

DATA MINING TEAM PREPROJECT

# TURTLE NECK SYNDROME POSTURE CORRECTION SYSTEM

TEAM 2

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## Method to Solve the Problem

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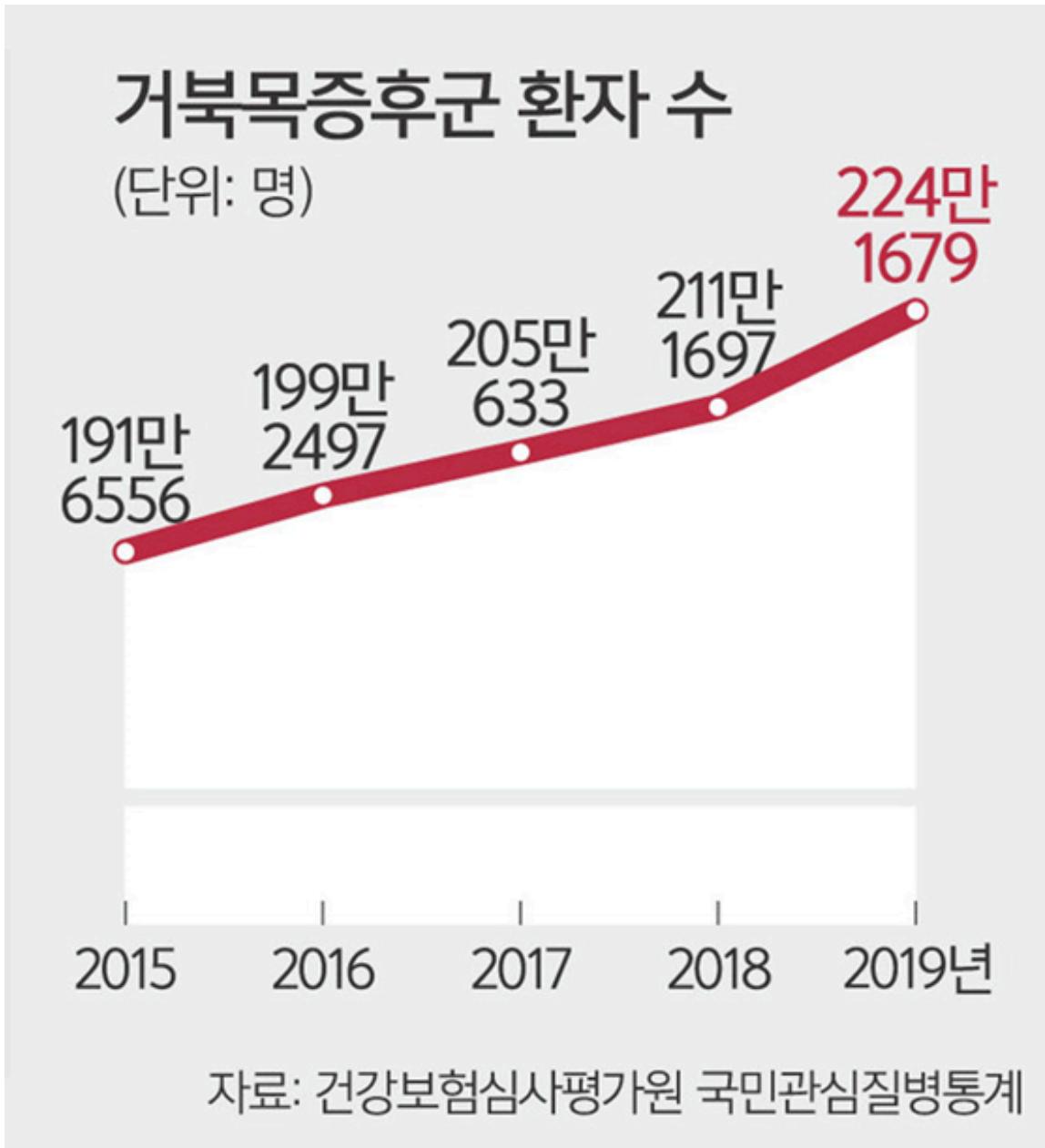
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# Purpose of Data Mining in the Specific Domain

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# Study Background - Turtle Neck Syndrome (1/2)

