Tactile Sensing as a Way to Communicate with Expressive Robot Arm

Research Internship
GV Lab - Human Robot Interactions

Self Introduction

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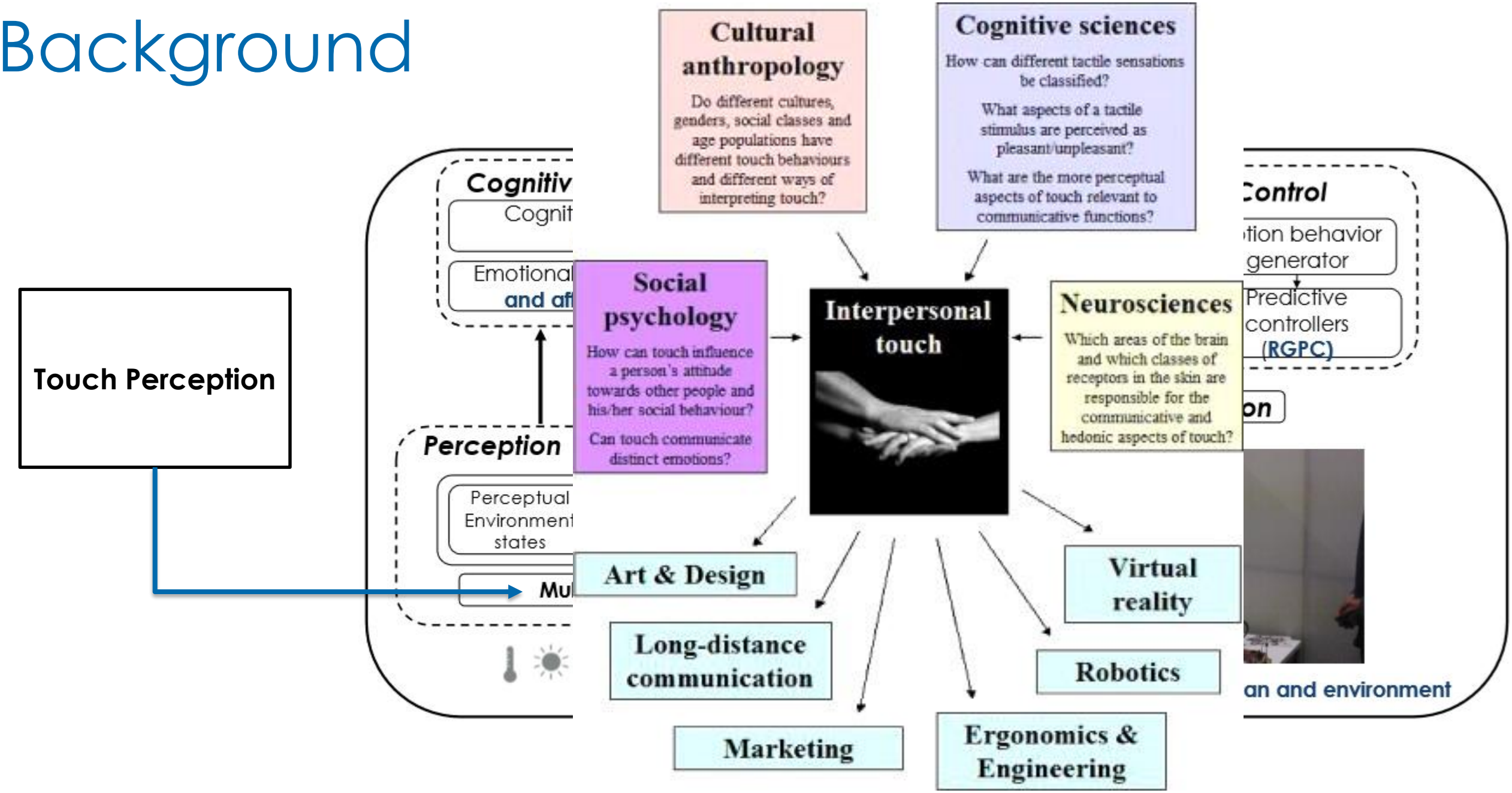
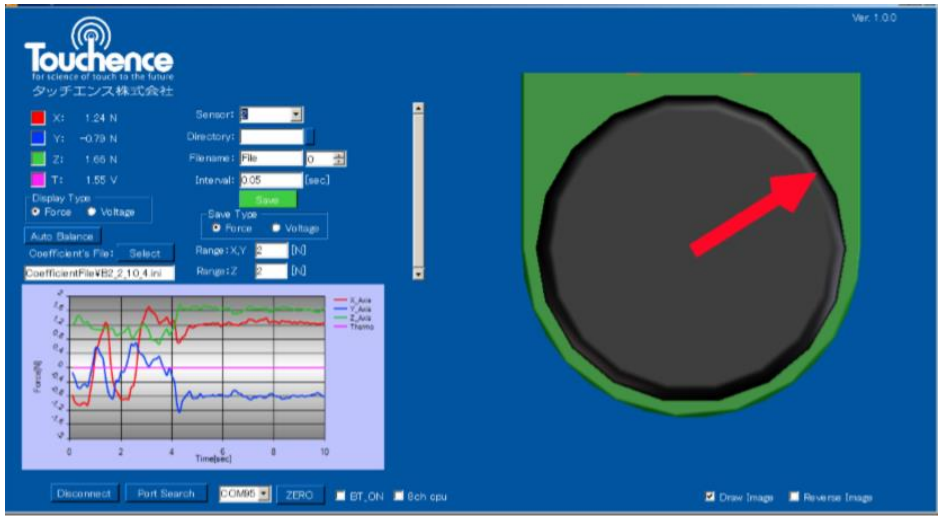
SV : Gentiane Venture

