**import** os  
**import** mediapipe **as** mp   
**import** numpy **as** np  
**import** cv2  
**import** pickle

**1. Gesture Collection**

[2]

mp\_holistic = mp.solutions.holistic  
holistic = mp\_holistic.Holistic(min\_detection\_confidence=0.7, min\_tracking\_confidence=0.7)  
mpDraw = mp.solutions.drawing\_utils

[17]

*# Path for exported data, numpy arrays*  
DATA\_PATH = os.path.join(**'../data/Gesture\_Data'**)   
LANDMARK\_PATH = os.path.join(**'../data/Gesture\_Landmarks'**)  
  
*# Actions that we try to detect*  
  
actions = np.array([**'eat'**, **'friend'**])  
*# actions = np.array(['Hello', 'Love You', 'Understand', 'Thanks', 'Some', 'Home', 'name', 'my', 'how'])*  
*# actions = np.array(['Sorry', "Help me", "Yes", "No", "eat", "friend"])*  
*# actions = np.array([ "No", "eat"])*  
  
*# Thirty videos worth of data*  
no\_sequences =  25  
  
*# Videos are going to be 30 frames in length*  
sequence\_length = 30  
  
*# Folder start*  
start\_folder = 0

[18]

**for** action **in** actions:   
    **for** sequence **in** range(no\_sequences):  
        **try**:   
            os.makedirs(os.path.join(DATA\_PATH, action, str(sequence)))  
            os.makedirs(os.path.join(LANDMARK\_PATH, action, str(sequence)))  
        **except**:  
            **pass**

[36]

**import** matplotlib.pyplot **as** plt  
plt.figure(figsize=(12,8))  
pkl = open(**'../data/Gesture\_Data/eat/0/8'**, **'rb'**)  
im = pickle.load(pkl)  
im = cv2.cvtColor(im, cv2.COLOR\_BGR2RGB)  
plt.imshow(im)

<matplotlib.image.AxesImage at 0x23b2f1a01d0>



[19]

**def** mediapipe\_detection(image, model):  
    image = cv2.flip(image, 1)  
    image = cv2.cvtColor(image, cv2.COLOR\_BGR2RGB) *# COLOR CONVERSION BGR 2 RGB*  
    results = model.process(image)                 *# Make prediction*  
    image = cv2.cvtColor(image, cv2.COLOR\_RGB2BGR) *# COLOR COVERSION RGB 2 BGR*  
    **return** image, results  
  
cap = cv2.VideoCapture(0)  
  
print(actions)  
*# Loop through actions*  
**for** action **in** actions:  
    *# Loop through sequences aka videos*  
    **for** sequence **in** range(start\_folder, start\_folder+no\_sequences):   
        *# Loop through video length aka sequence length*  
        **for** frame\_num **in** range(sequence\_length):  
  
            \_, frame = cap.read()  
              
            *# Get Camera dimensions*  
            x, y, c = frame.shape  
            frame, result = mediapipe\_detection(frame, holistic)  
            className = **''**  
              
            *# Process the result*  
            **if** result.left\_hand\_landmarks **or** result.right\_hand\_landmarks:  
                landmarks = []  
  
                *# Save Landmark Lists for future processing*  
                pkl\_path = os.path.join(LANDMARK\_PATH, action, str(sequence), str(frame\_num))  
                img\_path = os.path.join(DATA\_PATH, action, str(sequence), str(frame\_num))  
  
                **with** open(img\_path, **'wb'**) **as** im:  
                    pickle.dump(frame, im)  
  
  
                **with** open(pkl\_path, **'wb'**) **as** f:  
  
                    **if** result.left\_hand\_landmarks **and** result.right\_hand\_landmarks:  
                        pickle.dump({**"Left"**:result.left\_hand\_landmarks, **"Right"**:result.right\_hand\_landmarks,   
                                    **"Face"**: result.face\_landmarks, **"Pose"**: result.pose\_landmarks}, f)  
  
                    **elif** result.left\_hand\_landmarks:  
                        pickle.dump({**"Left"**:result.left\_hand\_landmarks, **"Right"**:0,   
                                    **"Face"**: result.face\_landmarks, **"Pose"**: result.pose\_landmarks}, f)  
  
                    **elif** result.right\_hand\_landmarks:  
                        pickle.dump({**"Left"**:0, **"Right"**:result.right\_hand\_landmarks,   
                                    **"Face"**: result.face\_landmarks, **"Pose"**: result.pose\_landmarks}, f)  
  
                *# lh = [[res.x, res.y] for res in result.left\_hand\_landmarks.landmark] if result.left\_hand\_landmarks else np.zeros(21\*2).reshape(-1,2).tolist()*  
                *# rh = [[res.x, res.y] for res in result.right\_hand\_landmarks.landmark] if result.right\_hand\_landmarks else np.zeros(21\*2).reshape(-1,2).tolist()*  
                  
                *# for i in range(len(lh)):*  
                *#     landmarks.append([lh[i][0], lh[i][1], rh[i][0], rh[i][1]])*  
                  
                *# Drawing landmarks on frames*  
                mpDraw.draw\_landmarks(frame, result.left\_hand\_landmarks, mp\_holistic.HAND\_CONNECTIONS) *# Draw left hand connections*  
                mpDraw.draw\_landmarks(frame, result.right\_hand\_landmarks, mp\_holistic.HAND\_CONNECTIONS) *# Draw right hand connections*  
  