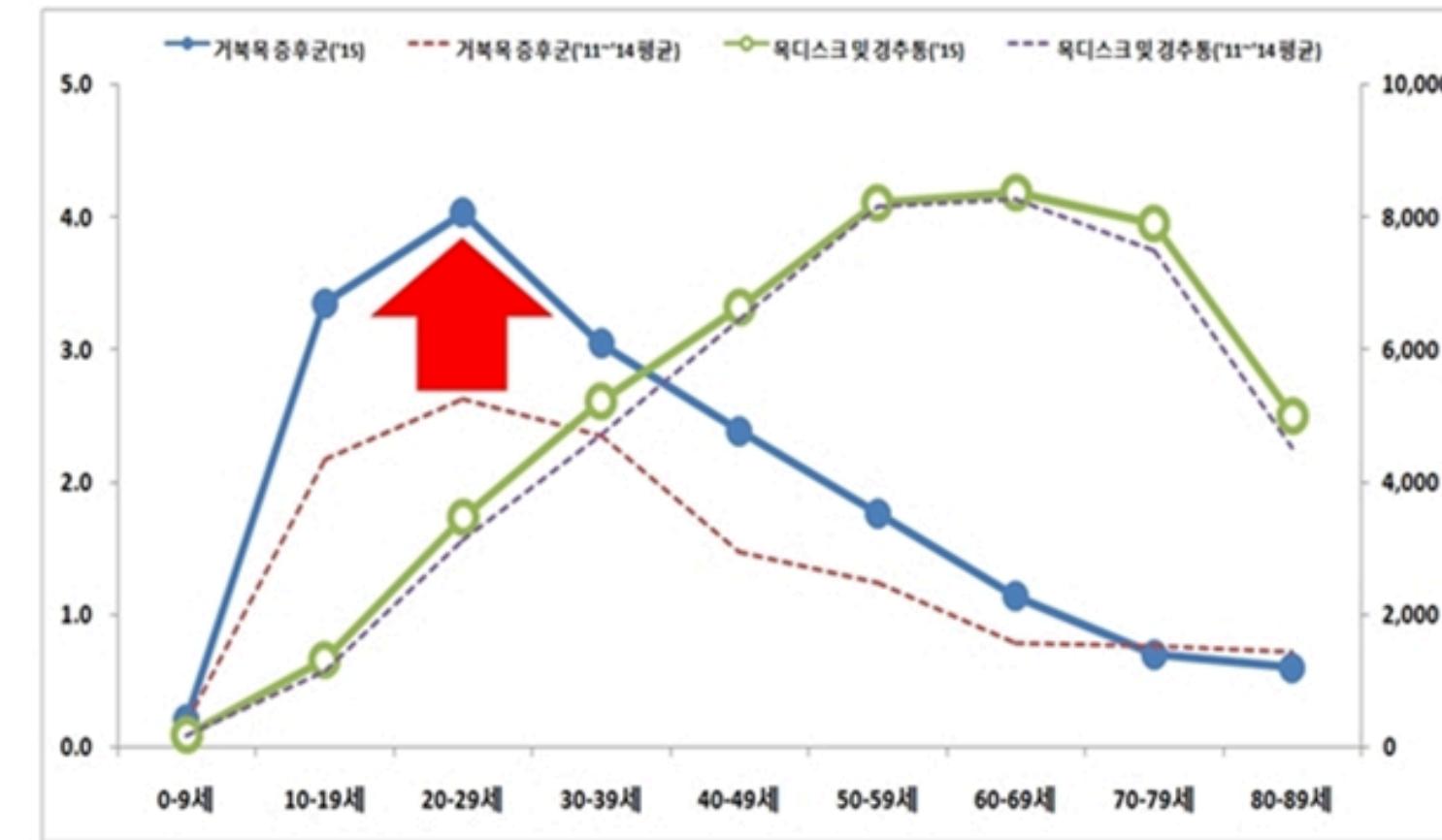
Problem Recognition



With the spread of electronic devices equipped with smartphones and displays, the number of patients with turtle necks and neck disks is increasing rapidly.

# Study Background - Turtle Neck Syndrome (2/2)

Problem Recognition



In particular, the number of turtle neck patients was observed to be higher than that of other age groups, mainly among younger age groups with high smartphone usage time.

# Government's Endeavor for Correction

Problem Recognition



경향신문

<https://m.khan.co.kr> › article

[서울25]학생·직장인 거북목 잡아낸다…강남구, 찾아가는 '…

2024. 2. 2. — 조성명 강남구청장은 “현장에 찾아가 바른 자세와 관리 필요성을 알리고, 아동·청소년들의 건강한 성장발달을 지원하겠다”고 말했다. 연재 레터 구독은



법제처

<https://www.moleg.go.kr> › lawinfo › reglAnalysisList

인천광역시 계양구는 관할구역 학생에 대하여 거북목, 굽은 …

2019. 12. 10. — 인천광역시 계양구는 관할구역 학생에 대하여 거북목, 굽은 등 및 척추측만증 등의 불균형 체형 예방교육을 실시하는 학교에 대하여 재정적 지원을 할 …

The government is aware of the growing number of turtle neck patients, and each local government is continuing preventive activities against turtle necks.

# Difficulty of Self Awareness of Turtle Neck Syndrome

Problem Recognition

Previous studies have shown that patients who complained of pain in their necks and shoulders are relatively less capable of maintaining a normal posture.

In particular, heavy users who have used the device for more than six hours a day and have maintained this pattern for more than 10 years have found that turtle neck symptoms are serious, but their ability to control their posture is significantly lower than that of normal people.

# Turtle Neck Syndrome Posture Correction System

Solution

<https://doi.org/10.5392/JKCA.2020.20.07.047>

**CNN기반의 학습모델을 활용한 거북목 증후군 자세 교정 시스템**  
**Turtle Neck Syndrome Posture Correction Service Using CNN-based Learning Model**

한지예, 박진호

숭실대학교 IT대학 글로벌미디어학부

Ji-Ye Han(mwldpm@naver.com), Jin-Ho Park(c2alpha@ssu.ac.kr)

A sensor-based turtle neck detection system through cameras has emerged as a new method of preventing turtle neck from Soongsil University.

# Method to Solve the Problem

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# Turtle Neck Syndrome Posture Correction System

Method

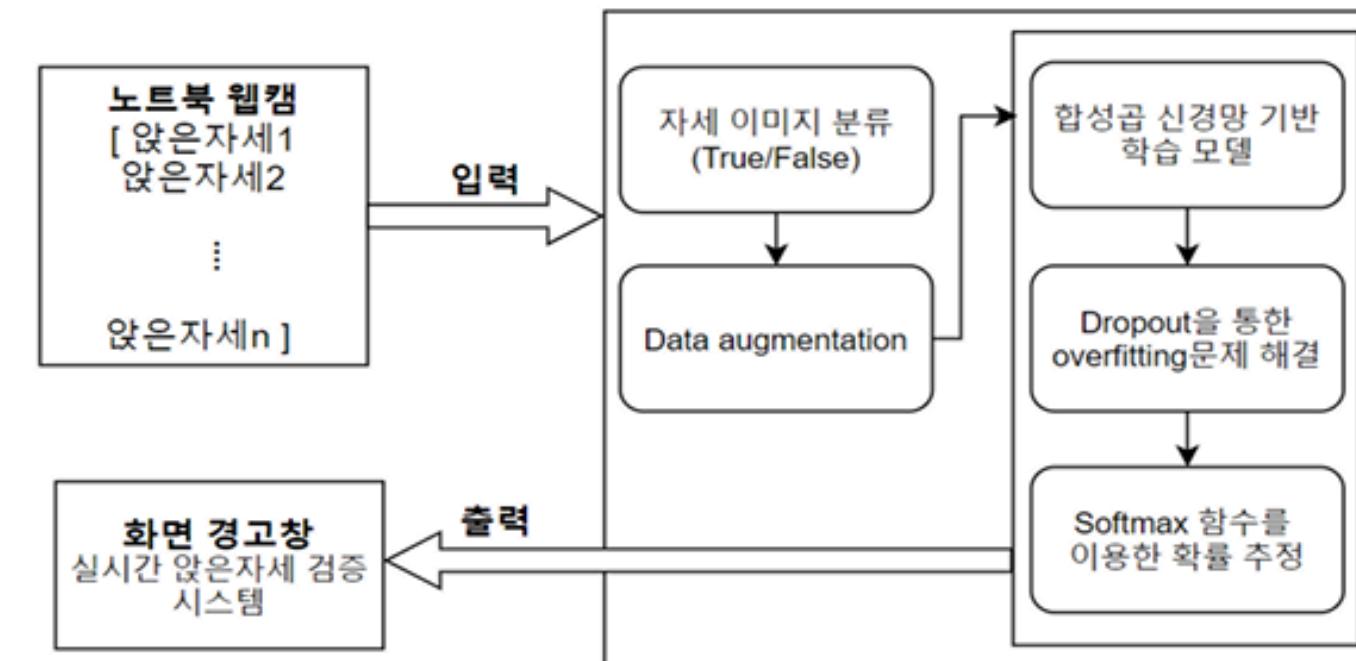


그림 2. 전체 시스템 구성 요약

After AI observes the user's computer usage posture, a system was presented that uses a convolutional neural network (CNN)-based learning model to determine whether the user has a turtle neck symptom and then displays notifications and warnings.

# Research Data

Data Used

As image data for model learning, images and videos were taken using cameras built into laptops from various backgrounds and processing for one man and one woman.

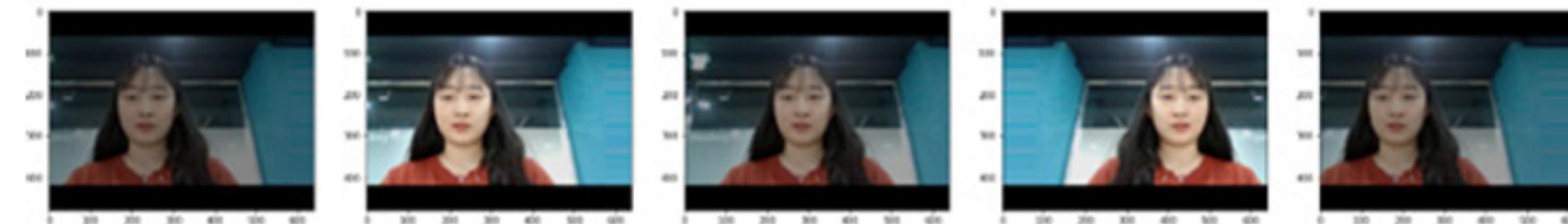
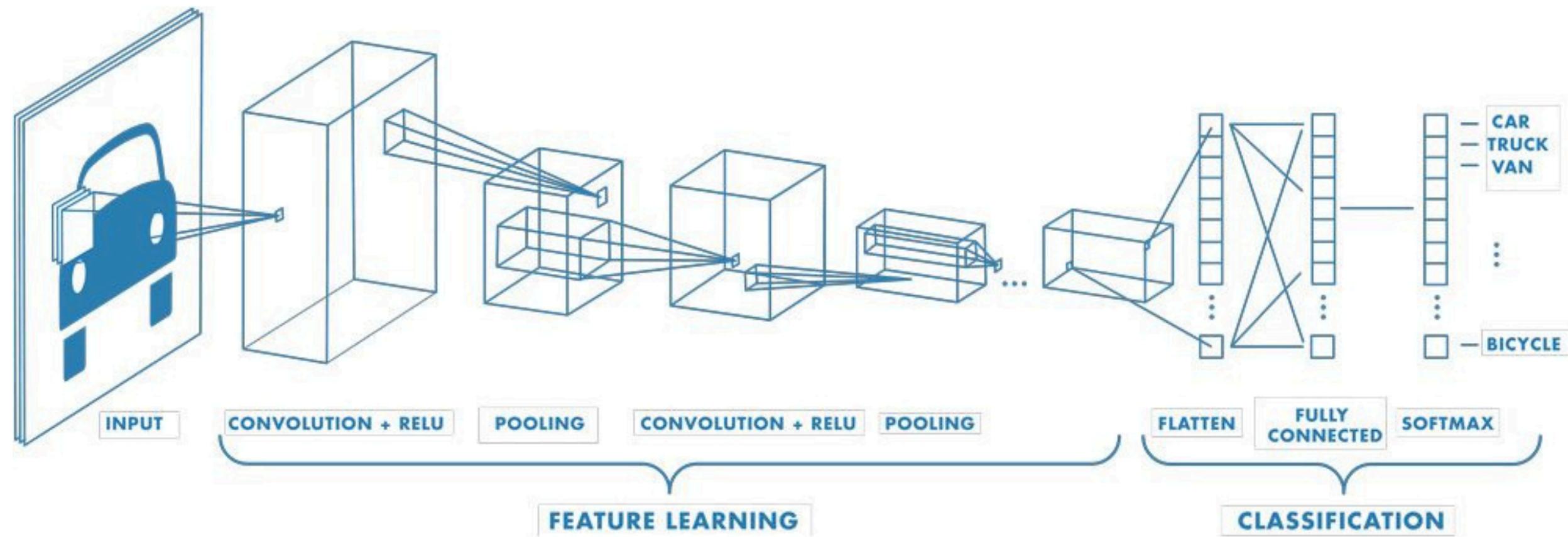


그림 3. Data Augmentation 예시

To compensate for the shortcomings, image data was expanded using Data Augmentation. In addition, variables such as glasses and masks were added to finally construct 2050 training data and 480 evaluation data.

# Convolution Neural Network (1/5)

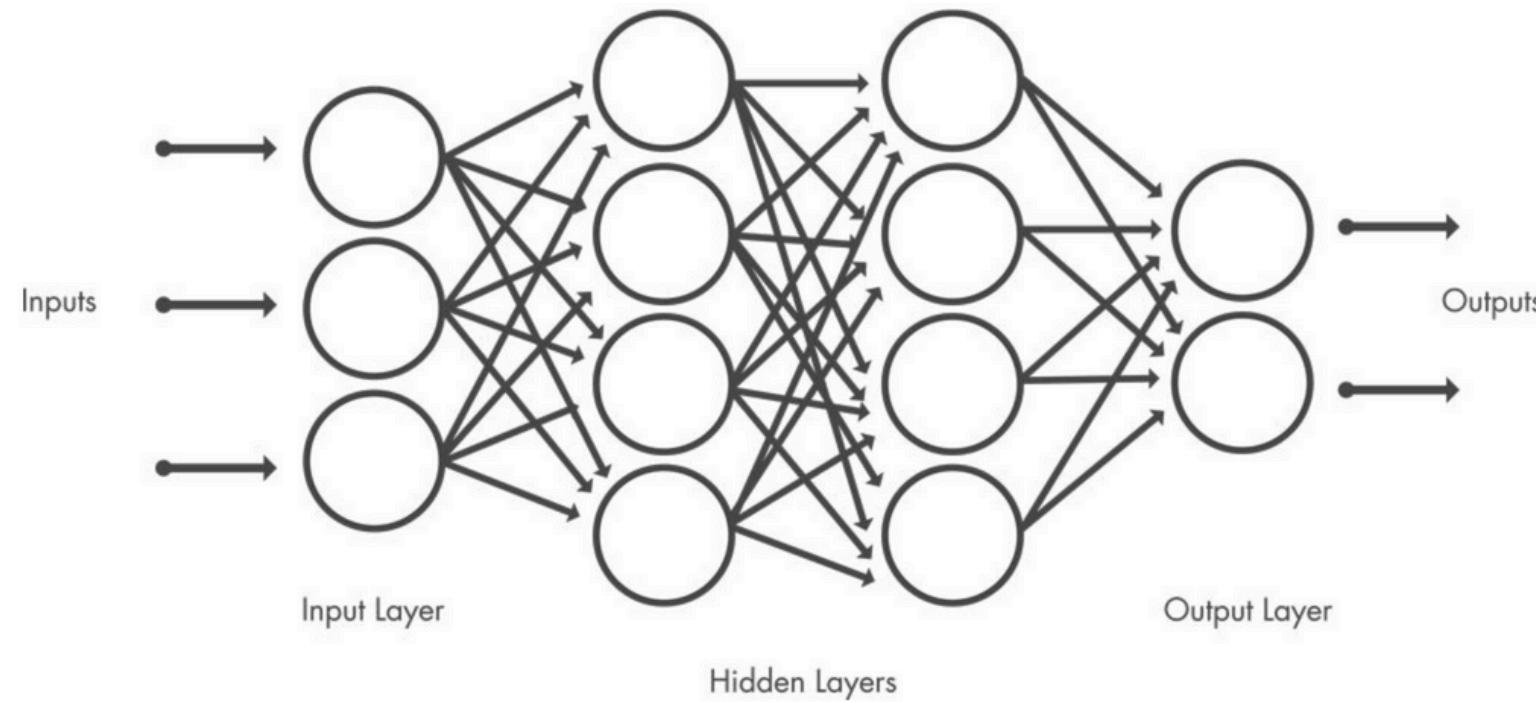
Data Mining Method



The primary data mining method used is a CNN-based machine learning model. This model is trained to extract features from the images and classify them into correct or incorrect postures.

# Convolution Neural Network (2/5)

Data Mining Method



## Convolutional Layer:

Passes the input image through a series of convolution filters.

## Activation or ReLU Layer:

Only the activated features are passed to the next layer, hence the term activation.