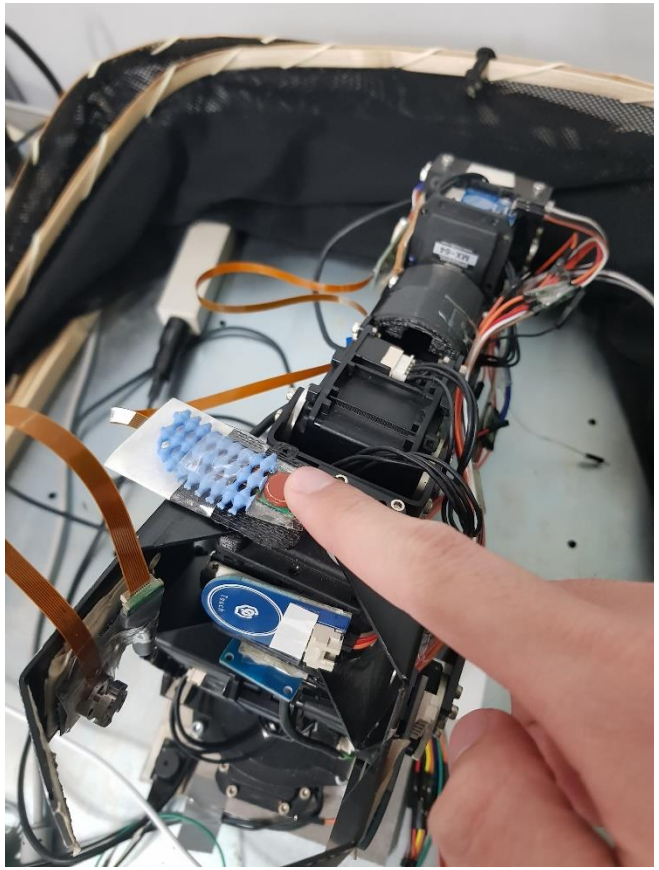
Background


Touch Perception
Cognitiv
Cognit
Emotional
and af
Perception
Perceptual
Environment
states
Mu
Cultural anthropology
Do different cultures, genders, social classes and age populations have different touch behaviours and different ways of interpreting touch?
Cognitive sciences
How can different tactile sensations be classified?
What aspects of a tactile stimulus are perceived as pleasant/unpleasant?
What are the more perceptual aspects of touch relevant to communicative functions?
Social psychology
How can touch influence a person's attitude towards other people and his/her social behaviour?
Can touch communicate distinct emotions?
Interpersonal touch
Neurosciences
Which areas of the brain and which classes of receptors in the skin are responsible for the communicative and hedonic aspects of touch?
Control
tion behavior
generator
Predictive
controllers
(RGPC)
on
an and environment
Art & Design
Virtual reality
Long-distance communication
Robotics
Marketing
Ergonomics & Engineering

The Sensor (Can this sensor recognize motion well?)

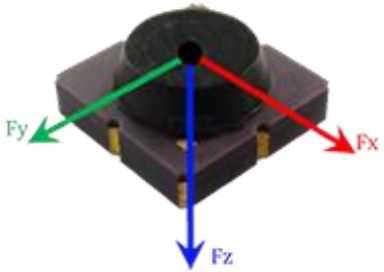
ShokacChip TS,
made by Touchence.Inc





Item	Number	Unit
Force range Fz	40	N
Force range Fx, Fy	±8	N
Maximum load	150	%
Linearity Error	±7	%R.O
Hysteresis	Z: ±3 X,Y: ±5	%R.O
Sensitivity Fz (typ.)	0.03	V/N
Sensitivity Fx, Fy (typ.)	0.10	V/N
Operating temp	10～40	℃

Overall System



Convolutional Neural Network/CNN (feature extraction)

Trained Model

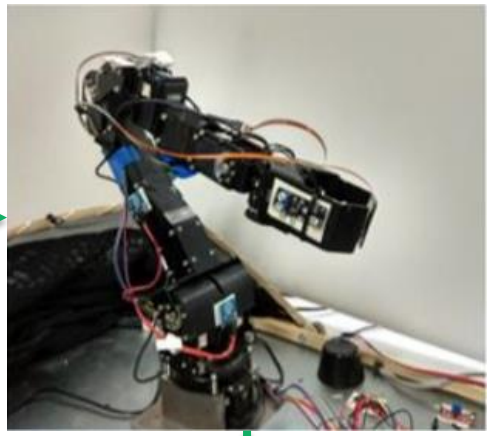
Motion Recognition (output : motion's name done by finger on sensor)

NEP (communication between different components written in different programming languages)

Blue = Offline

Green = Online/Realtime

RGPC Controller



Robot's Trajectory Based on Input (gentle stroke, poke, press, scratch)

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Methods

- Data Collection : Ask experiment subject to do the motion 30 times for each motion with index finger
- Making & Training the Model :

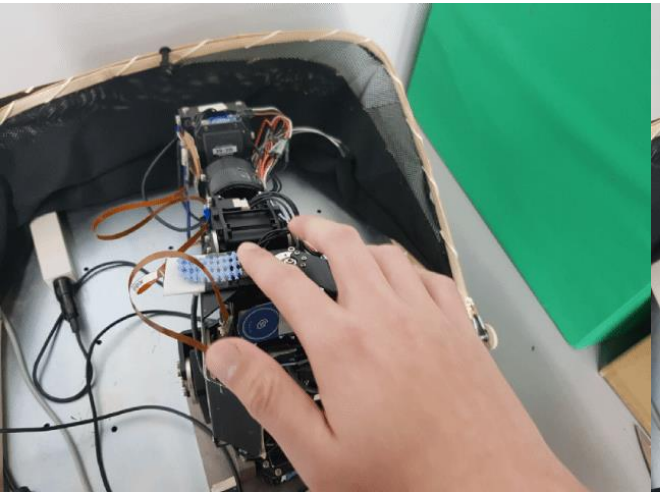
Model : CNN VGG16
Train : 49% Validation : 21% Test : 30%

- Real Time Recognition Testing :

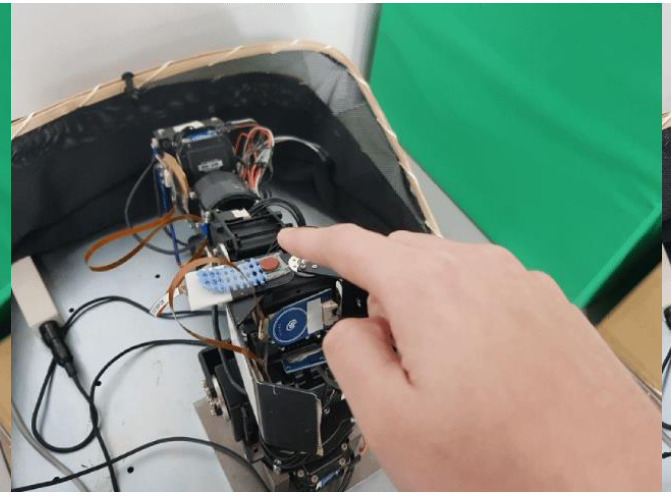
20 times for each motion, calculate how many the output is correct

Experiment

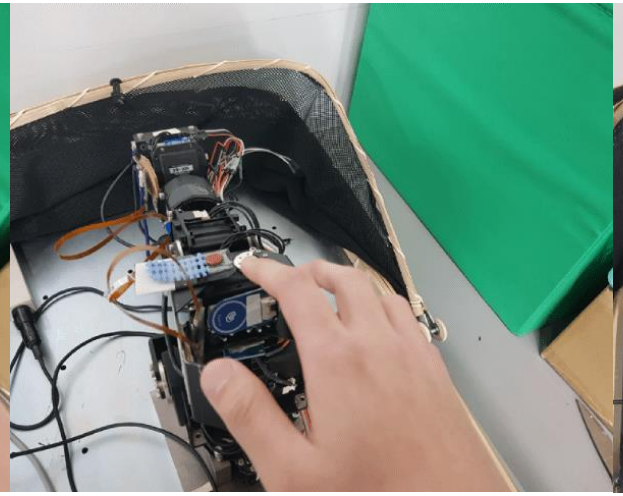
- 8 experiment subjects
- Each subject do 4 motions, 30 times for each motion + record “neutral data” 40 times. Total samples = 8*4*30 + 40 = 1000 samples (1 sample = about 5000 frames)



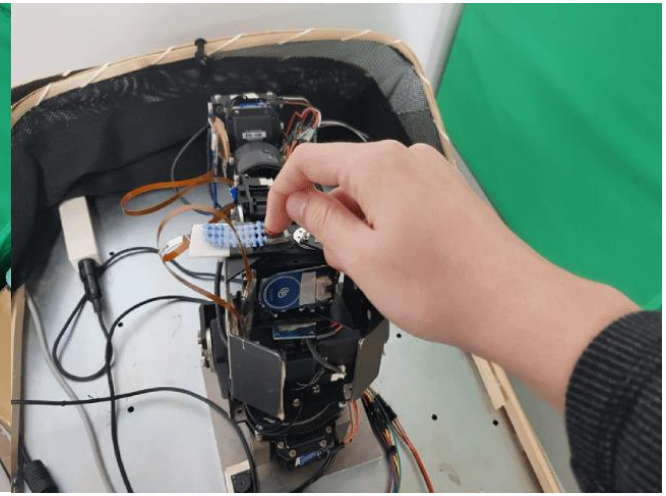
Gentle Stroke



Poke

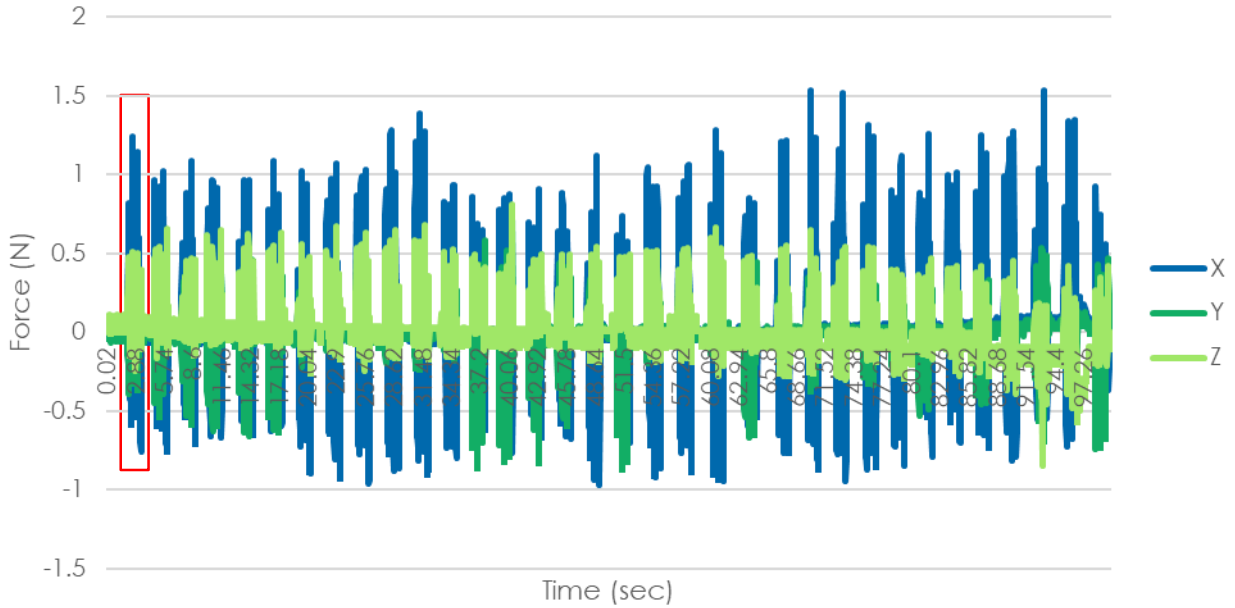


Press

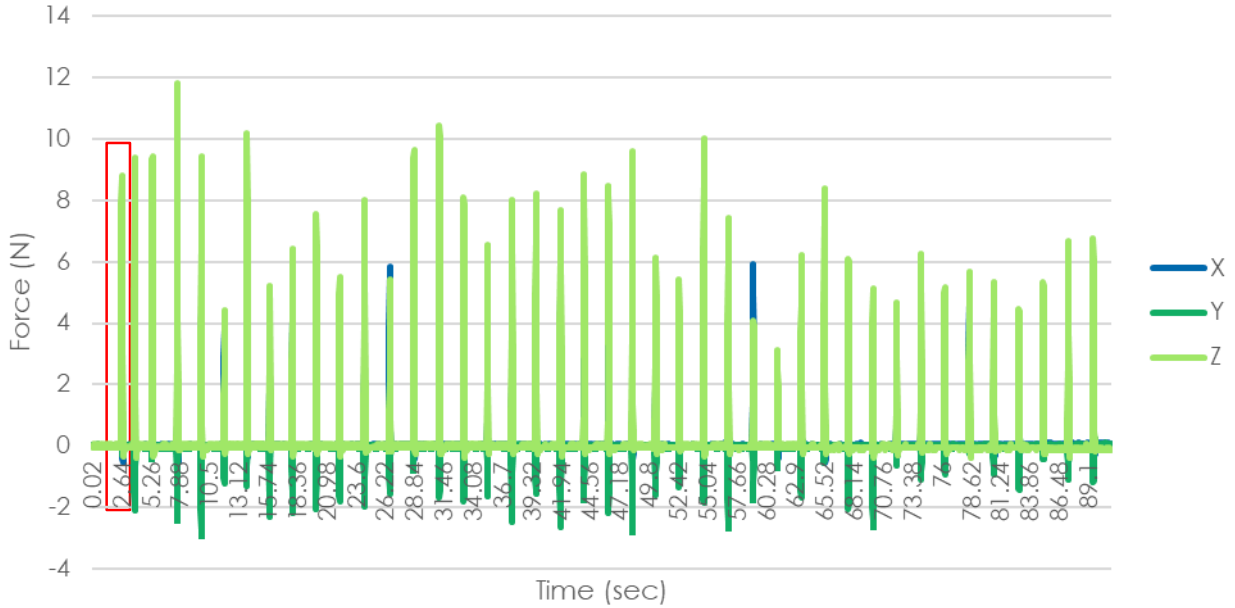


