive abilities, attention span, and creativity.

9. CONCLUSION

Sign language is a useful tool for facilitating communication between deaf and hearing people. Because it allows for two-way communication, the system aims to bridge the communication gap between deaf people and the rest of society. The proposed methodology translates language into English alphabets that are understandable to humans.

This system sends hand gestures to the model, who recognises them and displays the equivalent Alphabet on the screen. Deaf-mute people can use their hands to perform sign language, which will then be converted into alphabets, thanks to this project.

10. FUTURE SCOPE

Having a technology that can translate hand sign language to its corresponding alphabet is a game changer in the field of communication and Ai for the specially abled people such as deaf and dumb. With introduction of gesture recognition, the web app can easily be expanded to recognize letters beyond 'T', digits and other symbols plus gesture recognition can also allow controlling of software/hardware interfaces.

11. BIBLIOGRAPHY

1. Environment Setup: <https://www.youtube.com/watch?v=5mDYijMfSzs>
2. Sign Languages Dataset: <https://drive.google.com/file/d/1ITbDvhLwyTTkuUYfNjOKhcIZh7hDgi64/view?usp=sharing>
3. Keras Image Processing Doc: <https://keras.io/api/preprocessing/image/>
4. Keras ImageDataset From Directory Doc: <https://keras.io/api/preprocessing/image/#imagedatasetfromdirectory-function>
5. CNN using Tensorflow: https://www.youtube.com/watch?v=umGJ30-15_A
6. OpenCV Basics of Processing Image: <https://www.youtube.com/watch?v=mjKd1Tzl70I>

7. Flask Basics: https://www.youtube.com/watch?v=lj4I_CvBnt0
8. IBM Academic Partner Account Creation: <https://www.youtube.com/watch?v=x6i43M7BAqE>
9. CNN Deployment and Download through IBM Cloud: <https://www.youtube.com/watch?v=BzouqMGJ41k>

12. APPENDIX

Source Code for Model Training and Saving:

```
Model Training for Real Time Communication through AI for Specially Abled

Loading the Dataset & Image Data Generation

1 from tensorflow.keras.preprocessing.image import ImageDataGenerator

2 # Training Datasets
3 train_generator = ImageDataGenerator(rescale=1/255, image_resizer=(224,224), horizontal_flip=True, vertical_flip=True)
4 test_generator = ImageDataGenerator(rescale=1/255)

5 # Training Dataset
6 x_train=train_generator.flow_from_directory('E:\Project\SmartBridge\ModelGen\Dataset\training_set',target_size=(224,224), class_mode='categorical',batch_size=64)
7 # Testing Dataset
8 x_test=test_generator.flow_from_directory('E:\Project\SmartBridge\ModelGen\Dataset\test_set',target_size=(224,224), class_mode='categorical',batch_size=64)

Found 37000 images belonging to 8 classes.
Found 20727 images belonging to 8 classes.

1 print('len x-train : ', len(x_train))
2 print('len x-test : ', len(x_test))

len x-train : 36
len x-test : 29

1 # The Class Indices in Training Dataset
2 class_indices

['A': 0, 'B': 1, 'C': 2, 'D': 3, 'E': 4, 'F': 5, 'G': 6, 'H': 7, 'I': 8]
```

```
Model Creation

1 # Importing Libraries
2 from tensorflow.keras.models import Sequential
3 from tensorflow.keras.layers import Convolution2D, MaxPooling2D, Flatten, Dense

4 # Creating Model
5 model=Sequential()

6 # Adding Layers
7 model.add(Convolution2D(32,(3,3),activation='relu',input_shape=(224,224,3)))
8 model.add(MaxPooling2D(pool_size=(2,2)))
9 model.add(Flatten())
10
11 # Adding Hidden Layers
12 model.add(Dense(128,activation='relu'))
13 model.add(Dense(128,activation='relu'))
14
15 # Adding output layer
16 model.add(Dense(8,activation='softmax'))

1 # Compiling the Model
2 model.compile(loss='categorical_crossentropy',optimizer='adam',metrics=['accuracy'])
```

```

1 # Fitting the Naïve Generator
2 model_fit_generator(x_train, steps_per_epoch=len(x_train), epochs=10, validation_data=(x_val, y_val), validation_steps=len(x_val))

C:\Users\Hoshagra\AppData\Local\Temp\ipykernel_8807\847350998.py:2: DeprecationWarning: 'Model_Fit_generator' is deprecated and will be removed in a future version. Please use 'Model_Fit',
which supports generators.
  model_fit_generator(x_train, steps_per_epoch=len(x_train), epochs=10, validation_data=(x_val, y_val), validation_steps=len(x_val))

Epoch 1/10 [-----] - 25s 8s/step - loss: 2.1755 - accuracy: 0.1897 - val_loss: 2.0481 - val_accuracy: 0.3477
Epoch 2/10 [-----] - 48s 2s/step - loss: 1.7917 - accuracy: 0.4025 - val_loss: 1.8277 - val_accuracy: 0.4813
Epoch 3/10 [-----] - 47s 2s/step - loss: 1.3386 - accuracy: 0.5183 - val_loss: 1.1899 - val_accuracy: 0.6182
Epoch 4/10 [-----] - 48s 2s/step - loss: 1.0815 - accuracy: 0.6250 - val_loss: 0.8890 - val_accuracy: 0.6907
Epoch 5/10 [-----] - 47s 2s/step - loss: 0.8931 - accuracy: 0.6967 - val_loss: 0.7331 - val_accuracy: 0.7166
Epoch 6/10 [-----] - 47s 2s/step - loss: 0.7767 - accuracy: 0.7124 - val_loss: 0.6089 - val_accuracy: 0.8004
Epoch 7/10 [-----] - 47s 2s/step - loss: 0.6683 - accuracy: 0.7181 - val_loss: 0.5204 - val_accuracy: 0.8184
Epoch 8/10 [-----] - 47s 2s/step - loss: 0.6099 - accuracy: 0.7577 - val_loss: 0.4819 - val_accuracy: 0.8374
Epoch 9/10 [-----] - 47s 2s/step - loss: 0.5287 - accuracy: 0.8165 - val_loss: 0.4270 - val_accuracy: 0.8616
Epoch 10/10 [-----] - 47s 2s/step - loss: 0.4787 - accuracy: 0.8454 - val_loss: 0.3898 - val_accuracy: 0.8692

Keras callbacks history at 8415472354040:

Saving the Model

1 model.save('naive_model.h5')
2 # Current accuracy is 0.8692