  
                *# NEW Apply wait logic*  
                **if** frame\_num == 0:   
                    cv2.putText(frame, **'STARTING COLLECTION'**, (120,200),   
                            cv2.FONT\_HERSHEY\_SIMPLEX, 1, (0,255, 0), 4, cv2.LINE\_AA)  
                    cv2.putText(frame, **'Frames for {} Video Number {}'**.format(action, sequence), (15,15),   
                            cv2.FONT\_HERSHEY\_SIMPLEX, 0.7, (255, 0, 0), 1, cv2.LINE\_AA)  
                    *# Show to screen*  
                    cv2.imshow(**'OpenCV Feed'**, frame)  
                    cv2.waitKey(1000)  
                **else**:   
                    cv2.putText(frame, **'Frames for {} Video Number {}'**.format(action, sequence), (15,12),   
                            -cv2.FONT\_HERSHEY\_SIMPLEX, 0.7, (0, 0, 255), 1, cv2.LINE\_AA)  
                    *# Show to screen*  
                    cv2.imshow(**'OpenCV Feed'**, frame)  
                  
                  
                *# npy\_path = os.path.join(DATA\_PATH, action, str(sequence), str(frame\_num))*  
                *# # npy\_path = "./MP\_Data/" + action + "\_" + str(sequence) + "\_" + str(frame\_num)*  
                *# np.save(npy\_path, landmarks)*  
  
                *# Break gracefully*  
                **if** cv2.waitKey(10) & **0x**FF == ord(**'q'**):  
                    **break**  
                  
cap.release()  
cv2.destroyAllWindows()

['eat' 'friend']

[5]

cap.release()  
cv2.destroyAllWindows()

**Landmark Collection Processing Test**

**for** (dirpath, dirnames, filenames) **in** os.walk(os.path.join(LANDMARK\_PATH, action)):  
    **if** filenames != []:  
        print(dirpath, **" || "**, dirnames, **" || "**, filenames)

[23]

*# for (dirpath, dirnames, filenames) in os.walk(os.path.join('./data/MP\_Data\_Landmarks\ Hello/0')):*  
*#     print(dirpath, " || ", dirnames, " || ", filenames)*  
  
**with** open(**"../data/Gesture\_Landmarks/Hello/0/0"**, **'rb'**) **as** f:  
    temp = pickle.load(f)  
  
print(temp.keys())  
print(temp)

dict\_keys(['Left', 'Right', 'Face', 'Pose'])  
{'Left': landmark {  
 x: 0.7639003396034241  
 y: 0.4915165901184082  
 z: -1.4612560050863976e-07  
}  
landmark {  
 x: 0.7122788429260254  
 y: 0.5233388543128967  
 z: 0.0002445264835841954  
}  
landmark {  
 x: 0.6669280529022217  
 y: 0.5235884189605713  
 z: 0.002434847177937627  
}  
landmark {  
 x: 0.6293884515762329  
 y: 0.5087409615516663  
 z: -0.00031232571927830577  
}  
landmark {  
 x: 0.5933420658111572  
 y: 0.49066397547721863  
 z: -0.002898399019613862  
}  
landmark {  
 x: 0.6434884071350098  
 y: 0.4177962839603424  
 z: 0.03234456107020378  
}  
landmark {  
 x: 0.5971636176109314  
 y: 0.3968755006790161  
 z: 0.028217073529958725  
}  
landmark {  
 x: 0.5641341805458069  
 y: 0.3886408805847168  
 z: 0.017753422260284424  
}  
landmark {  
 x: 0.534692645072937  
 y: 0.3785668611526489  
 z: 0.00824954267591238  
}  
landmark {  
 x: 0.6497134566307068  
 y: 0.38496658205986023  
 z: 0.021541524678468704  
}  
landmark {  
 x: 0.5974389314651489  
 y: 0.3570370078086853  
 z: 0.01658041961491108  
}  
landmark {  
 x: 0.5604710578918457  
 y: 0.3431216776371002  
 z: 0.003943198826164007  
}  
landmark {  
 x: 0.5267713665962219  
 y: 0.32934093475341797  
 z: -0.006687747780233622  
}  
landmark {  
 x: 0.6625949144363403  
 y: 0.3576585352420807  
 z: 0.006767647806555033  
}  
landmark {  
 x: 0.6122836470603943  
 y: 0.32966089248657227  
 z: -0.001226685824804008  
}  
landmark {  
 x: 0.5737748146057129  
 y: 0.31911954283714294  
 z: -0.010899792425334454  
}  
landmark {  
 x: 0.53787761926651  
 y: 0.3136129081249237  
 z: -0.01797276735305786  
}  
landmark {  
 x: 0.6823981404304504  
 y: 0.3338802754878998  
 z: -0.009504126384854317  
}  
landmark {  
 x: 0.6364617943763733  
 y: 0.3099506199359894  
 z: -0.01745736226439476  
}  
landmark {  
 x: 0.603695273399353  
 y: 0.3073206841945648  
 z: -0.02162226103246212  
}  
landmark {  
 x: 0.5727784633636475  
 y: 0.3112488389015198  
 z: -0.02459949254989624  
}  
, 'Right': 0, 'Face': landmark {  
 x: 0.43288570642471313  
 y: 0.5657786726951599  
 z: -0.027231130748987198  
}  
landmark {  
 x: 0.4339527487754822  
 y: 0.5200719833374023  
 z: -0.058315377682447433  
}  
landmark {  
 x: 0.43312618136405945  
 y: 0.5320121049880981  
 z: -0.029068274423480034  
}  
landmark {  
 x: 0.42338886857032776  
 y: 0.47317788004875183  
 z: -0.046528156846761703  
}  
landmark {  
 x: 0.43396469950675964  
 y: 0.5061271786689758  
 z: -0.06286691129207611  
}  
landmark {  
 x: 0.43367892503738403  
 y: 0.4872446060180664  
 z: -0.059599824249744415  
}  
landmark {  
 x: 0.4326554834842682  
 y: 0.4404655694961548  
 z: -0.03347070887684822  
}  
landmark {  
 x: 0.3494853973388672  
 y: 0.43373602628707886  
 z: 0.009622586891055107  
}  
landmark {  
 x: 0.43232202529907227  
 y: 0.40575772523880005  
 z: -0.02858847752213478  
}  
landmark {  
 x: 0.43238455057144165  
 y: 0.3866242468357086  
 z: -0.03230825439095497  
}  
landmark {  
 x: 0.43214550614356995  
 y: 0.31267428398132324  
 z: -0.02575443685054779  
}  
landmark {  
 x: 0.4328182637691498  
 y: 0.5728445053100586  
 z: -0.02523435279726982  
}  
landmark {  
 x: 0.43275517225265503  
 y: 0.5779715180397034  
 z: -0.021274367347359657  
}  
landmark {  
 x: 0.4327060878276825  
 y: 0.579863965511322  
 z: -0.0160843413323164  
}  
landmark {  
 x: 0.43291306495666504  
 y: 0.5854804515838623  
 z: -0.013026727363467216  
}  
landmark {  
 x: 0.43297919631004333  
 y: 0.5919389128684998  
 z: -0.014477482996881008  
}  
landmark {  
 x: 0.43297237157821655  
 y: 0.6000596284866333  
 z: -0.016441654413938522  
}  
landmark {  
 x: 0.432977557182312  
 y: 0.6087784767150879  
 z: -0.01435926929116249  
}  
landmark {  
 x: 0.432892382144928  
 y: 0.62382972240448  
 z: -0.0033135691192001104  
}  
landmark {  
 x: 0.4337707757949829  
 y: 0.5266710519790649  
 z: -0.052252620458602905  
}  
landmark {  
 x: 0.42229512333869934  
 y: 0.5246173143386841  
 z: -0.03699227795004845  
}  
landmark {  
 x: 0.3104175627231598  
 y: 0.3729102313518524  
 z: 0.056526873260736465  
}  
landmark {  
 x: 0.3835223615169525  
 y: 0.44625699520111084  
 z: -0.0011483397101983428  
}  
landmark {  
 x: 0.37231993675231934  
 y: 0.4476046860218048  
 z: -0.0002652863913681358  
}  
landmark {  
 x: 0.3613385558128357  
 y: 0.4467761516571045  
 z: 0.0027866805903613567  
}  
landmark {  
 x: 0.3457323908805847  
 y: 0.43754303455352783  
 z: 0.011705273762345314  
}  
landmark {  
 x: 0.39248818159103394  
 y: 0.44252467155456543  
 z: 0.00012586050434038043  
}  
landmark {  
 x: 0.3663994371891022  
 y: 0.41101351380348206  
 z: -0.00698309438303113  
}  
landmark {  
 x: 0.3786868751049042  
 y: 0.41224271059036255  
 z: -0.007073965854942799  
}  
landmark {  
 x: 0.3550053536891937  
 y: 0.4123634696006775  
 z: -0.0031840098090469837  
}  
landmark {  
 x: 0.34752824902534485  
 y: 0.41667670011520386  
 z: 0.0015316486824303865  
}  
landmark {  
 x: 0.3384290337562561  
 y: 0.44575387239456177  
 z: 0.017826946452260017  
}  
landmark {  
 x: 0.39096543192863464  
 y: 0.6438201665878296  
 z: 0.012367909774184227  
}  
landmark {  
 x: 0.344992995262146  
 y: 0.4295532703399658  
 z: 0.012984666042029858  
}  
landmark {  
 x: 0.3080099821090698  
 y: 0.4341649115085602  
 z: 0.06571253389120102  
}  
landmark {  
 x: 0.3260819911956787  
 y: 0.43467703461647034  
 z: 0.028065236285328865  
}  
landmark {  
 x: 0.37524908781051636  
 y: 0.5031111240386963  
 z: -0.006823788397014141  
}  
landmark {  
 x: 0.4179813861846924  
 y: 0.5631580352783203  
 z: -0.02588753029704094  
}  
landmark {  
 x: 0.4199993312358856  
 y: 0.5775288343429565  
 z: -0.019619716331362724  
}  
landmark {  
 x: 0.40302807092666626  
 y: 0.5665454268455505  
 z: -0.019266027957201004  
}  
landmark {  
 x: 0.3939354419708252  
 y: 0.5710652470588684  
 z: -0.01052755955606699  
}  
landmark {  
 x: 0.4091634154319763  
 y: 0.5774964094161987  
 z: -0.015269937925040722  
}  
landmark {  
 x: 0.40105921030044556  
 y: 0.578072190284729  
 z: -0.007528899237513542  
}  
landmark {  
 x: 0.38071301579475403  
 y: 0.5919083952903748  
 z: 0.008662247098982334  
}  
landmark {  
 x: 0.42430058121681213  
 y: 0.5194433331489563  
 z: -0.05743628367781639  
}  
landmark {  
 x: 0.42270123958587646  
 y: 0.5062370896339417  
 z: -0.0616539791226387  
}  
landmark {  
 x: 0.330547034740448  
 y: 0.3996560871601105  
 z: 0.003223511390388012  
}  
landmark {  
 x: 0.39771124720573425  
 y: 0.4687834084033966  
 z: -0.011066722683608532  
}  
landmark {  
 x: 0.395845890045166  
 y: 0.5124064683914185  
 z: -0.030394313856959343  
}  
landmark {  
 x: 0.39489489793777466  
 y: 0.5047855973243713  
 z: -0.027412179857492447  
}  
landmark {  
 x: 0.3429284691810608  
 y: 0.49986332654953003  
 z: 0.007185064721852541  
}  
landmark {  
 x: 0.42299744486808777  
 y: 0.4885328412055969  
 z: -0.056081559509038925  
}  
landmark {  
 x: 0.35609301924705505  
 y: 0.3875451683998108  
 z: -0.016771061345934868  
}  
landmark {  
 x: 0.34076663851737976  
 y: 0.3908964991569519  
 z: -0.007812317460775375  
}  
landmark {  
 x: 0.3198433220386505  
 y: 0.34938207268714905  
 z: 0.0330815464258194  
}  
landmark {  
 x: 0.4067170321941376  
 y: 0.4024094343185425  
 z: -0.025572143495082855  
}  
landmark {  
 x: 0.3894434869289398  
 y: 0.41684699058532715  
 z: -0.00351849221624434  
}  
landmark {  
 x: 0.37190207839012146  
 y: 0.5777798295021057  
 z: 0.010292720049619675  
}  
landmark {  
 x: 0.3220003545284271  
 y: 0.5631071925163269  
 z: 0.10593704879283905  
}  
landmark {  
 x: 0.40434530377388  
 y: 0.5199019908905029  
 z: -0.025654064491391182  
}  
landmark {  
 x: 0.41399386525154114  
 y: 0.5250369906425476  
 z: -0.026229508221149445  
}  
landmark {  
 x: 0.3841395676136017  
 y: 0.5787267684936523  
 z: 0.008920788764953613  
}  
landmark {  
 x: 0.38976627588272095  
 y: 0.578078031539917  
 z: 0.005683296360075474  
}  
landmark {  
 x: 0.33432096242904663  
 y: 0.3802700638771057  
 z: -0.0031556477770209312  
}  
landmark {  
 x: 0.3953629732131958  
 y: 0.5177301168441772  
 z: -0.02384077198803425  
}  
landmark {  
 x: 0.37752801179885864  
 y: 0.39043092727661133  
 z: -0.023068323731422424  
}  
landmark {  
 x: 0.37529829144477844  
 y: 0.37821537256240845  
 z: -0.026321087032556534  
}  
landmark {  
 x: 0.3645396828651428  
 y: 0.3191993236541748  
 z: -0.011412381194531918  
}  
landmark {  
 x: 0.3272439241409302  
 y: 0.3644340932369232  
 z: 0.012317365035414696  
}  
landmark {  
 x: 0.37112224102020264  
 y: 0.3479307293891907  
 z: -0.019614048302173615  
}  
landmark {  
 x: 0.32409006357192993  
 y: 0.39195412397384644  
 z: 0.012086463160812855  
}  
landmark {  
 x: 0.3173929452896118  
 y: 0.38333913683891296  
 z: 0.03286184370517731  
}  
landmark {  
 x: 0.4187128245830536  
 y: 0.5716466307640076  
 z: -0.024046516045928  
}  
landmark {  
 x: 0.4063732624053955  
 y: 0.5733705759048462  
 z: -0.017679009586572647  
}  
landmark {  
 x: 0.39754965901374817  
 y: 0.5748893618583679  
 z: -0.00990623701363802  
}  
landmark {  
 x: 0.4071613848209381  
 y: 0.5225293636322021  
 z: -0.023184696212410927  
}  
landmark {  
 x: 0.3870525658130646  
 y: 0.5786246657371521  
 z: 0.007145463023334742  
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 z: -0.001959211891517043  
}  
landmark {  
 x: 0.504984974861145  
 y: 0.42437177896499634  
 z: 0.0009293192415498197  
}  
landmark {  
 x: 0.511013388633728  
 y: 0.42729538679122925  
 z: 0.004786213394254446  
}  
landmark {  
 x: 0.5510815382003784  
 y: 0.3990464210510254  
 z: 0.08320363610982895  
}  
landmark {  
 x: 0.5080484747886658  
 y: 0.4380042552947998  
 z: 0.007540546357631683  
}  
landmark {  
 x: 0.4714285135269165  
 y: 0.5465114712715149  
 z: -0.014353517442941666  
}  
landmark {  
 x: 0.4619571566581726  
 y: 0.5180435180664062  
 z: -0.029725169762969017  
}  
landmark {  
 x: 0.44928696751594543  
 y: 0.5434971451759338  
 z: -0.024841392412781715  
}  
landmark {  
 x: 0.5057117342948914  
 y: 0.6246417164802551  
 z: 0.042311277240514755  
}  
landmark {  
 x: 0.49202919006347656  
 y: 0.6421480178833008  
 z: 0.03213926777243614  
}  
landmark {  
 x: 0.4572385847568512  
 y: 0.672179102897644  
 z: 0.01074136234819889  
}  
landmark {  
 x: 0.5277288556098938  
 y: 0.5939629077911377  
 z: 0.09098593890666962  
}  
landmark {  
 x: 0.4687861204147339  
 y: 0.43156206607818604  
 z: 0.0020212288945913315  
}  
landmark {  
 x: 0.45164841413497925  
 y: 0.4659510850906372  
 z: -0.030470993369817734  
}  
landmark {  
 x: 0.47470301389694214  
 y: 0.6719442009925842  
 z: 0.03300641477108002  
}  
landmark {  
 x: 0.5457884073257446  
 y: 0.5248293280601501  
 z: 0.07876401394605637  
}  
landmark {  
 x: 0.4541948735713959  
 y: 0.5833560824394226  
 z: -0.007988271303474903  
}  
landmark {  
 x: 0.45608314871788025  
 y: 0.5872379541397095  
 z: -0.0097128851339221  
}  
landmark {  
 x: 0.4580540657043457  
 y: 0.5934110283851624  
 z: -0.011375262401998043  
}  
landmark {  
 x: 0.45967262983322144  
 y: 0.601426899433136  
 z: -0.009458732791244984  
}  
landmark {  
 x: 0.4630682170391083  
 y: 0.6141385436058044  
 z: -0.0005099186673760414  
}  
landmark {  
 x: 0.47059041261672974  
 y: 0.578361988067627  
 z: -0.00026811365387402475  
}  
landmark {  
 x: 0.47428610920906067  
 y: 0.5771676301956177  
 z: -0.0003562068159226328  
}  
landmark {  
 x: 0.47769930958747864  
 y: 0.5748226642608643  
 z: -0.00043795965029858053  
}  
landmark {  
 x: 0.4884759485721588  
 y: 0.5652840733528137  
 z: 0.0013548649149015546  
}  
landmark {  
 x: 0.527277946472168  
 y: 0.529628574848175  
 z: 0.022180428728461266  
}  
landmark {  
 x: 0.45116040110588074  
 y: 0.4515669643878937  
 z: -0.021438265219330788  
}  
landmark {  
 x: 0.45700278878211975  
 y: 0.42551934719085693  
 z: -0.00487841060385108  
}  
landmark {  
 x: 0.46386221051216125  
 y: 0.42735952138900757  
 z: -0.0003105615032836795  
}  
landmark {  
 x: 0.4677443504333496  
 y: 0.5764814615249634  
 z: 0.0008752373396418989  
}  
landmark {  
 x: 0.5282283425331116  
 y: 0.5631617903709412  
 z: 0.041439544409513474  
}  
landmark {  
 x: 0.4474172592163086  
 y: 0.4251081347465515  
 z: -0.01921181008219719  
}  
landmark {  
 x: 0.4689321219921112  
 y: 0.6279214024543762  
 z: 0.006773080676794052  
}  
landmark {  
 x: 0.44365742802619934  
 y: 0.4593307375907898  
 z: -0.038782887160778046  
}  
landmark {  
 x: 0.45995622873306274  
 y: 0.48697996139526367  
 z: -0.02866244688630104  
}  
landmark {  
 x: 0.451344758272171  
 y: 0.6378600597381592  
 z: 0.001395989558659494  
}  
landmark {  
 x: 0.49425387382507324  
 y: 0.5976565480232239  
 z: 0.016566261649131775  
}  
landmark {  
 x: 0.4817953109741211  
 y: 0.5212119221687317  
 z: -0.005628833081573248  
}  
landmark {  
 x: 0.48284420371055603  
 y: 0.6145609021186829  
 z: 0.012174054980278015  
}  
landmark {  
 x: 0.5054787993431091  
 y: 0.5193838477134705  
 z: -0.00028101252974011004  
}  
landmark {  
 x: 0.4913472533226013  
 y: 0.5356276631355286  
 z: -0.0024373054038733244  
}  
landmark {  
 x: 0.5142016410827637  
 y: 0.5415099263191223  
 z: 0.01028330996632576  
}  
landmark {  
 x: 0.4552684724330902  
 y: 0.65617835521698  
 z: 0.003705585142597556  
}  
landmark {  
 x: 0.4666520655155182  
 y: 0.4936234951019287  
 z: -0.02002447471022606  
}  
landmark {  
 x: 0.5031503438949585  
 y: 0.6088792681694031  
 z: 0.0283095370978117  
}  
landmark {  
 x: 0.48908913135528564  
 y: 0.627226710319519  
 z: 0.02227340266108513  
}  
landmark {  
 x: 0.5030381679534912  
 y: 0.5791619420051575  
 z: 0.016560722142457962  
}  
landmark {  
 x: 0.5372927784919739  
 y: 0.5447303652763367  
 z: 0.04990938678383827  
}  
landmark {  
 x: 0.5159150958061218  
 y: 0.5807384252548218  
 z: 0.027806073427200317  
}  
landmark {  
 x: 0.5404992699623108  
 y: 0.554157018661499  
 z: 0.07661723345518112  
}  
landmark {  
 x: 0.49937963485717773  
 y: 0.5538273453712463  
 z: 0.004335980862379074  
}  
landmark {  
 x: 0.458901584148407  
 y: 0.4741691052913666  
 z: -0.021835526451468468  
}  
landmark {  
 x: 0.459457665681839  
 y: 0.5148123502731323  
 z: -0.043454814702272415  
}  
landmark {  
 x: 0.46668288111686707  
 y: 0.516842246055603  
 z: -0.03092786855995655  
}  
landmark {  
 x: 0.45473602414131165  
 y: 0.5068427324295044  
 z: -0.051891956478357315  
}  
landmark {  
 x: 0.46659529209136963  
 y: 0.4136863946914673  
 z: -0.00914206076413393  
}  
landmark {  
 x: 0.48497962951660156  
 y: 0.4058384299278259  
 z: -0.01135201659053564  
}  
landmark {  
 x: 0.5005658864974976  
 y: 0.40394747257232666  
 z: -0.01025104895234108  
}  
landmark {  
 x: 0.5131955742835999  
 y: 0.4053376019001007  
 z: -0.00520589854568243  
}  
landmark {  
 x: 0.5216752290725708  
 y: 0.41082584857940674  
 z: 0.0021674898453056812  
}  
landmark {  
 x: 0.5260190963745117  
 y: 0.43317463994026184  
 z: 0.02064221166074276  
}  
landmark {  
 x: 0.5509005188941956  
 y: 0.46437469124794006  
 z: 0.07303263992071152  
}  
landmark {  
 x: 0.5174968838691711  
 y: 0.453131765127182  
 z: 0.01340942457318306  
}  
landmark {  
 x: 0.5063735246658325  
 y: 0.4578854739665985  
 z: 0.006778374779969454  
}  
landmark {  
 x: 0.4920850992202759  
 y: 0.45852264761924744  
 z: 0.0022305352613329887  
}  
landmark {  
 x: 0.47830697894096375  
 y: 0.4554804563522339  
 z: -0.00025309796910732985  
}  
landmark {  
 x: 0.4678650200366974  
 y: 0.45084336400032043  
 z: -0.0010161916725337505  
}  
landmark {  
 x: 0.46069690585136414  
 y: 0.4464426636695862  
 z: -0.0020005488768219948  
}  
landmark {  
 x: 0.5489404797554016  
 y: 0.46191349625587463  
 z: 0.11433915048837662  
}  
landmark {  
 x: 0.46619829535484314  
 y: 0.5199927687644958  
 z: -0.025193488225340843  
}  
landmark {  
 x: 0.45198675990104675  