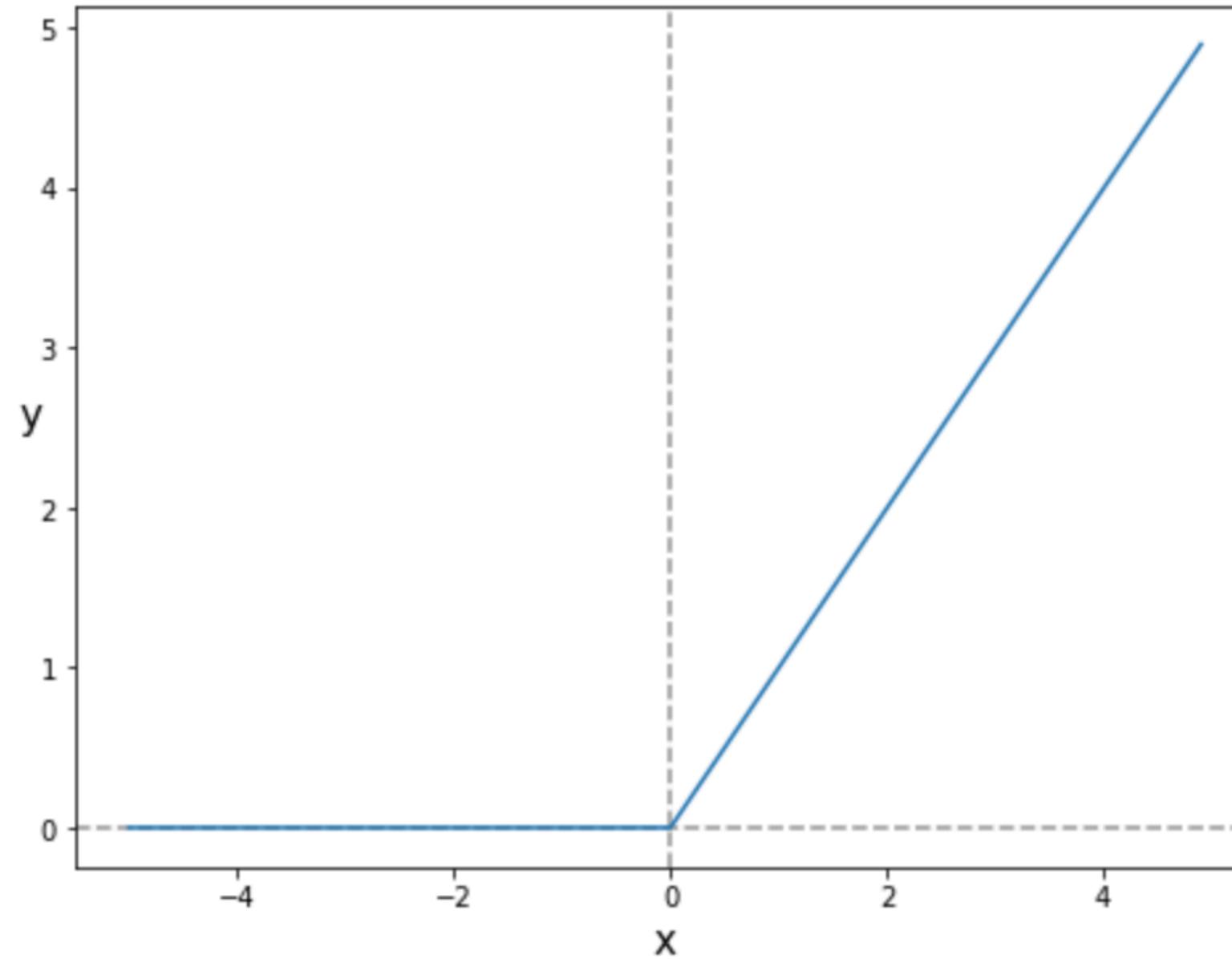
## Pooling Layer:

Performs linear downsampling to simplify the output by reducing the number of parameters.

# Convolution Neural Network (3/5)

Data Mining Method

ReLU



Maps negative values to zero and keeps positive values unchanged, allowing for faster and more effective training.

# Convolution Neural Network (4/5)

Data Mining Method

## Filters and Kernels:

- play a crucial role in **feature extraction**.
- filters are designed to **detect various features** such as edges, textures, and shapes.

## Feature Maps:

- Feature maps are generated by applying **filters to different parts of the image**.
- Each feature map **highlights specific patterns or features** detected by the filters, such as edges or textures.

# Convolution Neural Network (5/5)

Data Mining Method

## Shared Weights and Biases

CNNs have the same shared weights and bias values for all hidden neurons.

Means that **all hidden neurons detect the same features** in different regions of the image.  
Consequently, the neural network allows for translational invariance of objects within the image.

## Classification Layer

After learning features in multiple layers, the CNN architecture moves to the classification layer.

The penultimate layer is a fully connected layer that outputs a K-dimensional vector (where K is the number of possible classes), containing the probabilities for each class of the classified image.

**The final layer of the CNN architecture uses a classification layer** to provide the final classification output.

# Convolution Neural Network Applied to Article (1/2)

Data Mining Method

## Shared Weights and Biases:

- Emphasizes shared weights and biases in CNNs.
- Efficiently recognizes various spatial patterns in images.
- **Important for recognizing forward head posture (FHP).**

## Filters and Kernels:

- Describes the process of using filters and kernels to process small parts of the input image.
- **Analyzes neck and shoulder angles, head position for FHP recognition.**

## Feature Maps:

- Uses feature maps generated by filters to extract patterns from different parts of the image.
- **Detects posture abnormalities by analyzing spatial relationships in user images.**

# Convolution Neural Network Applied to Article (2/2)

Data Mining Method

## Layered Structure:

- Explains the extraction of increasingly abstract features through CNN's layered structure.
- Initial layers extract simple features; **later layers recognize complex patterns for accurate FHP detection.**

## Pooling:

- Describes the process of reducing feature map size while retaining important features.
- **Reduces model complexity and computation cost.**

## Fully Connected Layers:

- Details the final classification process using fully connected layers.
- **Determines if the user's posture is normal or requires a warning.**

# Result

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# Implications of Data Analysis Result

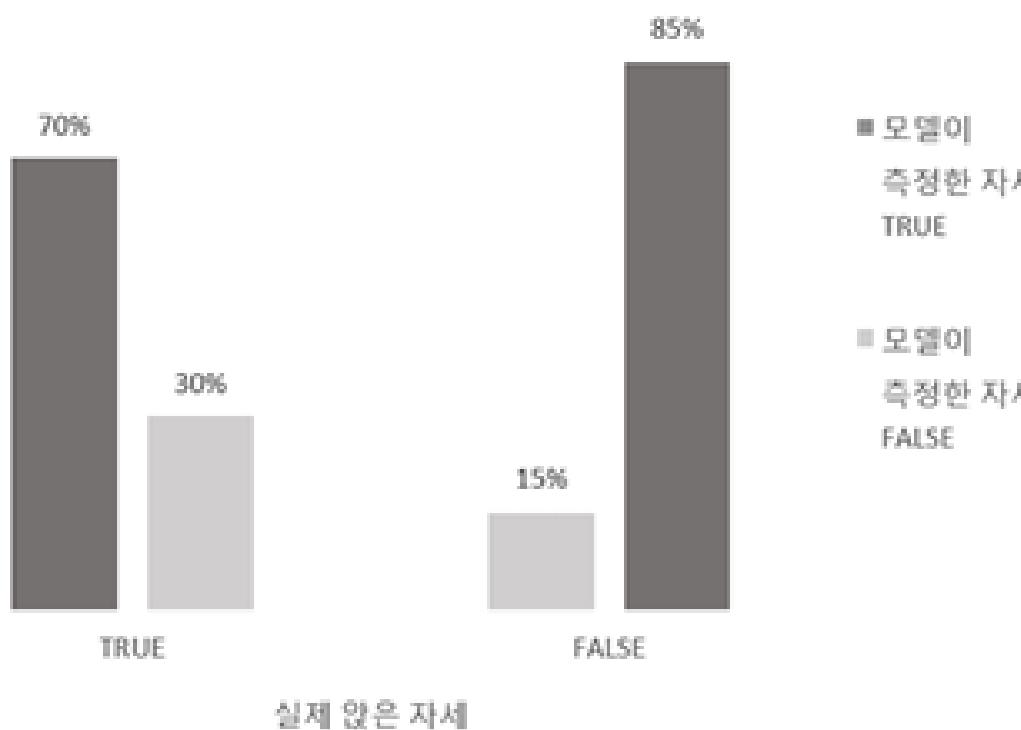
Implication



The implications of the data analysis suggest that real-time monitoring and correction of posture can significantly reduce the incidence of Turtle Neck Syndrome. This system not only helps in correcting posture but also raises awareness about maintaining proper posture habits, potentially preventing more severe health issues.

# What is the Conclusion?

Conclusion



## Experiment

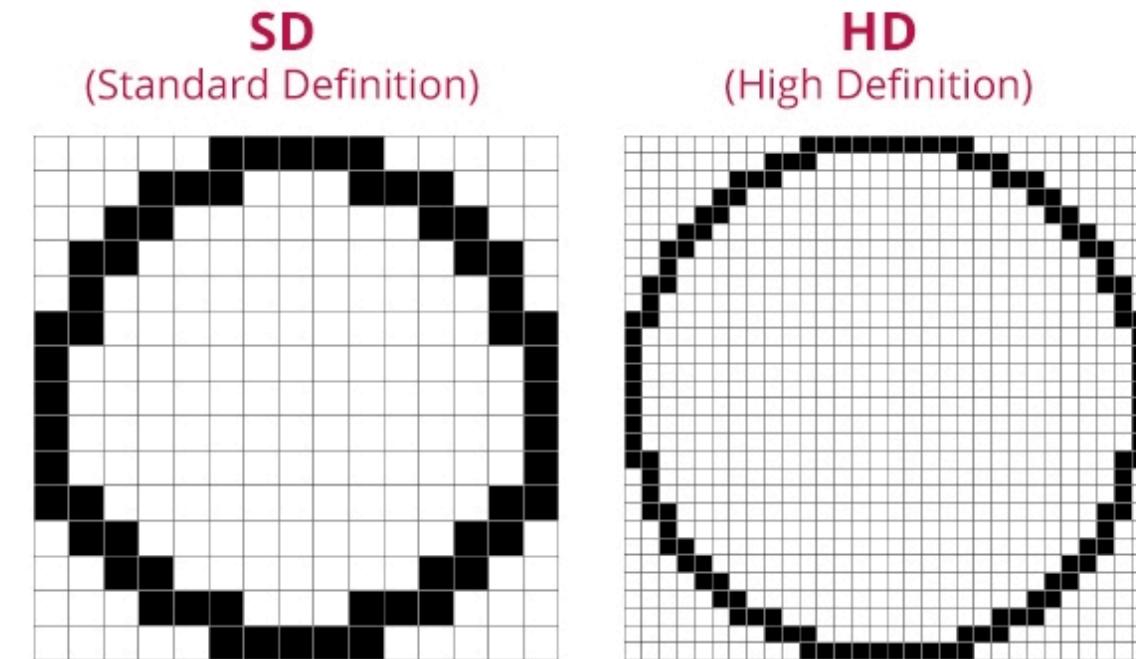
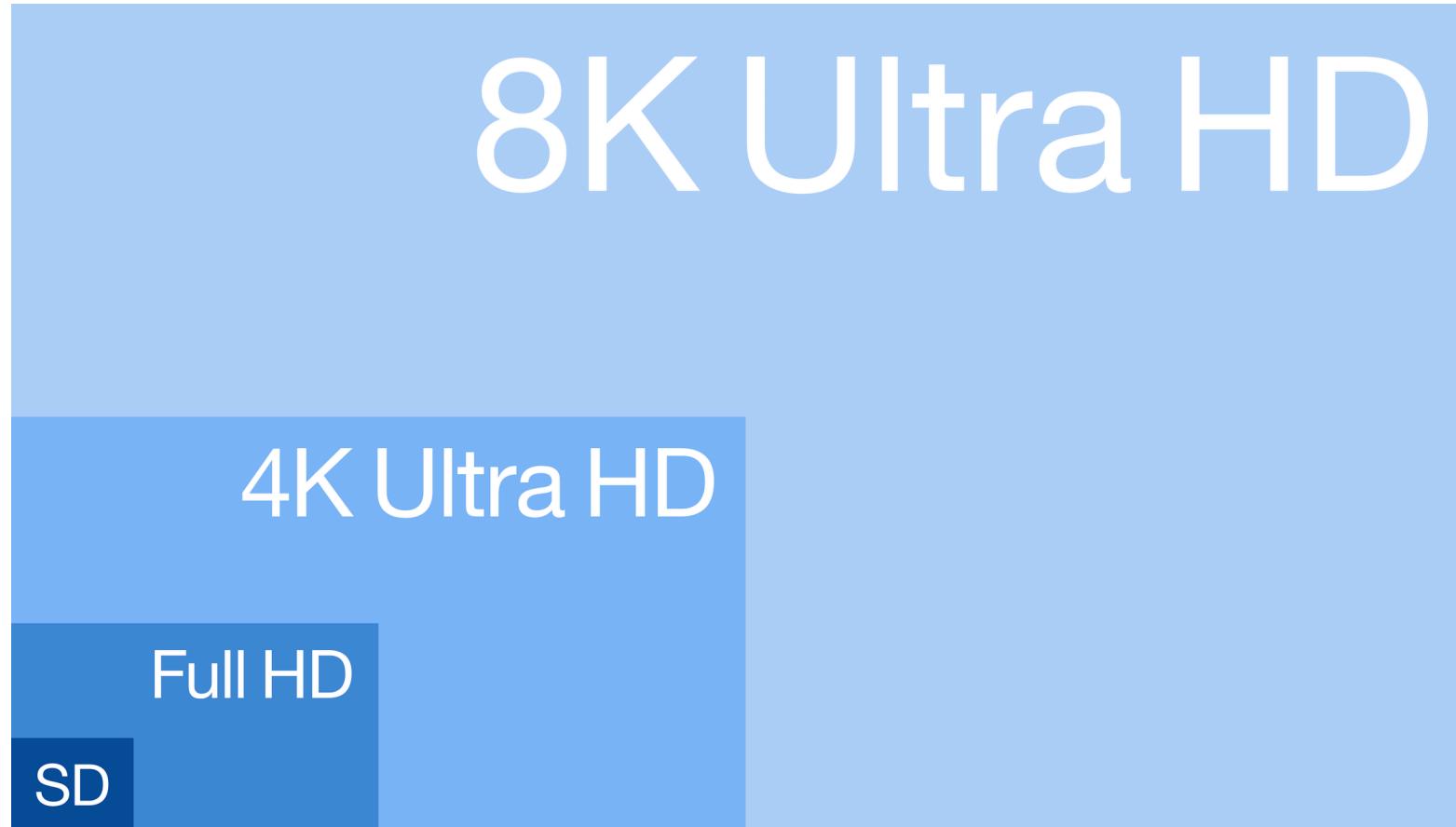
- Subjects: 20 people in their 20s (10 males, 10 females)
- Locations: Conducted in 4 different locations
- Results:
  - Correct posture (True) detected: 14 correct, 6 incorrect
  - Poor posture (False) detected: 17 correct, 3 incorrect

## Conclusion

- Effectiveness: Effective in improving poor posture and reducing pain
- Convenience: Usable without additional device installation

# Resolution Issue (1/2)

limitation

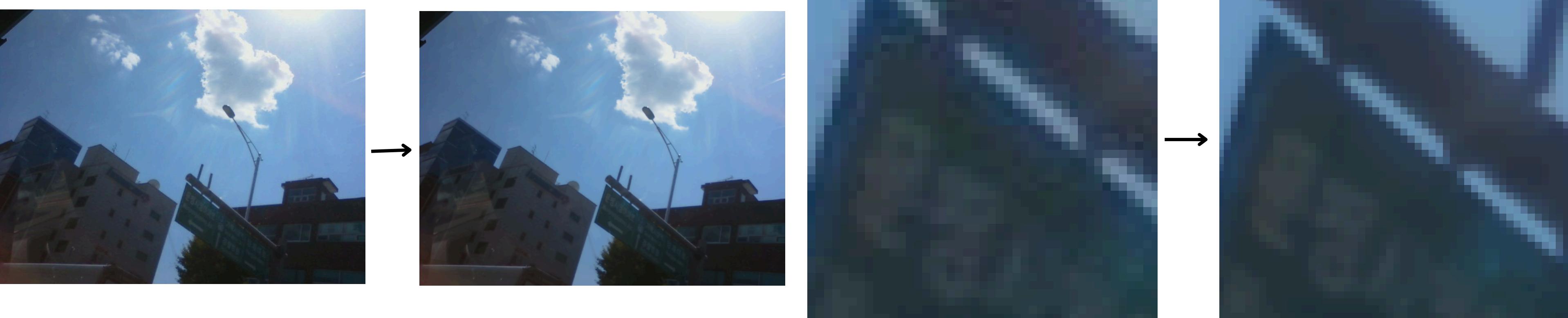


LG디스플레이  
공식 기업블로그  
[blog.lgdisplay.com](http://blog.lgdisplay.com)

In the case of SD and HD, there is more than a 2.5 times difference in the amount of pixels, making it difficult to recognize them similarly during data processing. Therefore, low-resolution images may not convey the characteristics of the subject well, leading to potential problems in judgment.

# Resolution Issue (2/2)

Solution



Using a machine learning-based restoration program can increase the number of pixels and restore the image with precise details of the subject.

# Laptop Angle Issue (1/2)

limitation



120°



150°

In the test of the thesis, there were many instances where True was recognized as False, and we believed that the angle of the laptop influenced this.