Scratch

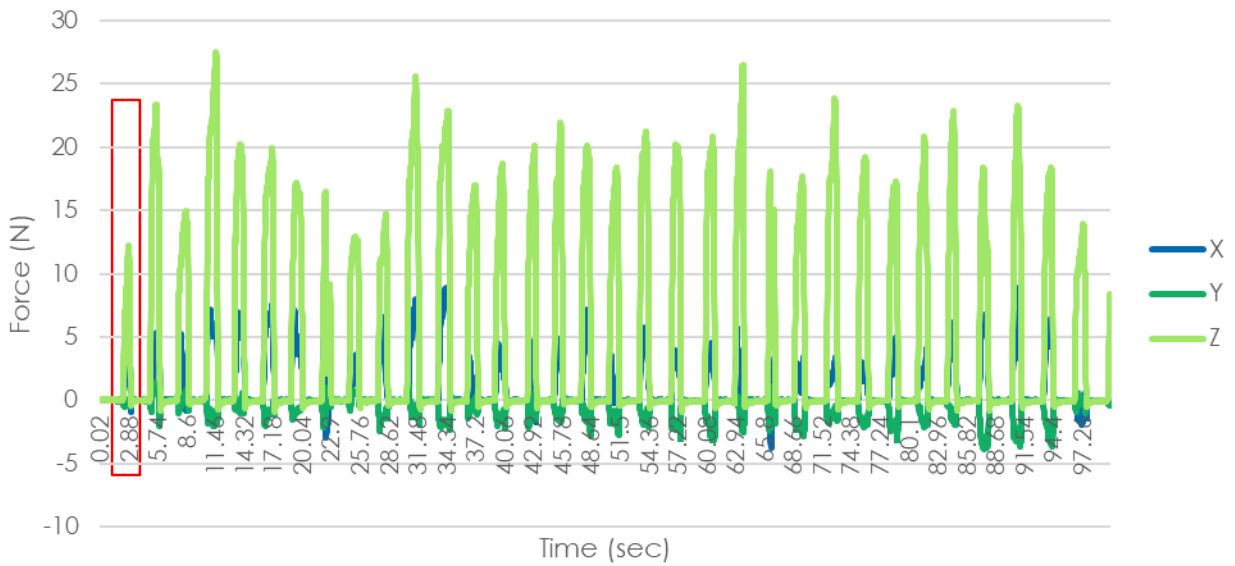
Gentle Stroke



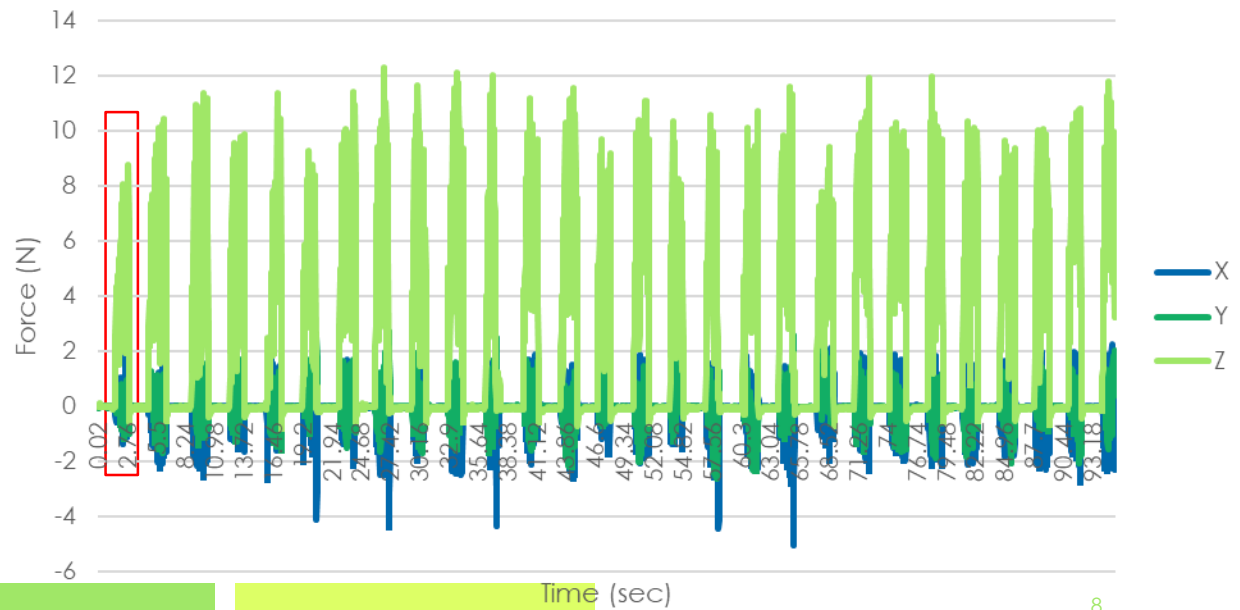
Poke



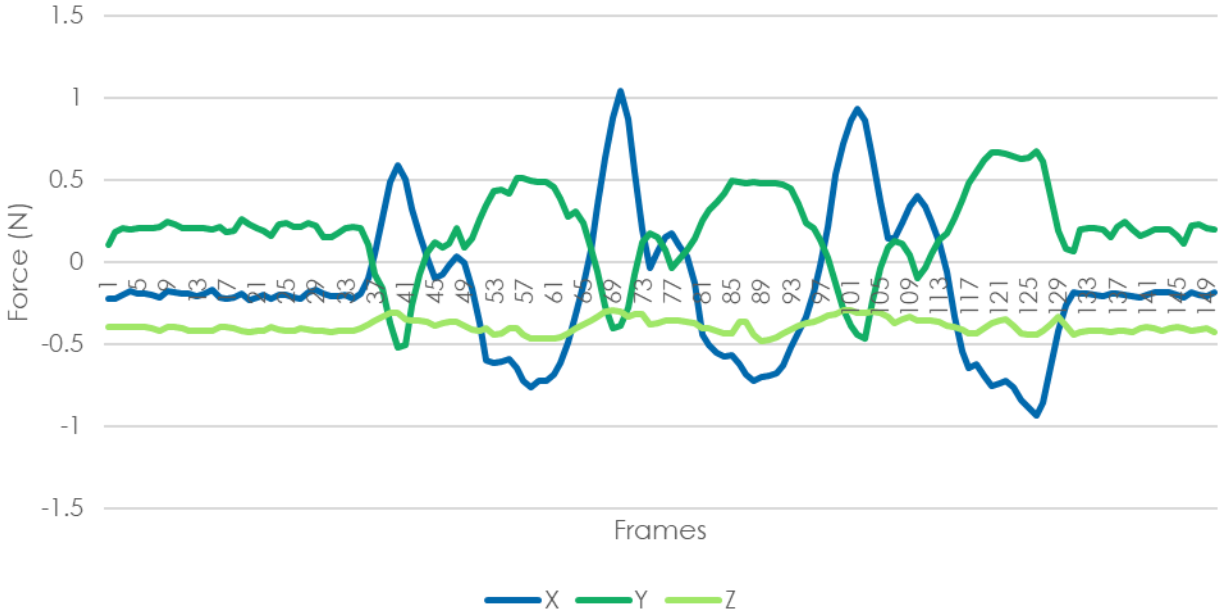
Press



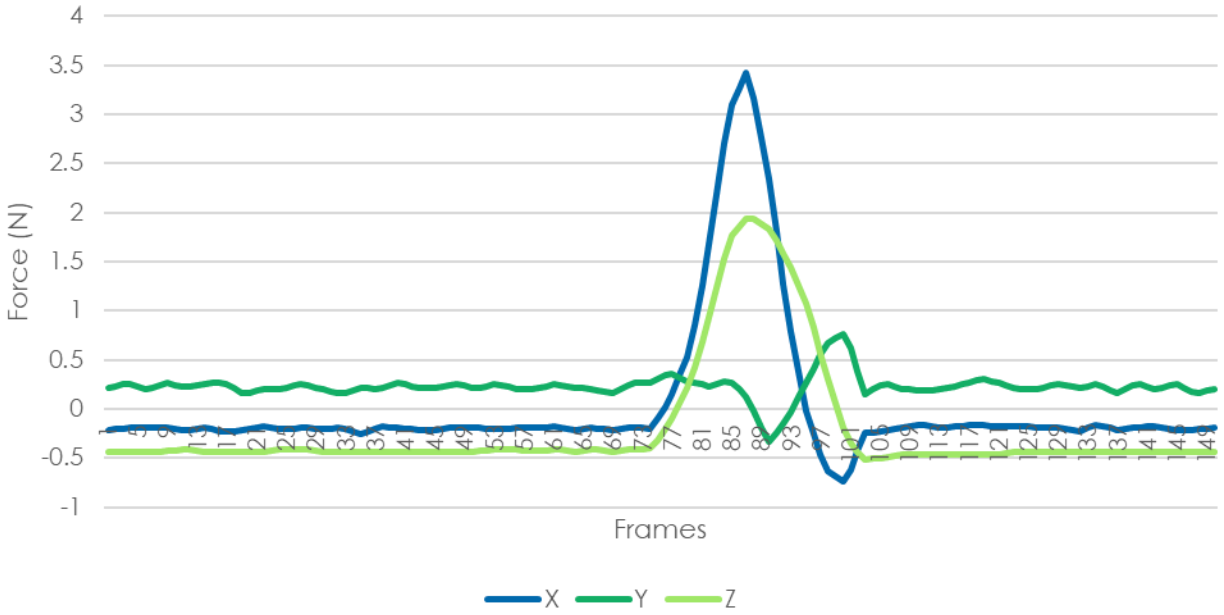
Scratch



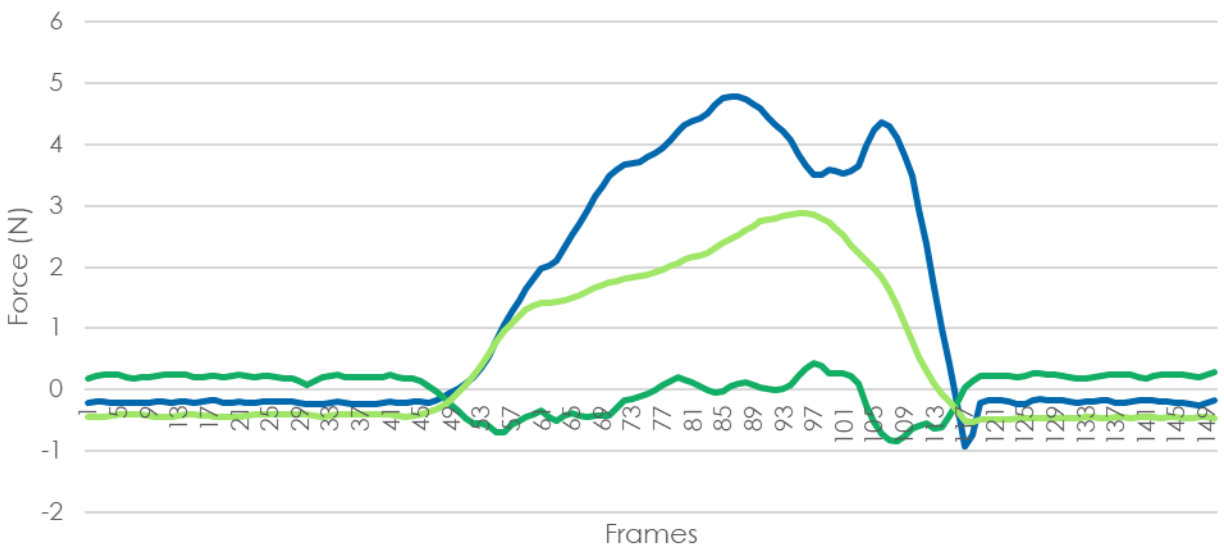
Gentle Stroke (Cut & Normalized)



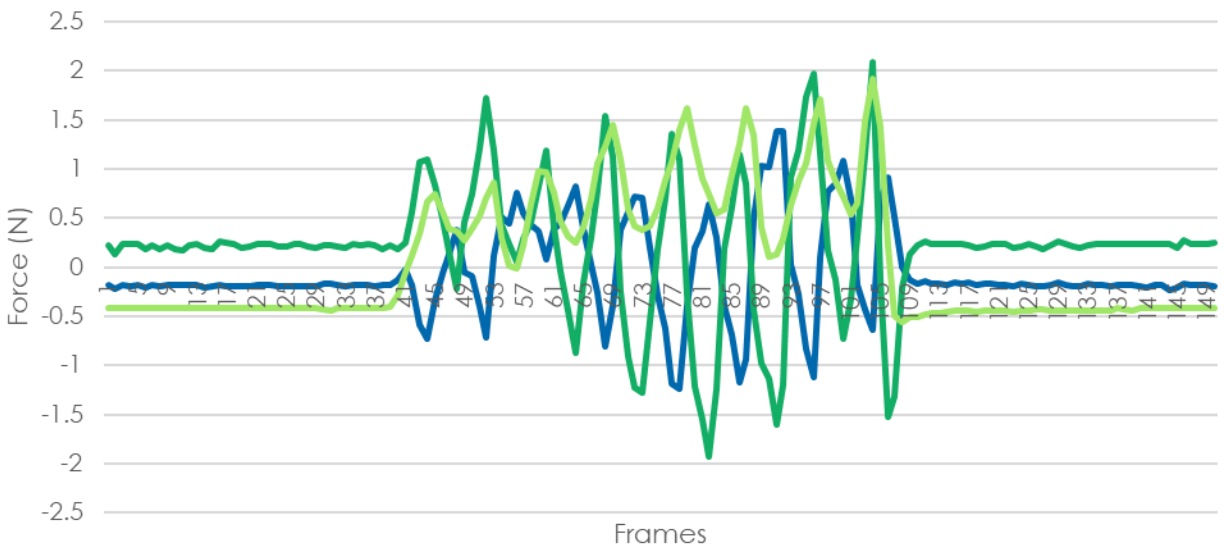
Poke (Cut & Normalized)



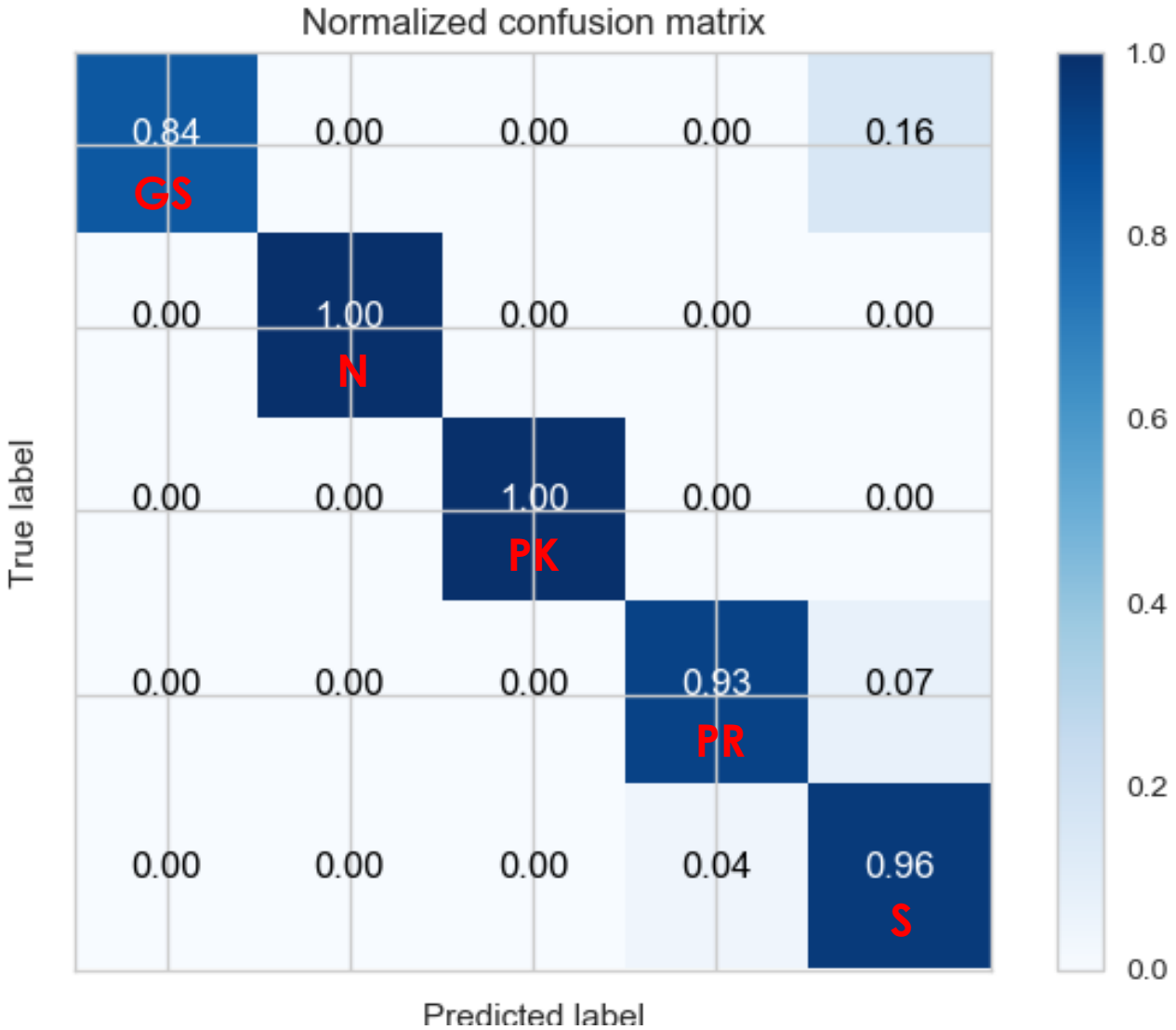
Press (Cut & Normalized)



Scratch (Cut & Normalized)



Result (Offline Recognition)



Training Result :

Model Accuracy : 94.6%
Train on 489 samples
Validate on 211 samples
Test on 300 samples

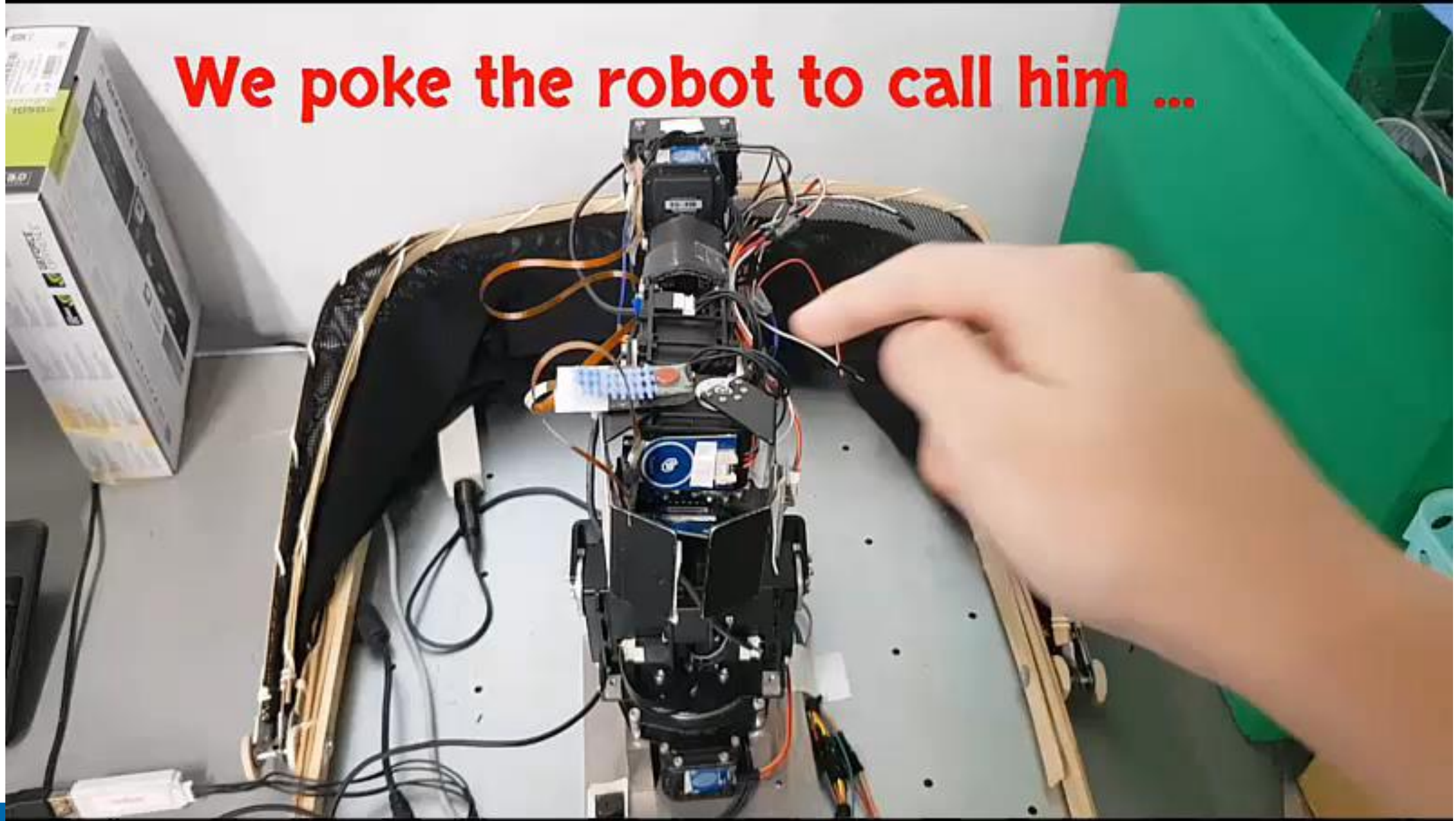
GS = Gentle Stroke
N = Neutral
PK = Poke
PR = Press
S = Scratch

Result (Online/Real Time Recognition)

Online Test Output Result

Input		Output: Neutral	Gentle Stroke	Poke	Press	Scratch
I	Neutral	1.0				
N	Gentle Stroke		0.95	0.05		
P	Poke		0.1	0.85		0.05
U	Press				0.85	0.15
T	Scratch		0.05	0.1	0.1	0.75

Real Time Recognition
Accuracy : 88%


We poke the robot to call him ...

Conclusion

- ShokacChip TS can be used as a motion recognition sensor with real time accuracy 88%
- The small size of the sensor sometimes make a broad motion like scratch hard to be done correctly, causing false prediction

Future Work

- Apply more sensors in different places on the robot arm
- Increase the number of motions to be recognized
- Increase the robustness of the motion recognition by collecting more data

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Any Question?