 y: 0.47885116934776306  
 z: -0.038113683462142944  
}  
landmark {  
 x: 0.4514533281326294  
 y: 0.5167478919029236  
 z: -0.05206717550754547  
}  
landmark {  
 x: 0.44512665271759033  
 y: 0.5232029557228088  
 z: -0.04720502719283104  
}  
landmark {  
 x: 0.4513528048992157  
 y: 0.518340528011322  
 z: -0.04653789848089218  
}  
landmark {  
 x: 0.46293824911117554  
 y: 0.5241513848304749  
 z: -0.021253176033496857  
}  
landmark {  
 x: 0.4431333541870117  
 y: 0.5249411463737488  
 z: -0.050017502158880234  
}  
landmark {  
 x: 0.4419323205947876  
 y: 0.5270261168479919  
 z: -0.036566004157066345  
}  
landmark {  
 x: 0.46149998903274536  
 y: 0.435773104429245  
 z: 0.0023715938441455364  
}  
landmark {  
 x: 0.4551146924495697  
 y: 0.439194917678833  
 z: -0.004123962018638849  
}  
landmark {  
 x: 0.4519377648830414  
 y: 0.4417264461517334  
 z: -0.011570336297154427  
}  
landmark {  
 x: 0.5144167542457581  
 y: 0.4294883906841278  
 z: 0.00883173756301403  
}  
landmark {  
 x: 0.5197369456291199  
 y: 0.42312633991241455  
 z: 0.009060878306627274  
}  
, 'Pose': landmark {  
 x: 0.446443647146225  
 y: 0.5030257701873779  
 z: -0.8790966272354126  
 visibility: 0.9999964237213135  
}  
landmark {  
 x: 0.4688083231449127  
 y: 0.4209843873977661  
 z: -0.8130429983139038  
 visibility: 0.9999926090240479  
}  
landmark {  
 x: 0.4869900345802307  
 y: 0.41805410385131836  
 z: -0.8126438856124878  
 visibility: 0.9999922513961792  
}  
landmark {  
 x: 0.5029262900352478  
 y: 0.41582632064819336  
 z: -0.8122204542160034  
 visibility: 0.999991774559021  
}  
landmark {  
 x: 0.4034753739833832  
 y: 0.43148326873779297  
 z: -0.8284305334091187  
 visibility: 0.999991774559021  
}  
landmark {  
 x: 0.38112127780914307  
 y: 0.43474864959716797  
 z: -0.8273134231567383  
 visibility: 0.9999892711639404  
}  
landmark {  
 x: 0.36186474561691284  
 y: 0.4384843111038208  
 z: -0.8274855613708496  
 visibility: 0.9999880790710449  
}  
landmark {  
 x: 0.5293742418289185  
 y: 0.4327414333820343  
 z: -0.4138931334018707  
 visibility: 0.9999939203262329  
}  
landmark {  
 x: 0.3380972146987915  
 y: 0.4715878665447235  
 z: -0.47043830156326294  
 visibility: 0.9999939203262329  
}  
landmark {  
 x: 0.486093670129776  
 y: 0.5636065006256104  
 z: -0.7291505932807922  
 visibility: 0.9999904632568359  
}  
landmark {  
 x: 0.4095175266265869  
 y: 0.5786192417144775  
 z: -0.7474803924560547  
 visibility: 0.9999915361404419  
}  
landmark {  
 x: 0.7103500366210938  
 y: 0.7632513642311096  
 z: -0.20474830269813538  
 visibility: 0.9997841715812683  
}  
landmark {  
 x: 0.2073235958814621  
 y: 0.8636583685874939  
 z: -0.2329804003238678  
 visibility: 0.9969954490661621  
}  
landmark {  
 x: 1.0072393417358398  
 y: 0.9718599319458008  
 z: -0.5932084321975708  
 visibility: 0.9668106436729431  
}  
landmark {  
 x: 0.165879487991333  
 y: 1.3588415384292603  
 z: 0.0035895747132599354  
 visibility: 0.09385249763727188  
}  
landmark {  
 x: 0.7839558124542236  
 y: 0.4806027412414551  
 z: -0.9328359365463257  
 visibility: 0.9880605340003967  
}  
landmark {  
 x: 0.15134450793266296  
 y: 1.7309373617172241  
 z: -0.17434944212436676  
 visibility: 0.08702109009027481  
}  
landmark {  
 x: 0.7268738746643066  
 y: 0.3785511255264282  
 z: -1.0274306535720825  
 visibility: 0.9625961780548096  
}  
landmark {  
 x: 0.12420675903558731  
 y: 1.8591194152832031  
 z: -0.19851145148277283  
 visibility: 0.15547168254852295  
}  
landmark {  
 x: 0.685626745223999  
 y: 0.39045608043670654  
 z: -0.8681071400642395  
 visibility: 0.9696366786956787  
}  
landmark {  
 x: 0.15393531322479248  
 y: 1.8533110618591309  
 z: -0.30424928665161133  
 visibility: 0.2535477578639984  
}  
landmark {  
 x: 0.6855407357215881  
 y: 0.4355727434158325  
 z: -0.8884848356246948  
 visibility: 0.9654226899147034  
}  
landmark {  
 x: 0.17493483424186707  
 y: 1.8060349225997925  
 z: -0.22922301292419434  
 visibility: 0.25785812735557556  
}  
landmark {  
 x: 0.6536270976066589  
 y: 1.6142312288284302  
 z: -0.07196687906980515  
 visibility: 0.0009186184033751488  
}  
landmark {  
 x: 0.34157896041870117  
 y: 1.6507718563079834  
 z: 0.07930468022823334  
 visibility: 0.0003977963060606271  
}  
landmark {  
 x: 0.6810697317123413  
 y: 2.3204214572906494  
 z: -0.19802770018577576  
 visibility: 0.0006973552517592907  
}  
landmark {  
 x: 0.3817279040813446  
 y: 2.338632822036743  
 z: 0.1601889729499817  
 visibility: 0.00010745259351097047  
}  
landmark {  
 x: 0.6879216432571411  
 y: 2.9217844009399414  
 z: 0.3295019567012787  
 visibility: 4.882227131020045e-06  
}  
landmark {  
 x: 0.3955884873867035  
 y: 2.939582109451294  
 z: 0.5936133861541748  
 visibility: 6.32067440164974e-07  
}  
landmark {  
 x: 0.6955447793006897  
 y: 3.011507272720337  
 z: 0.353939026594162  
 visibility: 4.40793428424513e-06  
}  
landmark {  
 x: 0.3933960199356079  
 y: 3.038041114807129  
 z: 0.6200202107429504  
 visibility: 2.1282157831592485e-06  
}  
landmark {  
 x: 0.6540369987487793  
 y: 3.128223419189453  
 z: -0.22974762320518494  
 visibility: 3.558783282642253e-05  
}  
landmark {  
 x: 0.44894322752952576  
 y: 3.1331710815429688  
 z: 0.001464695087634027  
 visibility: 1.0009997822635341e-05  
}  
}

**2. Alphabet Collection**

[12]

mpHands = mp.solutions.hands  
hands = mpHands.Hands(max\_num\_hands=1, min\_detection\_confidence=0.7)  
mpDraw = mp.solutions.drawing\_utils

[28]

DATA\_PATH = os.path.join(**'./data/Character\_Data'**)   
LANDMARK\_PATH = os.path.join(**'./data/Character\_Data\_Landmarks'**)  
  
actions = np.array( [ chr(i) **for** i **in** range(ord(**'U'**), ord(**'Y'**)+1) ] )  
*# actions = np.array(['E'])*  
print(actions)  
  
no\_sequences =  25  
sequence\_length = 30  
start\_folder = 0

['U' 'V' 'W' 'X' 'Y']

[29]

**for** action **in** actions:   
    **for** sequence **in** range(no\_sequences):  
        **try**:   
            *# os.makedirs(os.path.join(DATA\_PATH, action, str(sequence)))*  
            os.makedirs(os.path.join(LANDMARK\_PATH, action, str(sequence)))  
        **except**:  
            **pass**

[10]

**import** math  
   
**def** getAngle(a, b, c):  
    ang = math.degrees(math.atan2(c[1]-b[1], c[0]-b[0]) - math.atan2(a[1]-b[1], a[0]-b[0]))  
    **return** ang + 360 **if** ang < 0 **else** ang

[30]

**def** mediapipe\_detection(image, model):  
    image = cv2.flip(image, 1)  
    image = cv2.cvtColor(image, cv2.COLOR\_BGR2RGB) *# COLOR CONVERSION BGR 2 RGB*  
    results = model.process(image)                 *# Make prediction*  
    image = cv2.cvtColor(image, cv2.COLOR\_RGB2BGR) *# COLOR COVERSION RGB 2 BGR*  
    **return** image, results  
  
  
cap = cv2.VideoCapture(0)  
      
*# NEW LOOP*  
*# Loop through actions*  
**for** action **in** actions:  
    *# Loop through sequences aka videos*  
    **for** sequence **in** range(start\_folder, start\_folder+no\_sequences):  
        *# Loop through video length aka sequence length*  
        **for** frame\_num **in** range(sequence\_length):  
  
            \_, frame = cap.read()  
  
            x, y, c = frame.shape  
            frame, result = mediapipe\_detection(frame, hands)    
            className = **''**  
              
            *# post process the result*  
            **if** result.multi\_hand\_landmarks:  
                landmarks = []  
  
                pkl\_path = os.path.join(LANDMARK\_PATH, action, str(sequence), str(frame\_num))  
                **with** open(pkl\_path, **'wb'**) **as** f:  
                    pickle.dump(result.multi\_hand\_landmarks, f)  
  
                **for** handslms **in** result.multi\_hand\_landmarks:  
                      
                *#     angle\_1 = getAngle((handslms.landmark[mpHands.HandLandmark.THUMB\_TIP].x, handslms.landmark[mpHands.HandLandmark.THUMB\_TIP].y),*  
                *#                             (handslms.landmark[mpHands.HandLandmark.WRIST].x, handslms.landmark[mpHands.HandLandmark.WRIST].y),*  
                *#                             (handslms.landmark[mpHands.HandLandmark.PINKY\_TIP].x, handslms.landmark[mpHands.HandLandmark.PINKY\_TIP].y))*  
  
                *#     angle\_2 = getAngle((handslms.landmark[mpHands.HandLandmark.INDEX\_FINGER\_TIP].x, handslms.landmark[mpHands.HandLandmark.INDEX\_FINGER\_TIP].y),*  
                *#                         (handslms.landmark[mpHands.HandLandmark.INDEX\_FINGER\_MCP].x, handslms.landmark[mpHands.HandLandmark.INDEX\_FINGER\_MCP].y),*  
                *#                         (handslms.landmark[mpHands.HandLandmark.MIDDLE\_FINGER\_TIP].x, handslms.landmark[mpHands.HandLandmark.MIDDLE\_FINGER\_TIP].y))*  
  
                *#     # angle\_3 = getAngle((handslms.landmark[mpHands.HandLandmark.THUMB\_TIP].x, handslms.landmark[mpHands.HandLandmark.THUMB\_TIP].y),*  
                *#     #                     (handslms.landmark[mpHands.HandLandmark.WRIST].x, handslms.landmark[mpHands.HandLandmark.WRIST].y),*  
                *#     #                     (handslms.landmark[mpHands.HandLandmark.INDEX\_FINGER\_TIP].x, handslms.landmark[mpHands.HandLandmark.INDEX\_FINGER\_TIP].y))*  
                      