```

IBM Model Training & Download Code:

```

# Downloading From IBM

Connecting to IBM Cloud Storage to Get Model from Deployment

1 from ibmcloud_sdk import spaces
2 api_key = 'https://us-south-01.cloud.ibm.com'
3 endpoint = 'https://us-south-01.cloud.ibm.com'
4 client = spaces.Spaces(api_key, endpoint)

5 def get_model_from_ibm(client, space_id):
6     space = client.spaces.get_details(space_id)
7     return space['resources'] if space['entity'] == 'space' else space['resources'][0]

8 space_id = '22c1bae0-ea16-4970-b615-eb19e72c10fa'
9 print('Space ID: ', space_id)

10 client.set_default_space(space_id)

11 'SUCCESS'

12 client.repository.download('naive_model.h5', 'naive_model.h5')

Successfully saved model content to file: 'naive_model.h5'
'e:\Projects\SmartBridge\IBMModelGen\IBM_Model_Download.tar.gz'

```

Web app code:

```
1 from flask import Flask, render_template
1 from flask_socketio import SocketIO, emit
2 from camera import Video
3
4 app = Flask(__name__)
5 index=['A','B','C','D','E','F','G','H','I']
6 ll = None
7 app.route('/')
8 def index():
9     return render_template('index.html', predict_result=ll)
10
11 def gen(camera):
12     global ll
13     while True:
14         frame = camera.get_frame()
15         ll = camera.y
16         yield(b'--frame\r\n'
17              + b'Content-Type: image/jpeg\r\n\r\n' + frame +
18              + b'\r\n\r\n')
19
20 app.route('/video_feed')
21 def video_feed():
22     video = Video()
23     return Response(gen(video), mimetype='multipart/x-mixed-replace; boundary=frame')
24
25
```

```
1 import cv2
1 import numpy as np
2 from tensorflow.keras.models import load_model
3 from tensorflow.keras.preprocessing import image
4
5 class VideoCamera(object):
6     def __init__(self):
7         self.video = cv2.VideoCapture(0)
8         self.roi_start = (50, 150)
9         self.roi_end = (250, 350)
10         # self.model = load_model('asl_model.h5') # Execute Local Trained Model
11         self.model = load_model('IBM_Communication_Model.h5') # Execute IBM Trained Model
12         self.index=['A','B','C','D','E','F','G','H','I']
13         self.y = None
14     def __del__(self):
15         self.video.release()
16     def get_frame(self):
17         ret, frame = self.video.read()
18         frame = cv2.resize(frame, (640, 480))
19         copy = frame.copy()
20         copy = copy[150:150+250, 50:50+250]
21         # Prediction Start
22         cv2.imwrite('image.jpg', copy)
23         copy_img = image.load_img('image.jpg', target_size=(50,64))
24         # copy_img = image.load_img('image.jpg', target_size=(28,28))
25         x = image.img_to_array(copy_img)
26         x = np.expand_dims(x, axis=0)
27         pred = np.argmax(self.model.predict(x), axis=1)
28         self.y = pred[0]
29         cv2.putText(frame, 'The Predicted Alphabet is: ' + self.index[self.y], (180, 50),
30                    cv2.FONT_HERSHEY_SIMPLEX, 1, (0, 0, 0), 3)
31         ret, jpg = cv2.imwrite('image.jpg', frame)
32         return jpg.tobytes()
```

American Sign Language Standard Reference:

