

Face to Robot Interaction To Support Wellness and Mental Health

CS 7633 Spring 2023

Project Theme: **User Interaction**

Final Poster

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Outline

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- Problem Statement
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- Discussion

Introduction

Mental health includes our **emotional, psychological, and social well-being**. It affects how we think, feel, and act. It also helps determine how we handle stress, relate to others, and make choices.

Someone experiencing **mental health problems** could have their **thinking, mood, and behavior affected**.

Some of the benefits of positive mental health include:

- Coping with life's stresses
- Being productive and positively contributing to the community

There are several ways to maintain positive mental health that include:

- Connecting with others
- Staying positive
- Getting physically active



Face to Robot interaction with Anki Vector refers to **making facial expressions** (happy, sad, ...) to the robot.

Introduction

Scoglio et al. [1] report evidence that **social robots can have positive effects** on mental health and well-being, particularly in the areas of **stress reduction**, **emotional regulation**, and **social support**.

Social robots can be designed to provide emotional support, social interaction, and personalized feedback to users, which can help them manage stress, regulate emotions, and stay positive.

Geva et al. [2] found that interaction with a social robot is effective among all age groups in **creating positive emotions**. Additionally, Rasouli et al. [3] research findings suggest that **interactions with social robots** could **alleviate anxiety and tension** in both persons with and without social anxiety.

The above findings suggest that robots can be used as a complement to other forms of support and treatment for mental health.

Motivation

- There are many effective treatments available, including
 - Therapy,
 - Medication
 - lifestyle changes
- Our vision is to use Anki Vector to **supplement** the current means of treatment.



Problem Statement

Project goal: To explore the wellness and mental health effects of face to robot interaction with anki vector.

- **Determine whether or not face to robot with anki vector robot can be used to uplift user's mood or relaxation feeling.**

Team goals:

- **Intelligent vision system:** Implement a deep learning model that perceives the user's emotions through robot vision and performs actions in response to a given facial expression.
- **User Study:** Perform user study with students on GaTech campus who are interested in using technology to support their well-being.



Related Works- Real-time Emotion and Gender Classification using Ensemble CNN [5]

- **What are they doing?**
The authors are predicting emotion and gender on single-face images as well as multiple-face images.
- **How are they doing it?**
The complete pipeline of the real-time system is less than 0.5 seconds to generate results when feeding input through the webcam. The proposed model is an ensemble of two CNN models: Mini-Xception CNN and 4-Layer CNN. The Mini-Xception model is a deep CNN architecture that contains depth wise separable convolutions: Depthwise convolutions and pointwise convolutions.
- **Results**
The classification system detects emotions and gender with 68% accuracy into 7 classes (angry, fear, sad, happy, surprise, neutral, disgust) and 95% for Gender Classification (Male or Female).
- **Strengths**
The model achieves good result for gender the classification.
- **Weakness**
Low accuracy on emotion classifier.

Related Works 2- Integrating socially assistive robotics into mental healthcare interventions: Applications and recommendations for expanded use [6]

- **What are they doing?**

The authors are investigating the potential of socially assistive robots (SAR) in mental healthcare therapies. They conduct a literature review on the use of SAR in mental health therapy and provide recommendations for its expansion.

- **How are they doing it?**

By evaluation of the literature on the use of SAR in mental healthcare therapies, they explain the advantages and disadvantages of employing SAR in mental health therapy, the authors conducted the survey using different types of therapy bots such as therapy dog, play partner that were available for people to help them in cheering the mood based on their facial expressions. They also use NLP to determine their emotion based on the way they speak.

- **Results**

SAR has the potential to increase the quality and efficacy of mental healthcare interventions by offering patients with individualized, 24/7 support, eliminating the stigma associated with mental health treatment, and increasing patient involvement and motivation. The authors made suggestions for increasing the use of SAR in mental healthcare, such as creating standardized procedures for SAR-based therapies and doing more research on the efficacy of SAR interventions.

- **Strengths**

Thorough evaluation of current evidence, useful recommendations for extending SAR usage, and emphasis on the potential advantages of SAR in mental health therapy.

- **Weakness**

The authors does not go into detail on the limitations and problems of using SAR in mental healthcare therapy.

Related Works 3 - Robot-Based Psychotherapy: Concepts Development, State of the Art, and New Directions [7]

- **What are they doing?**

The authors provide an overview of the concept development, state of the art, and new directions in robot-based psychotherapy.

- **How are they doing it?**

The authors performed a literature study of robot-based psychotherapy, with an emphasis on idea creation, state of the art, and new approaches. The current state of the art is described in terms of many sorts of robots, such as humanoid robots, animal-like robots, and socially helpful robots. The writers also address several sorts of treatment that robots can provide, such as cognitive-behavioral therapy, exposure therapy, and play therapy. They aggregated the data in order to present an overview of the current state of research on robot-based psychotherapy and to recommend new study avenues for the future. The paper also explores possible ethical difficulties with utilizing robots in psychotherapy, such as privacy concerns and the possibility of human therapists being replaced.

- **Results**

The authors discovered that robot-based psychotherapy has the potential to improve treatment results while also boosting access to care and lowering stigma associated with mental illness. They also highlighted various barriers to the adoption of robot-assisted psychotherapy, such as worries regarding the efficacy and ethical implications of utilizing robots in psychotherapy.

- **Strengths**

The study gives an in-depth look at the present state of research on robot-assisted psychotherapy, outlining the possible benefits and drawbacks of this technique.

- **Weakness**

The authors does not give an in-depth study of the limits and problems connected with robot-based psychotherapy.

Related Works 4 - Validation of the short Mood and Feelings Questionnaire[18]

- **What are they doing?**

The authors of the study are looking at the short Mood and Feelings Questionnaire (sMFQ) as a measure of depression in young adults, notably those under the age of 25. They want to find sMFQ cut-points that best capture DSM-5 depression diagnosis at this age. The Avon Longitudinal Study of Parents and Children (ALSPAC) data were used in the study.

- **How are they doing it?**

They are identifying cut-points on the sMFQ that best capture DSM-5 depression diagnosis at this age using sensitivity and specificity values. They are analyzing the outcomes for both boys and females using data from a longitudinal population cohort, the Avon Longitudinal Study of Parents and Children (ALSPAC).

- **Results**

The short Mood and Feelings Questionnaire (sMFQ) was discovered to be a reliable measure of depression in young people in the general population, and it may be used to screen for and monitor depression throughout adolescence and early adulthood. At age 25, the sMFQ exhibited good accuracy for distinguishing Major Depressive Disorder (MDD) cases from non-cases, and the frequently used adolescent cut-point (12) functioned well, best combining sensitivity and specificity.

- **Strengths**

The short Mood and Feelings Questionnaire (sMFQ) was validated in this study as a measure of depressive symptoms in young adults, in addition to its recognized usage in childhood and adolescence. The study also gives sMFQ cut-points that best capture DSM-5 depression diagnosis at age 25, which may be used for screening and monitoring depression in this age range.

- **Weakness**

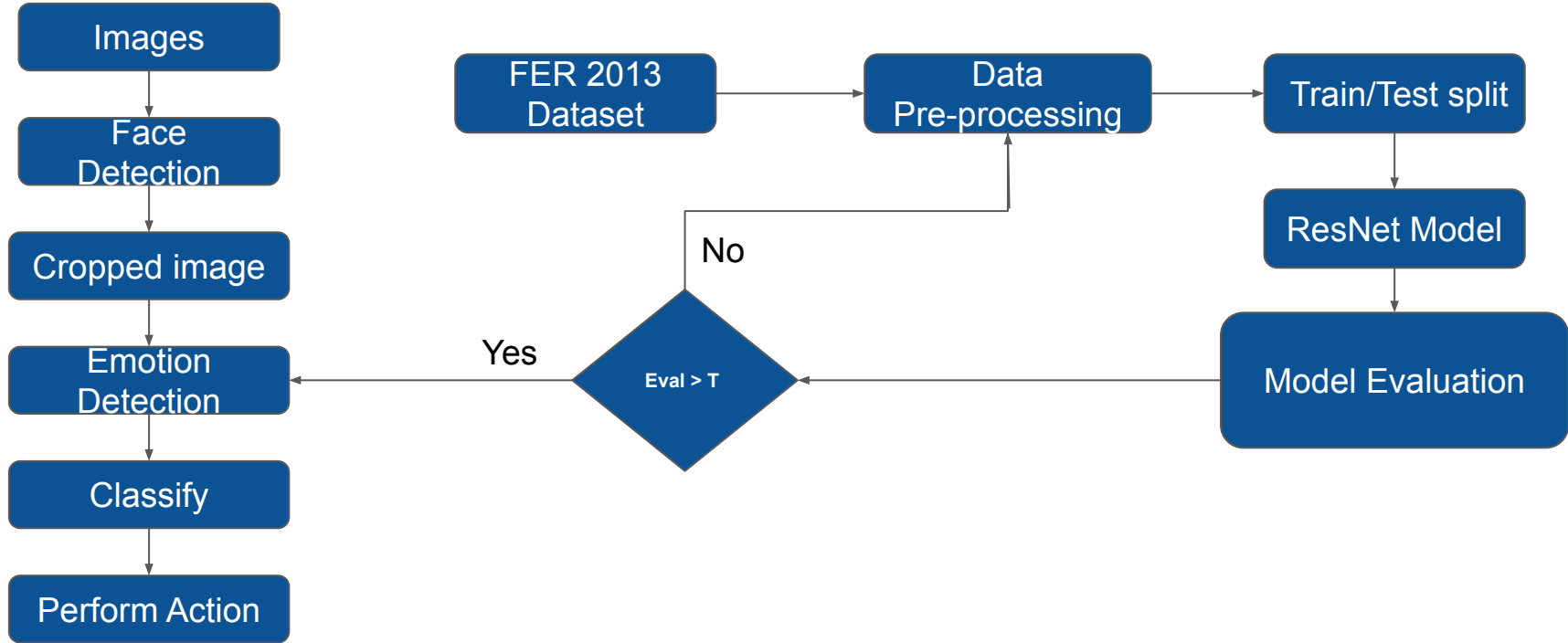
The authors does not give an in-depth study of the limits about sMFQ study.

Approach

Recall our Team goals?

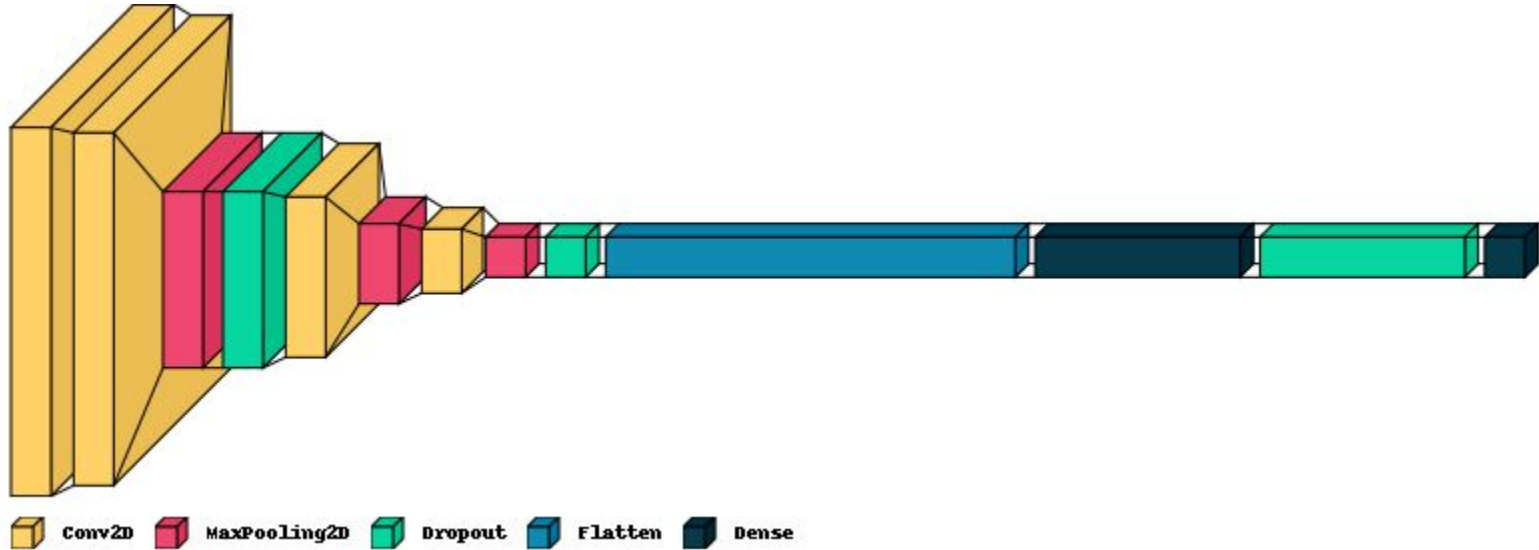
- **Intelligent vision system:** Implement a deep learning model that perceives the user's emotions through robot vision and performs actions in response to a given facial expression.
- **User Study:** Perform user study with students on GaTech campus who are interested in using technology to support their well-being.

Approach - Intelligent vision system



Approach - Intelligent vision system

- Model Design



Approach - Intelligent vision system

- Data Transforms

```
transforms_train = T.Compose([
    T.Resize((128, 128)),
    T.RandomHorizontalFlip(),
    T.ToTensor(),
    transforms.Normalize(dataset_mean, dataset_std),
])
transforms_val = T.Compose([
    T.Resize((128, 128)),
    T.ToTensor(),
    transforms.Normalize(dataset_mean, dataset_std)
])
```

Approach - Intelligent vision system

Random pictures from train dataset

sad



sad



sad



happy



surprise



neutral



happy



surprise



happy



neutral



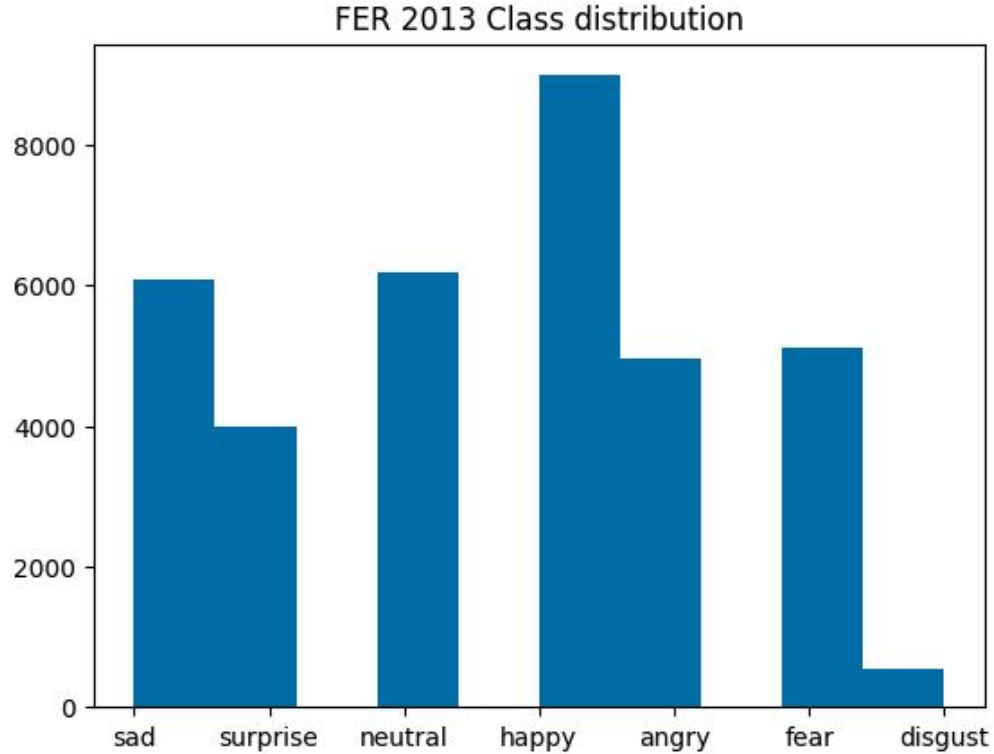
angry



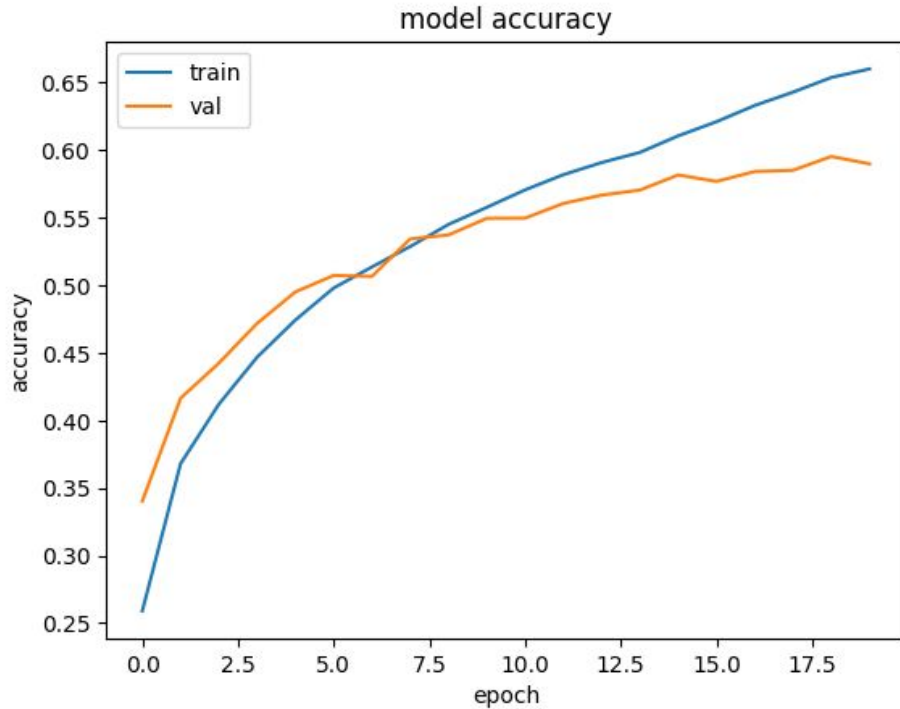
happy



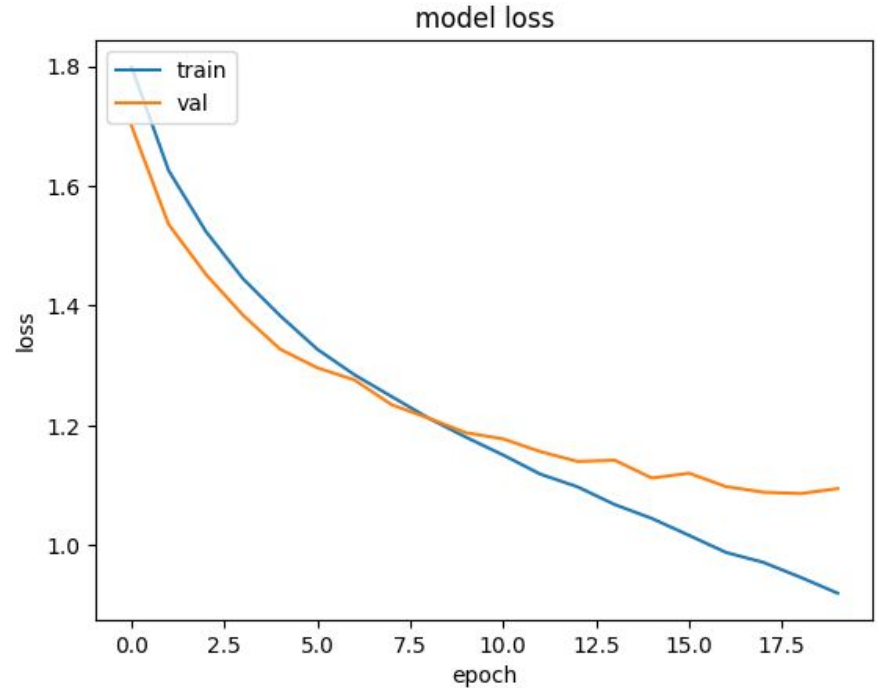
Approach - Intelligent vision system



Approach - Intelligent vision system



Model accuracy: **70%**



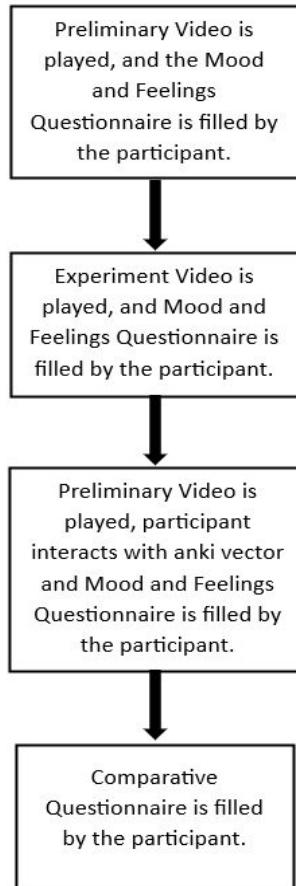
Approach - User Study

H1: People who visually interact with Anki Vector report **increased relaxation feelings** when compared to watching relaxation videos.

H2: Face to robot interaction with Anki Vector **improves self reported mood**.



Approach - User Study



The user study group is aimed to be between **15-25** and an approximate split of male and female members is taken between the **ages of 18 and 30**.

The instructions provided to the participants would be :

- 1) Please watch the **2-minute Preliminary video** and **fill in the Mood and Feelings Questionnaire** based on your feelings.
- 2) Please watch the **3-minute experiment video** and **fill in the Mood and Feelings Questionnaire** based on your feelings.
- 3) **Rewatch the 2-minute Preliminary video 2, interact with anki vector for 3 minutes**, and **fill in the Mood and Feelings Questionnaire** based on your feelings.
- 4) Please fill out the **Comparative Questionnaire** and **optional feedback**.

The approximate time to complete the user study is **16 minutes/participant**.

The estimated time for the entire user study to be completed is **400 minutes**.
The robot used for this user study is anki Vector.

Approach - User Study

Evaluation metrics:

- **Heart Rate:** the heart rate is collected in order to check if one's mood is improved or not
- **Paired-Sample t-test:** the test is first compared with the base mood and the mood after watching the video and then the base mood is compared with the mood after interaction with the robot.
- **Likert Scale Analysis:** the Likert scale NOT TRUE = 0, SOMETIMES = 1, TRUE = 2



Anki Vector's Action Based on Emotion

- **Happy:** The robot moves forming a square.
- **Sad:** The robot plays an audio recording of a joke.
- **Angry:** The robot performs two preset action by anki vector.
- **Neutral:** The robot lifts its fork up and down continuously for 6 seconds.
- **Surprised:** The robot changes its eye colour continuously for 6 seconds.

Results - User Study

Heart Rate:

S. No	GENDER	START	EXPERIMENT VIDEO	ANKI VECTOR	Difference -Exp-Video	Difference- Anki Vector
P1	MALE	70	65	59	+5	+11
P2	MALE	70	65	74	+5	-4
P3	MALE	97	74	65	+23	+32
P4	MALE	90	89	82	+1	+8
P5	MALE	89	70	69	+19	+20

Results - User Study

Heart Rate:

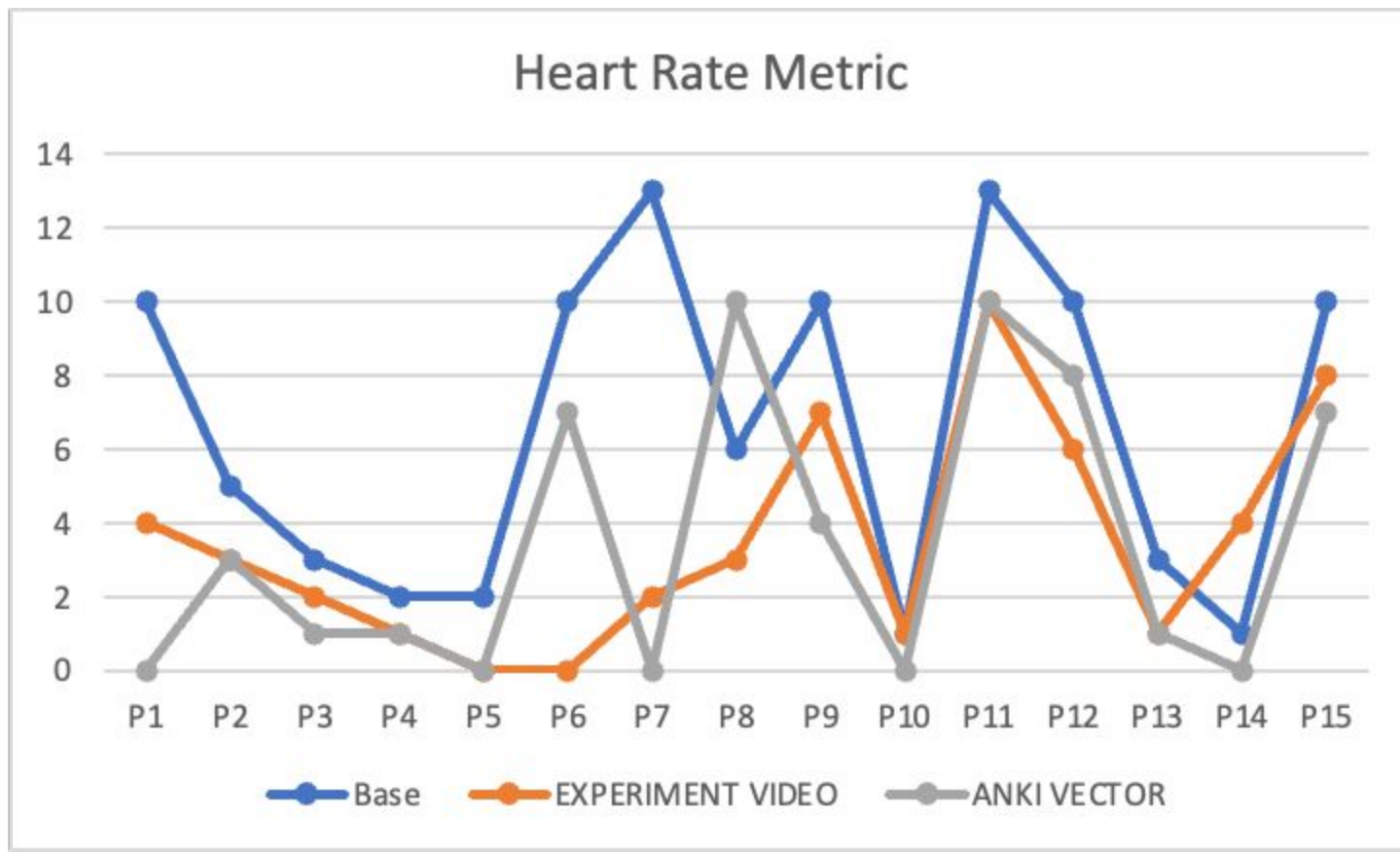
S. No	GENDER	START	EXPERIMENT VIDEO	ANKI VECTOR	Difference -Exp-Video	Difference- Anki Vector
P6	MALE	88	75	60	+13	+28
P7	MALE	84	79	76	+5	+8
P8	MALE	92	85	86	+7	+6
P9	FEMALE	80	69	68	+11	+12
P10	MALE	70	68	73	+2	-3

Results - User Study

Heart Rate:

S. No	GENDER	START	EXPERIMENT VIDEO	ANKI VECTOR	Difference -Exp-Video	Difference-Anki Vector
P11	MALE	82	80	77	+2	+5
P12	FEMALE	104	94	91	+10	+13
P13	MALE	88	77	86	+11	+2
P14	MALE	71	76	75	-5	-4
P15	MALE	89	88	90	+1	-2

Heart Rate- Result



Discussion - User Study

Heart Rate:

The study involved **15 participants**.

The difference between the baseline and the experiment video is taken.

Then the difference between the baseline and the Anki Vector is taken.

From the heart rate result table, the difference value is compared based on the heart rate.

The Anki-Vector **better improves** mood for **10/15 (66.66%)** occasions and the experiment video proves to be better 5/15 (33.33%) times.

These results suggest that the Anki vector in terms of **mood improvement with respect to heart rate** is better when compared to the experiment video.

Hypothesis Testing

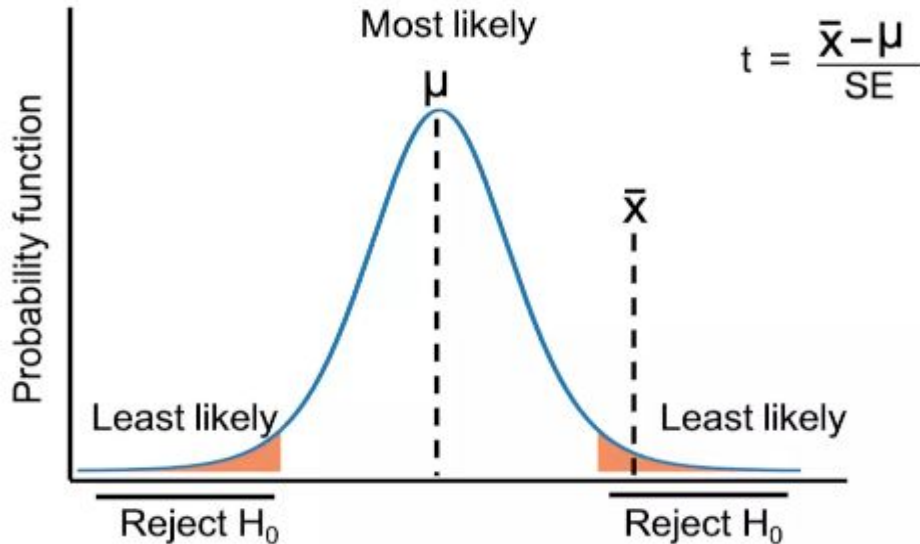
It is a statistical method used to **determine whether a hypothesis** about a population parameter is **supported by the evidence provided by a sample of data**.

- **Null Hypothesis (H_0)**: the hypothesis that there is no significant difference between the observed data and what would be expected under a particular assumption.
- **Alternative Hypothesis (H_a)**: the hypothesis that **there is a significant** difference between the observed data and what would be expected under a particular assumption.
- **Interpretation**: A significant p value ($p < 0.05$), yield a rejection of the null hypothesis and therefore, we conclude that alternative hypothesis holds.

Hypothesis Testing - Numerical Features

t-test (also known as Student's t-test) is a parametric hypothesis testing method used for **comparing the means between two different groups**

In t-test, test statistic follows the t-distribution under the null hypothesis.



Hypothesis Testing - Numerical Features

Based on group comparisons, t-test has three main types

- **One sample t-test:** used to compare a sample mean with the specific value
- **Two sample t-test :** compares the means of two independent groups.
- **Paired t-test:** used to compare the differences between the pair of dependent variables for the same subject

$$t = \frac{\bar{d}}{s_d/\sqrt{n}}$$

Results - User Study

Paired-Sample t-test:

S.no	ANKI (MEAN1)	VECTOR EXPERIMENT VIDEO (MEAN 2)	DIFFERENCE
P1	39	36	3
P2	23	25	-2
P3	34	35	-1
P4	30	30	0
P5	38	36	2

Results - User Study

Paired-Sample t-test:

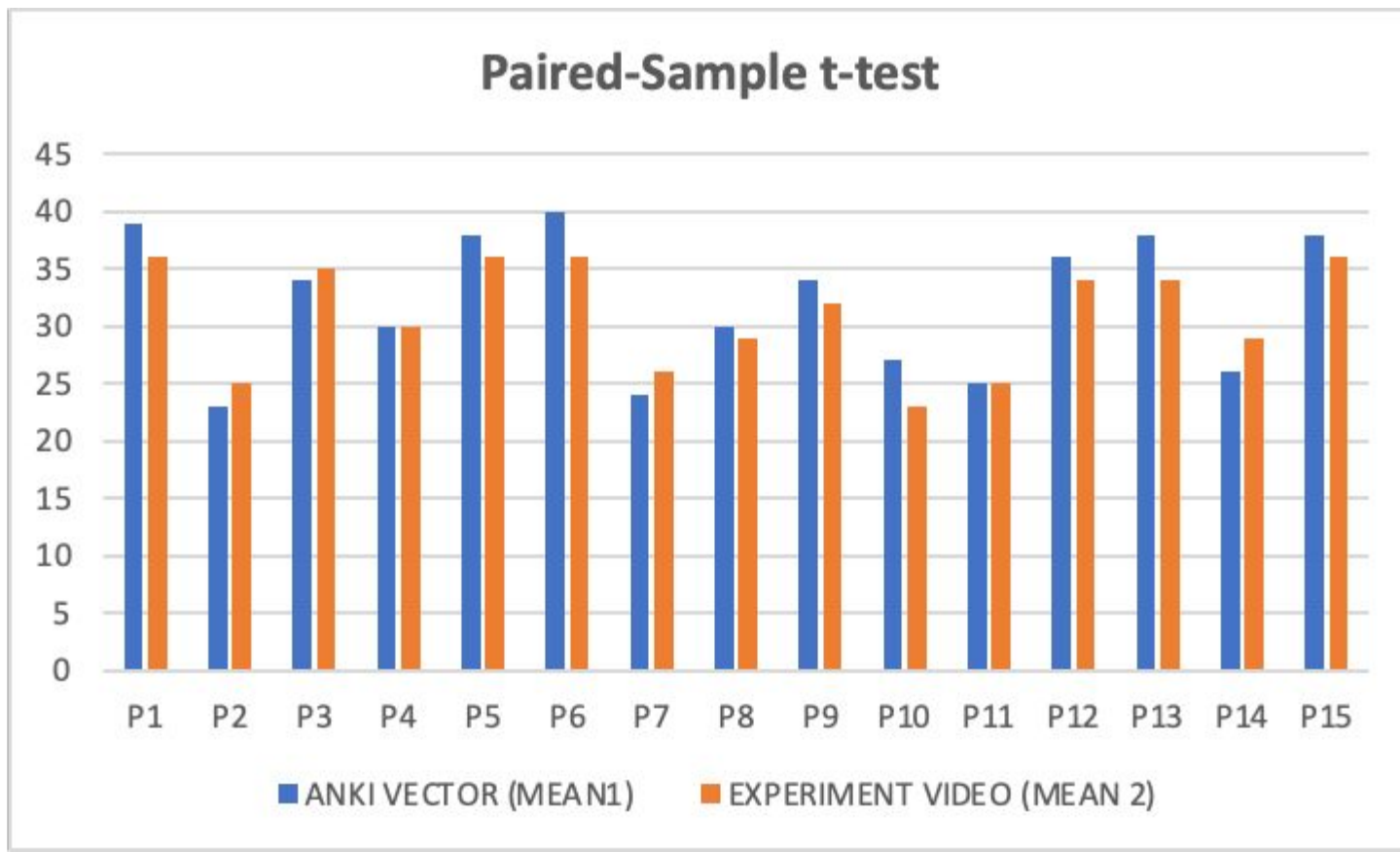
S.no	ANKI (MEAN1)	VECTOR EXPERIMENT VIDEO (MEAN 2)	DIFFERENCE
P6	40	36	4
P7	24	26	-2
P8	30	29	1
P9	34	32	2
P10	27	23	4

Results - User Study

Paired-Sample t-test:

S.no	ANKI (MEAN1)	VECTOR EXPERIMENT VIDEO (MEAN 2)	DIFFERENCE
P11	25	25	0
P12	36	34	2
P13	38	34	4
P14	26	29	-3
P15	38	36	2
MEAN	32.133	31.067	1.067
STANDARD DEVIATION	6.022	4.667	2.314

Results- Paired Sample t-test



Discussion - User Study

Paired-Sample t-test:

The standard deviation is **2.314**, the sample mean is **1.0667**, and the sample size is **15**.

The estimated standard error of the mean is **0.5964**. The value of t is $1.0667/0.5964 = 1.789$.

The critical value here is **2.145**. The critical value for a left-tailed test is **$t_c = -1.761$** .

The rejection region $R = \{t: t < -1.761\}$. The t statistics $t = 1.786$. Since $t = 1.786 \geq t_c = -1.761$, it is concluded that the **null hypothesis is not rejected**.

Hence the mean of the Anki vector is greater and can be concluded that **Anki vector better improves mood when compared to the Experiment video**.

Results - User Study

Likert Scale:

S.no	BASE	EXPERIMENT VIDEO	ANKI VECTOR	BASE-EXPERIMENT VIDEO	BASE-ANKI VECTOR
P1	10	4	0	6	10
P2	5	3	3	2	2
P3	3	2	1	1	1
P4	2	1	1	1	1
P5	2	0	0	2	2

Results - User Study

Likert Scale:

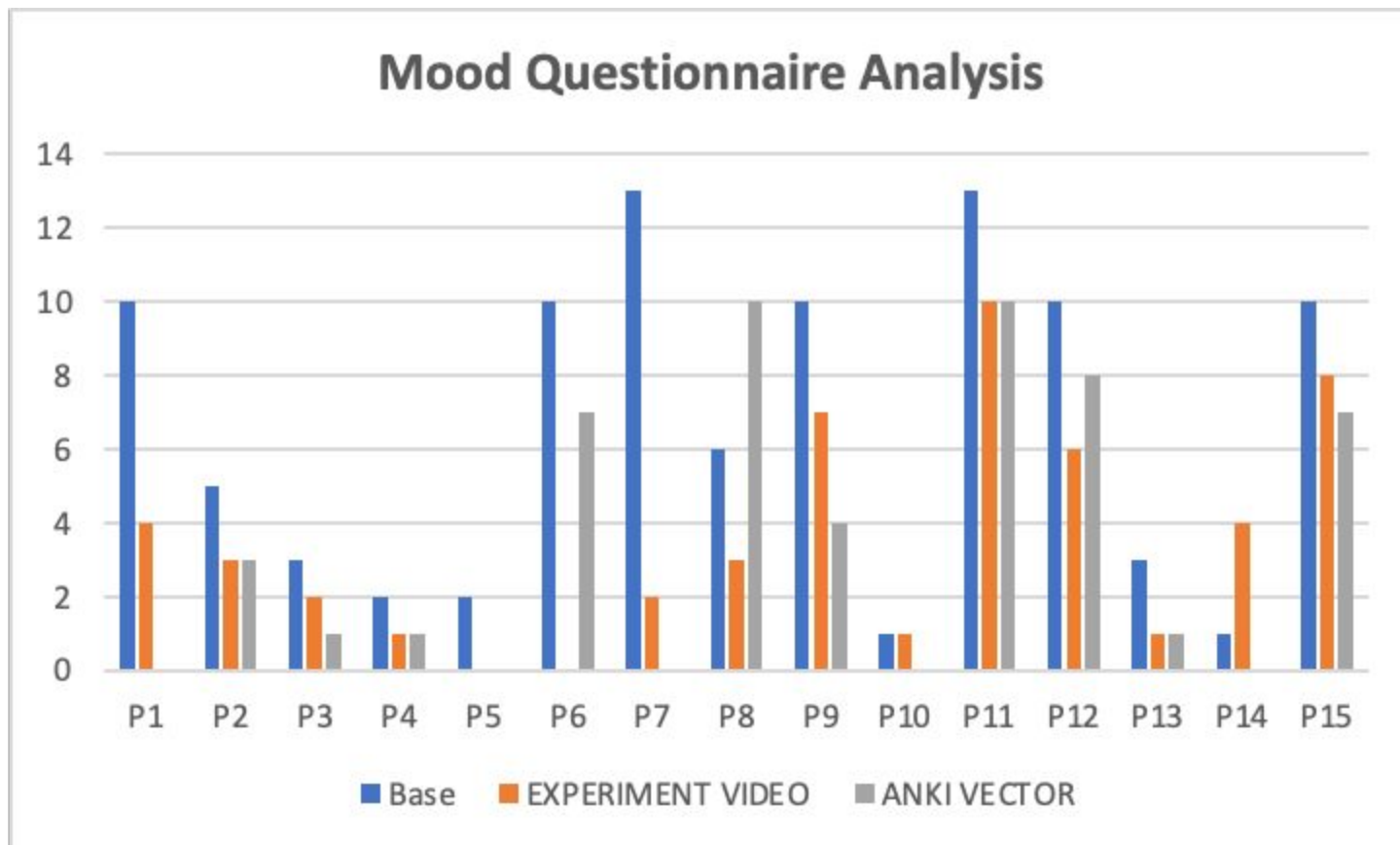
S.no	BASE	EXPERIMENT VIDEO	ANKI VECTOR	BASE-EXPERIMENT VIDEO	BASE-ANKI VECTOR
P6	10	0	7	10	3
P7	13	2	0	11	13
P8	6	3	10	3	-4
P9	10	7	4	3	6
P10	1	1	0	0	1

Results - User Study

Likert Scale:

S.no	BASE	EXPERIMENT VIDEO	ANKI VECTOR	BASE-EXPERIMENT VIDEO	BASE-ANKI VECTOR
P11	13	10	10	3	3
P12	10	6	8	4	4
P13	3	1	1	2	2
P14	1	4	0	-3	-1
P15	10	8	7	2	3

Results- Likert Scale



Discussion - User Study

Likert Scale of Mood Questionnaire:

From the Likert scale result table, the mood when measured by watching the experiment video is better **2/15(6.66%)** of the time.

The Anki Vector seems to improve mood by **6/15(40%)** of the time.

Meanwhile, both of these methods improve mood at the same rate. This was recorded the most 7/15(46.6%) of the time.

A conclusive result is not obtained by using this method to analyze as this is a neutral result.

Conclusion

Heart rate and Paired-Sample t-test support our hypothesis. However, the Likert scale was inconclusive.

Our current limitations are with mood questionnaire from Likert Scale. Future improvement would be increasing 3 points to 7 points Likert Scale. Nonetheless, the current research only suggest 3 points Likert scale for mood questionnaire. This would require implementing a 7 points question.

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Thank You!