                *#     for lm in handslms.landmark:*  
                *#         lmx = int(lm.x \* x)*  
                *#         lmy = int(lm.y \* y)*  
                          
  
                *#         landmarks.append([lmx, lmy])*  
                *#     landmarks.append([angle\_1, angle\_2])*  
  
                    *# Drawing landmarks on frames*  
                    mpDraw.draw\_landmarks(frame, handslms, mpHands.HAND\_CONNECTIONS)  
  
  
                *# NEW Apply wait logic*  
                **if** frame\_num == 0:   
                    cv2.putText(frame, **'STARTING COLLECTION'**, (120,200),   
                            cv2.FONT\_HERSHEY\_SIMPLEX, 1, (0,255, 0), 4, cv2.LINE\_AA)  
                    cv2.putText(frame, **'Frames for {} Video Number {}'**.format(action, sequence), (15,15),   
                            cv2.FONT\_HERSHEY\_SIMPLEX, 0.7, (255, 0, 0), 1, cv2.LINE\_AA)  
                    *# Show to screen*  
                    cv2.imshow(**'OpenCV Feed'**, frame)  
                    cv2.waitKey(1000)  
                **else**:   
                    cv2.putText(frame, **'Frames for {} Video Number {}'**.format(action, sequence), (15,12),   
                            -cv2.FONT\_HERSHEY\_SIMPLEX, 0.7, (0, 0, 255), 1, cv2.LINE\_AA)  
                    *# Show to screen*  
                    cv2.imshow(**'OpenCV Feed'**, frame)  
                  
                  
                *# npy\_path = os.path.join(DATA\_PATH, action, str(sequence), str(frame\_num))*  
                *# # npy\_path = "./MP\_Data/" + action + "\_" + str(sequence) + "\_" + str(frame\_num)*  
                *# np.save(npy\_path, landmarks)*  
  
                *# Break gracefully*  
                **if** cv2.waitKey(10) & **0x**FF == ord(**'q'**):  
                    **break**  
                  
cap.release()  
cv2.destroyAllWindows()

[19]

cap.release()  
cv2.destroyAllWindows()

**Landmark Processing**

**for** (dirpath, dirnames, filenames) **in** os.walk(os.path.join(LANDMARK\_PATH, action)):  
    **if** filenames != []:  
        print(dirpath, **" || "**, dirnames, **" || "**, filenames)

[24]

**with** open(LANDMARK\_PATH + **"/A/0/0"**, **'rb'**) **as** f:  
    temp = pickle.load(f)  
  
print(temp)

[landmark {  
 x: 0.703121542930603  
 y: 0.7075721621513367  
 z: -1.4293437743617687e-05  
}  
landmark {  
 x: 0.6407036185264587  
 y: 0.6598061323165894  
 z: -0.00026755392900668085  
}  
landmark {  
 x: 0.6133453249931335  
 y: 0.5866129398345947  
 z: -0.0033629087265580893  
}  
landmark {  
 x: 0.6085043549537659  
 y: 0.517384946346283  
 z: -0.01776842586696148  
}  
landmark {  
 x: 0.6079214811325073  
 y: 0.45565229654312134  
 z: -0.030422991141676903  
}  
landmark {  
 x: 0.6418766379356384  
 y: 0.5336267948150635  
 z: 0.05150540918111801  
}  
landmark {  
 x: 0.6357977986335754  
 y: 0.4693397581577301  
 z: 0.01953570358455181  
}  
landmark {  
 x: 0.6321566700935364  
 y: 0.5193647742271423  
 z: 0.004923675674945116  
}  
landmark {  
 x: 0.6371386647224426  
 y: 0.5522836446762085  
 z: 0.010959232226014137  
}  
landmark {  
 x: 0.6727499961853027  
 y: 0.531866729259491  
 z: 0.03800182789564133  
}  
landmark {  
 x: 0.6635476350784302  
 y: 0.4697135388851166  
 z: -0.010434870608150959  
}  
landmark {  
 x: 0.6554995775222778  
 y: 0.5405893921852112  
 z: -0.025175705552101135  
}  
landmark {  
 x: 0.6626913547515869  
 y: 0.5658836960792542  
 z: -0.005635339766740799  
}  
landmark {  
 x: 0.7055467963218689  
 y: 0.5386548042297363  
 z: 0.015106668695807457  
}  
landmark {  
 x: 0.6972611546516418  
 y: 0.48176026344299316  
 z: -0.023082025349140167  
}  
landmark {  
 x: 0.6860032081604004  
 y: 0.552194356918335  
 z: -0.025684406980872154  
}  
landmark {  
 x: 0.6934293508529663  
 y: 0.5772029161453247  
 z: -0.008611074648797512  
}  
landmark {  
 x: 0.7404024600982666  
 y: 0.5523325204849243  
 z: -0.007791577838361263  
}  
landmark {  
 x: 0.7291049957275391  
 y: 0.5078904628753662  
 z: -0.022851699963212013  
}  
landmark {  
 x: 0.7168023586273193  
 y: 0.5552054047584534  
 z: -0.02007845602929592  
}  
landmark {  
 x: 0.7221730351448059  
 y: 0.5772821307182312  
 z: -0.002213236875832081  
}  
]

[2]

**from** tensorflow.keras.models **import** load\_model  
**import** tensorflowjs **as** tfjs  
  
model = load\_model(**'../model\_saves/checkpoints/alphabets\_Z\_model'**)  
print(**"Model: "**, model)  
tfjs.converters.save\_keras\_model(model, **"../model\_saves/tensorflowjs\_model"**)

Model: <tensorflow.python.keras.engine.sequential.Sequential object at 0x000001E6DC3584E0>