Graphical Parameter Evaluation for Affective Image Classification using Dimensional Affective Groups of International Affective Picture System

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***Abstract*— Input parameter evaluation for affective image classification using dimensional affective groups is proposed against the existing researches that use discrete affective groups which are not accurate enough due to not covering all three emotional vectors Valence, Arousal and Dominance. We obtain dimensional affective groups by clustering the known emotional vectors of International Affective Picture System set for all subjects, evaluate the affective group contents by using photo description. The histogram based and texture based fundamental graphical features of photos without borders are tested as input data sets for classification. Evaluation is by training neural network to identify the affective groups where the inputs originated. The test results shows the potentials like that the gray scale is suitable for high Valence groups or high Arousal groups, edges and corners are suitable for high Valence groups, blue histogram is accurate for high Arousal groups.**

***Keywords*— International Affective Picture System, Emotion Vector, Dimensional Affective Groups, Affective Image Classification, Neural Network**

I. INTRODUCTION

The International Affective Picture System (denotes IAPS) is a set of static stimulus image set which is widely used in human emotional researches. According to recent psychological studies the emotions from its perception can be considered as a representation of three dimensional emotional vectors called Valence, Arousal and Dominance (denotes VAD bellow). Therefore it is important to include all three emotional vectors in relevant studies for accuracy.

In our research we use IAPS set for all subjects [1] where the known VAD vectors ranged 0 to 9, assuming this set provide us with a wider emotion options. Fig. 2 is a 3D plot of these known vectors.

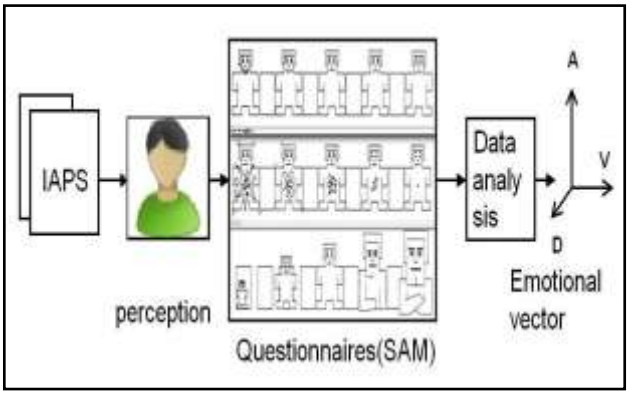

Fig. 1 obtain emotional vectors from perception

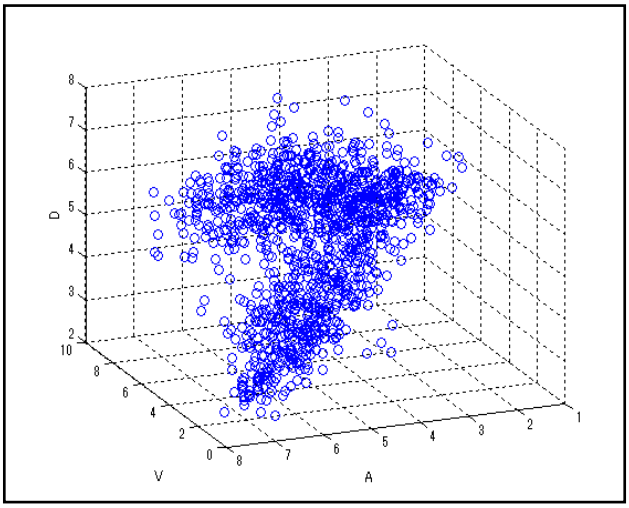

Fig. 2 emotional vectors of the set for all subjects

Affective image classification is a research area that combines arts, psychology and computer science. Searching for input parameters for artificial intelligence

to accomplish this task is the common interest in many resent researches. Since there are no global parameter set exist for this task, priory grouping before input evaluation is necessary. The groupings are either dimensional or discrete, with existing ones belongs to the latter.

In [5] Joseph et al., 2005 explained the usage of IAPS for obtaining the core emotions for a discrete categorization. In [3] V. Yanulevskaya et al. used selected photos for a manual categorization to obtain 10 discrete emotional groups as emotional valence categorization named anger, amusement, contentment, awe, disgust, excitement, fear, sadness, undifferentiated positive and undifferentiated negative. Despite the different names of core emotion categories all these previous categorizations are discrete approaches.

The problem with discrete approaches is the uncertainty about the contents within undifferentiated groups and lack of completeness (selected photos) and less accuracy. Also missing important information related to a particular vector such as dominance is not appropriate.

We proposed dimensional approach which is more complete to experiment on than previous discrete groups. In our research we avoid unnecessary labeling of the data into discrete groups, rather concern about their location of vector space. On the other hand location does capable to represent core emotions, trade off is just the distinguished core names(labels), i.e. for a group with high valence and low arousal some may name it a happy group, others may name it as pleasant group.

We use spectrum based inputs and texture based input for evaluation. These inputs were originated in different approach [6] where we experimented on designing an intelligent engine to predict the emotion vector as an extended affective classification and interface design prospective.

The prospect of the evaluation in this research is to analyse the potential of the object parameters to recognize the target group. Once the potential is known, accuracy increase is going to be of rearrange those parameters and adding more features as in [4] Jana Machadjdik et al. Therefore the inputs that subject to evaluation here are fundamental histogram based and texture based parameters.

This screening necessity appears with shifting to dimensional groups from discrete groups, as well as previous efforts are considered to be missing basic information such as the importance of gray scale, or a particular color histogram.

II. Obtain Dimensional Affective Groups

Since the emotional vector of the data set is known, the affective categorization could be considered as grouping the affective photographs according to their location on vector space. In other words group the nearby photographs into a cluster.

There are many possible ways of such categorizations, linear and non linear methods. One could consider each group like in a shape of a cube. However there is no such a necessity to be in a finite shape.

We tested using density based clustering algorithms expectation maximization (EM) and the famous k-means, model based clustering algorithm self organizing map (SOM) and soft computing based clustering algorithm fuzzy c-means (FCM).

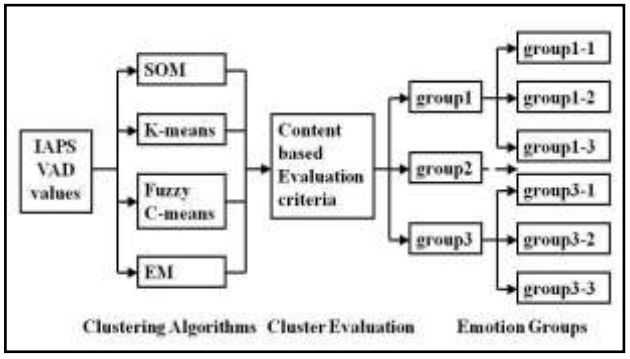

Fig. 3 clustering test

As external evaluation criteria measure we used description of photographs to represent group contents. A good cluster is considered to have similar contents. As an indicator we used keyword count of the photo description. The clustering results show a similarity among SOM, FCM and k-means, but EM which was quite different and less accurate. Table 1, 2 and 3 shows counts of some keywords per algorithm within groups1, 2 and 3. The counts exclude single plural issue, e.g. baby and babies, man and men are counted separately.

After comparing the cluster evaluation results we decided to use SOM based results which were better than others. The training method used in this approach was batch unsupervised weight bias training, which result in cluster the data according to their location of space. At first all data are clustered into 3 primary groups contending pleasant, moderate and unpleasant photos. Then re-cluster each group into 3 sub groups.

TABLE 1

group1-1				group1-2				group1-3			
description	som	k-means	FCM	description	som	k-means	FCM	description	som	k-means	FCM
Father	4	4	4	Attractive Male	3	3	3	Mountains	2	1	2
Nature	4	5	4	Diver	3	1	3	Plane	2	2	2
Children	6	5	6	Romance	3	4	3	Rollercoaster	2	2	2
Mother	6	6	6	Couple	4	4	5	EroticFem	4	6	4

								ale			
Romance	6	5	6	EroticMale	5	5	5	Romance	4	4	4
Family	8	8	8	AttractiveFem	6	7	6	Skier	6	6	6
Baby	9	9	8	EroticFemale	17	11	17	EroticCouple	38	39	37

TABLE 2

group2-1				group2-2				group2-3			
description	som	k-means	FCM	description	som	k-means	FCM	description	som	k-means	FCM
woman	2	2	2	Musicion	3	3	2	Women	2	1	2
NeutralMale	2	2	2	Adult	3	3	3	EroticMale	3	2	3
Abstract Art	3	3	3	Butterfly	3	1	3	Prostitute	3	3	3
Girl	3	3	3	Couple	3	2	3	AbstractArt	4	3	4
Shoes	3	3	3	Flower	4	0	4	Boy	4	5	4
Mushroom	5	5	5	Attractive Man	6	6	6	EroticFemale	4	3	4
Man	7	6	7	Woman	9	8	8	Woman	7	8	8

TABLE 3

group3-1				group3-2				group3-3			
description	som	k-means	FCM	description	som	k-means	FCM	description	som	k-means	FCM
StarvingChild	2	2	2	AimedGun	4	5	4	Attack	4	2	4
CarAccident	3	3	3	Fire	4	4	4	Garbage	4	5	4
DeadBody	3	3	3	Tornado	4	3	4	Injection	4	4	4
BurnVictim	4	4	4	Mutilation	5	5	5	Spider	4	4	4
AimedGun	6	6	6	Soldier	5	5	5	Gun	5	5	5
Attack	11	11	11	CarAccident	7	7	7	Police	6	6	6
Mutilation	17	17	17	Assault	8	8	8	Snake	14	5	14

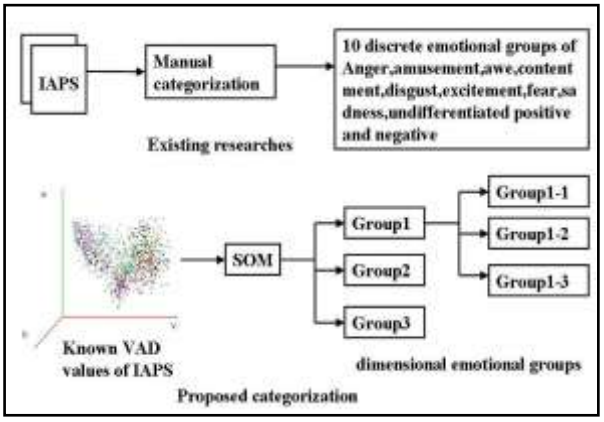

Fig. 4 distinguished emotional groups

III. DESCRIPTION OF TARGET EMOTION GROUPS

Group 1-1
V=6.24 to 8.34 A=3.08 to 5.71 D=5.00 to 7.71
Women,Ferret,Seal,PolarBears,Kitten,Dog,Cat,Horse,Butterfly,Rabbit,Antelope,Fawn,Puppies,Tigers,Jaguars,Lion,Owl,Bunnies,Elephants,Porpoise,Mickey,Kid,Baby,Father,Father/Child,Mother,Family,Children,BoysReading,NeutBaby,Children,Boy,Binoculars,Girl&Dog,Band,Kids,Boy,Boat,Couple,Couple,Balloons,AttractiveMan,Romance,Garden,Flowers,Nature,Seaside,Sky,Mountains,Field,Nature,Courtyard,Lake,Flowers,Mountains,Sea,Sunset,Seagulls,Beach,Clouds,Sky,Skyline,Brownie,AbstractArt,Cake,Torte,Wines,Desserts,Watermelon,IceCream,Pizza,IceCream,Candy,Pancakes,Pasta,Ferry,House,IceSkater,Athlete,HotAirBalloon,Waterskiing,CarnivalRide,Money,SportCar,Athletes

Group 1-2
V=4.91 to 7.27 A=4.01 to 6.08 D=4.06 to 6.37
Hawk,Pony,Gorilla,Hippo,Crocodile,Woman,Cheerleaders,ManInPool,Diving,Clowns,Pregnant,Dance,Dancer,SmilingGirl,EroticFemale,AttractiveFem,Bikini,EroticMale,AttractiveMale,BeachBoys,Couple,Romance,Wedding,FemaleKiss,Harbor,Galaxy,Shark,Mountains,Flowers,Earth,Sky,IceCream,Teeth,Gym,Alcohol,Pancakes,Chicken,Pizza,Cookout,Cheeseburger,FrenchFries,Sushi,Food,Lamb,Chicken,Ferry,Street,Concert,Cards,FerrisWheel,Skyscraper,Crowd,Dragon,Jet,Crowd,Basketball,Diver,Kickboxing,Hockey,Rugby,VolcanoSkier,Surfer,Sailboat,MotorcyclistRafting,Runners,Mascot,Woman

Group 1-3
V=5.63 to 8.10 A=5.19 to 7.35 D=3.56 to 6.64
Jaguar,Bride,AttractiveFem,Teens,EroticFemale,EroticMale,Romance,EroticCouple,Waterfall,Nature,Liftoff,Astronaut,Fireworks,Mountains,SkyDivers,Windsurfers,HangGlider,Hiker,Fireworks,Lightning,Turkey,IceCream,Cupcakes,Hamburger,City,Skyline,City,Skier,Sailing,Gymnast,Football,Hiker,HangGlider,Parachute,Bungee,

CliffDivers,Skysurfer,Skier,IceClimber,WaterSkier,Surfers,Pilot,Plane,Wingwalker,Rafting,Athletes,Rafters,Tubing,RollerCoaster,Gold,Money

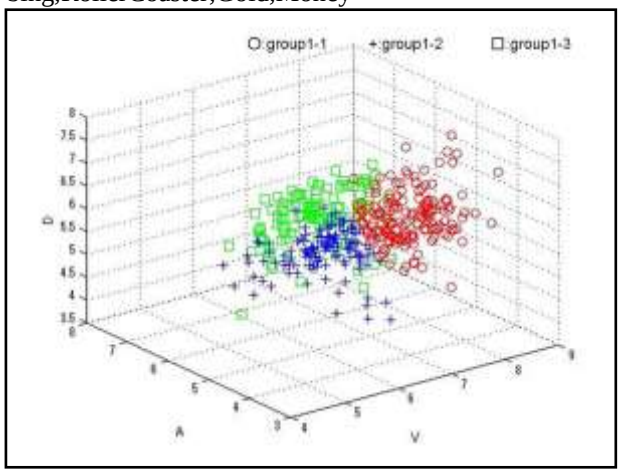

Fig. 5 Group 1

Group 2-1
V=4.03 to 5.71 A=1.72 to 3.69 D=4.97 to 7.04
Man,NeuWoman,NeuMan,NeutFace,Judge,Reading,Secretary,Factoryworker,Couple,Men,Girl,Woman,Shopping,Chess,Tourist,Teenager,Twins,FoodBasket,PineNeedles,Rocks,Boat,Satellite,Mushroom,Flowers,Outlet,RollingPin,Buttons,Disk,Spoon,Bowl,Mug,Basket,Rubberbands,Scissors,Razor,Video,Tools,Fan,PicnicTable,Iron,Shoes,Mug,Shipyard,Shoes,DustPan,Baskets,Drill,Zipper,HairDryer,Clothespins,Candlestick,Lightbulb,Tool,Coffeecup,Keyring,TrashCan,Sewing,Fork,Book,Hammer,Umbrella,FabricPole,LightBulb,Lamp,Rug,AbstractArt,Scarves,Beads,Plate,IroningBoard,Cracker,Tomato,Window,Building,Bridge,Tissue,Golf,EmptyPool

Group 2-2
V=5.19 to 7.14 A=2.51 to 4.66 D=5.16 to 7.40
Parrots,Birds,Gannet,Butterfly,Cow,Fish,Shrimp,GrouperTurtles,Octopus,Adult,AttractiveFem,Adult,Woman,Makeup,Baby,Male,Farmer,Class,Butcher,NeutChild,Boy,ChildCamera,Children,Family,Mother/Child,ThreeMen,Artist,Fisherman,Couple,ManW/Fish,Mom/Son,DryingHair,Feet,Musician,Man,Couple,OldLady,Harvest,ManW/Dog,Picnic,Propeller,Bakers,Men,City,Beer,Urinating,AttractiveMan,EroticMale,Condom,Flower,Venusflytrap,Nature,Cockpit,Mushrooms,WinterStreet,Cave,Building,Field,Farmland,Grain,Nature,Field,Leaves,Clouds,Bicyclist,Desert,Whistle,Barbells,Puzzle,Luggage,Headlight,BathRoom,Checkerboard,AbstractArt,Clock,Vase,AbstractArt,BuildingPeanuts,Pizza,Garlic,Grapes,Store,CardDealer,Painting,Paintbrush,Chess,Crochet,Bridge,Bed,Violin,RaceCars,Runner
Group 2-3
V=3.47 to 5.61 A=3.0 to 5.37 D=4.26 to 6.06
Snake, Lizard, Spider, Pig, Bird, Wolf, Buffalo, Jellyfish, HermitCrab,Turtle,VeiledWoman,TongueOut,Fingerprint,NeutFace,Man,MaleFace,LonelyBoy,Braces,GirlMakeup,Girl,Cow,Mother,Woman,Boy,NeutralGirl,Boots,CryingBaby,Amerindian,ElderlyMan,Market,Cowboy,Terrorist,Soldiers,DrugAddict,Smoking,Alcoholic,AttractiveFem,EroticMale,Prostitute,Boat,Stilllife,Jail,BlowDry,Police,GasCan,Lightbulb,Screw,Garbage,Trains,Scale,Pill,Glass,Dice,Stove,Bucket,Scale,Truck,Checkerboard,Clock,Fish,Meat,Ramen,Fish,Pastry,Crowd,Casino,Hospital,Office,Traffic,Airplane,Agate,Runner,Athlete,Boxer,Nudists,Needle,Cocaine,Puddle,Fisher,Rain,Hands,Dishes,Knives,Mob,Battleship,Grafitti,Building,Bridge,Fire,Truck

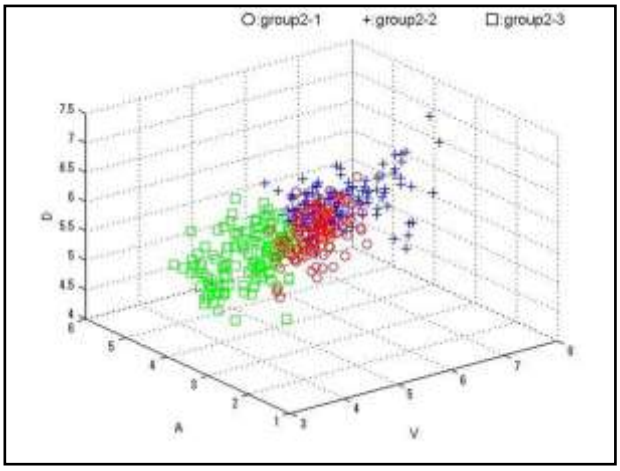

Fig. 6 Group 2

Group 3-1
V=1.31 to 3.46 A=5.78 to 7.35 D=2.15 to 3.95
Snake,SadChildren,NativeBoy,Gun,HeadlessBody,BurnVictim,Injury,DeadBody,Mutilation,Stitches,Attack,PlaneCrash,AimedGun,Gang,Fire,StarvingChild,Soldiers,HurtDog,InjuredDog,Assault,Vomit,DeadMan,Hanging,Execution,Dog,Ship,ManOnFire,KKKrally,CarAccident,Fire,Explosion

Group 3-2
V=1.78 to 4.00 A=4.00 to 6.93 D=2.93 to 4.92
Snake,PitBull,Attackdog,Shark,Baby,Hospital,BlackEye,War,Hunters,Riot,DrugAddict,DrunkDriving,SadChild,CryingBoy,DeerHead,Organs,Mutilation,BatteredFem,Stitches,Surgery,DyingMan,Tumor,Tornado,Assault,AimedGun,Soldier,BoysW/Guns,Gang,Abduction,BeatenFem,Attack,Suicide,CarTheft,Military,Police,CarDamage,RoachOnPizza,Cemetery,HIVTattoo,Teeth,Cow,DeadCows,InjuredDog,DeadDog,WarVictim,Garbage,Toilet,Vomit,CryingWoman,Garbage,Soldiers,Assault,Soldier,Bomb,Accident,DeadBody,Kids,DuckInOil,Cat,Injecting,Accident,Ship,Jet,Fire,Bomb,Skinhead,CarAccident,BurningCar,Fire,Flood,ShipWave,Fire

Group 3-3
V=2.54 to 5.16 A=3.67 to 6.97 D=3.47 to 6.04
Snake,Spiders,Roaches,Rat,Bees,DogRace,Mole,Tiger,

ManInPool,BodyPierce,AngryFace,Kids,KidCry,SadGirls,CryingFamily,CryingBoy,Man,ElderlyWoman,Baby,Bomb,Refugees,Smoking,Shoplifter,Bum,Mask,CryingBoy,Scream,Scar,Surgery,MedicalAssist,OpenChest,Incubator,Fetus,Volcano,Tornado,Prison,ElectricChair,Attack,AimedGun,Gun,Police,Missiles,Waste,CarBoot,CarDamage,PieW/bug,FliesOnPie,MeatSlicer,Hospital,Freeway,Skyscraper,RockClimber,Boxer,Biking/train,BikerOnFire,CemeteryMemorial,HIVTattoo,BarbedWire,Mud,ScaredChild,StickThruLip,Wires,Exhaust,Cow,Matador,Horses,Vultures,OilFire,HungMan,ToxicWaste,Smoke,Garbage,Vomit,HomelessMan,Pollution,Dishes,MenW/guns,Handicapped,Ticket,Skulls,Skeleton,BurntBldg,Corpse,Fire,Boys,SickKitty,DentalExam,Injection,Cigarettes,Firefighter,Flood

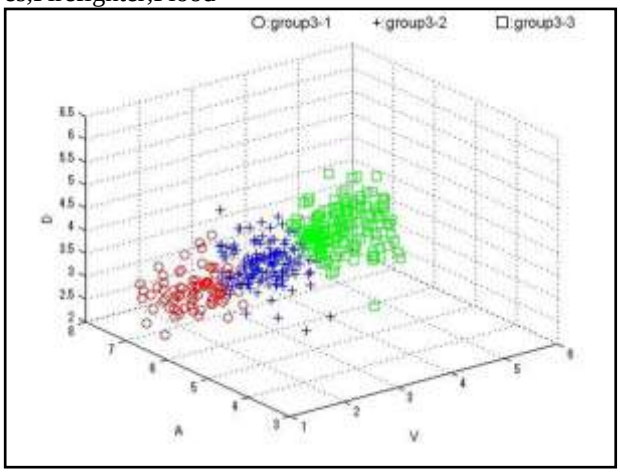

Fig. 7 Group 3

IV. Input Data Sets

The research objective becomes finding the most accurate input data set per group. The following are considered to be inputs for evaluation.

(1)Sum of edges and sum of corners(denotes p2 scale)
(2)Sum of edges, corners, regional maximums and regional minimums (denotes p4 scale)
(3)Eight sectored R histogram(denotes rsec8)
(4)Eight sectored G histogram(denotes gsec8)
(5)Eight sectored B histogram(denotes bsec8)
(6)Eight sectored R,G histogram(denotes rgsec8)
(7)Eight sectored R,B histogram(denotes rbsec8)
(8)Eight sectored B,G histogram(denotes bgsec8)
(9)Eight sectored RGB histogram(denotes rgbsec8)
(10)rgbsec8+p4 scale(denotes rgb8p4)
(11)Eight sectored Gray scale histogram (denotes gray8scale)
(12)graysec8+p4 scale(denotes gray8p4)

Affective photos that contain border are opted during these evaluation to avoid their effects on input scales.

V. Input Evaluation

The input evaluation method is through training the artificial neural network using pattern recognition tools. 70% of data from each input data set is used for training and 30% for testing. Data selection above is on random basis.

The network is trained to recognize its target groups and test inputs are feed to the trained network to predict the group it belongs. If the predicted groups are similar to target groups the input data set is considered to be valid for affective classification, means capable to recognize the emotion group it belongs. The percentage of accuracy is evaluation factor here.

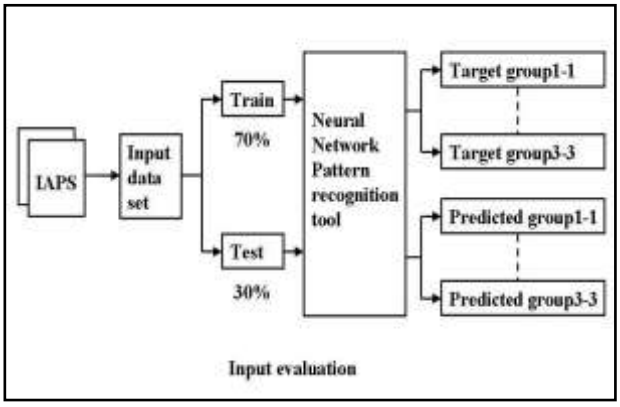

Fig. 8 Input data evaluation

VI. Conclusion

The evaluation results shows that accuracy varies across groups and input data scales such that there exists a more accurate input data scale per emotion group. With the test results summarized in Table 4, the following points can be considered as achievements. Although the results are still on its development phase due to limitations on technical capacity, some input scales show their potential as valid inputs.

Table 4
Evaluation Results

	p2	bsec8	rgb8	rgb8p4	gray8	gray8p4
group1-1	64%	34%	38%	63%	81%	70%
group1-2	65%	45%	44%	48%	58%	61%
group1-3	28%	27%	51%	56%	48%	52%
group2-1	41%	30%	53%	48%	38%	35%
group2-2	48%	27%	22%	28%	32%	31%
group2-3	17%	48%	58%	61%	49%	54%
group3-1	39%	68%	34%	43%	41%	45%
group3-2	46%	58%	42%	21%	71%	67%
group3-3	24%	48%	65%	58%	73%	70%

(1) Usage of edges and corners in high valence groups (happy contents) can be considered to be appropriate.
(2) Gray scale is capable of detecting either high valence groups (happy contents) or high arousal groups(scary photos)
(3) Color blue plays an important role in high arousal groups. But this feature has to be further tested.
(4) It is difficult to locate a unique scale for high dominance groups(groups 2-1,2-2 and 2-3).
The diversity of the contents within these groups could be considered as the reason. Therefore further sub scaling is recommended.

Figure 6.1 indicate plot of results for p2, bsec8, rgb8p4, gray8 and gray8p4 scales.

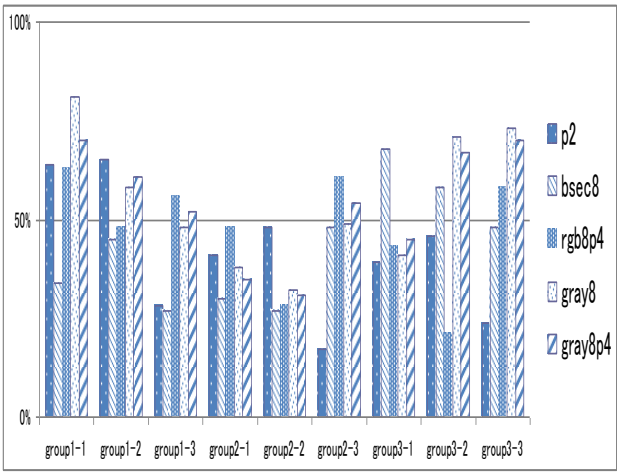

Fig. 9 Evaluation results (P2, bsec8, rgb8p4, gray8, gray8p4 scales)

Finally the results suggest that it is not accurate enough to do the classification using single data scale for all groups like usage of edges in [3], rather the input data set depends on the location of emotional vector space.

As a future research prospect one can experiment with smaller emotion groups to improve evaluation accuracy as well as addition of features like Hue, Saturation, Brightness etc.

ACKNOWLEDGMENT

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