# Laptop Angle Issue (2/2)

Solution



자동 Upright 모드



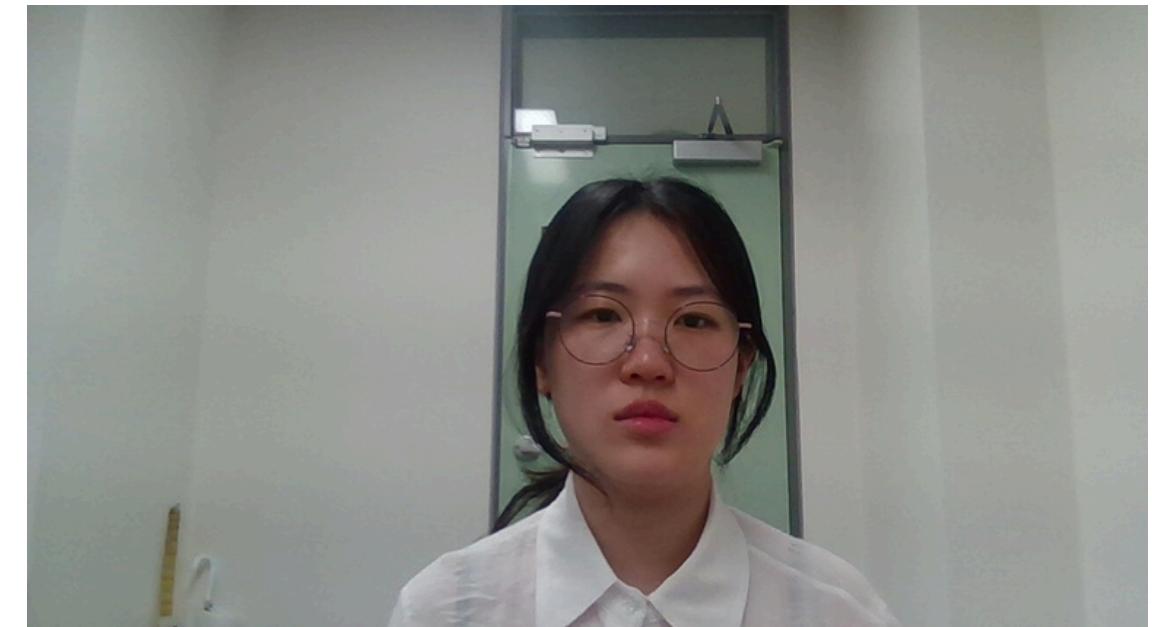
전체 Upright 모드



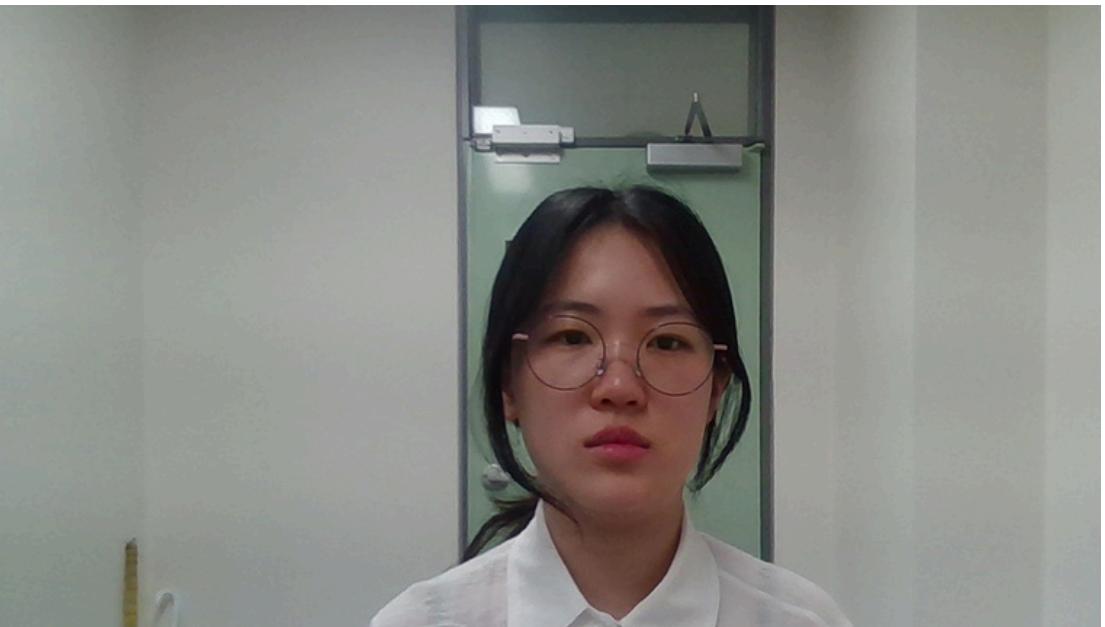
수평 Upright 모드



세로 Upright 모드



Original



자동 Upright 모드

By using Adobe Lightroom's automatic Upright mode, it is possible to correct distortions caused by the camera angle and tilt to a state suitable for reading. After correction, conducting the inspection is expected to overcome the differences in laptop camera angles and yield more accurate results.

This technology is achieved through 3D positioning via bundle adjustment.

# Possibility of Overfitting

limitation

In the study, the original dataset consisted of only two samples, one female and one male. Consequently, even with Data Augmentation, the data may lack sufficient representativeness, leading to the possibility that the model has learned noise.

**\*Noise Learning:** Occurs when the training dataset is too small, underrepresented, or contains a lot of noise. This may lead the model to learn the noise and act as a basis for false predictions.

\*Ying, X. (2019). An Overview of Overfitting and its Solutions. Journal of Physics: Conference Series, 1168, 022022.

# Data Augmentation & Overfitting

limitation



그림 3. Data Augmentation 예시

In fact, there is the study that shows data augmentation alone may not significantly improve model performance if the original data is not diverse enough

\*Aquino, N. M. R., Gutoski, M., Hattori, L. T., & Lopes, H. S. (2017). The Effect of Data Augmentation on the Performance of Convolutional Neural Networks. In \*Proceedings of the 16th Brazilian Conference on Intelligent Systems (BRACIS)\* (pp. 1-8). Federal University of Technology - Paraná. DOI: 10.21528/CBIC2017-51.

# Data Expansion vs Data Augmentation

Solution

Data Expansion: Expanding the dataset by collecting new data or resampling existing data.

Data Augmentation: Transform existing data to create new data.(It is also used for Data Expansion)

In the above study, it is judged that Data Expansion, which collects additional data or resamples, is essential.

\*Ying, X. (2019). An Overview of Overfitting and its Solutions. Journal of Physics: Conference Series, 1168, 022022.

# Advanced Data Augmentation Techniques

Solution

Additionally, Using GANs for advanced data augmentation can help overcome the limitations of the study. These techniques increase the diversity and quantity of training data, thereby enhancing the robustness and generalization capabilities of machine learning models.

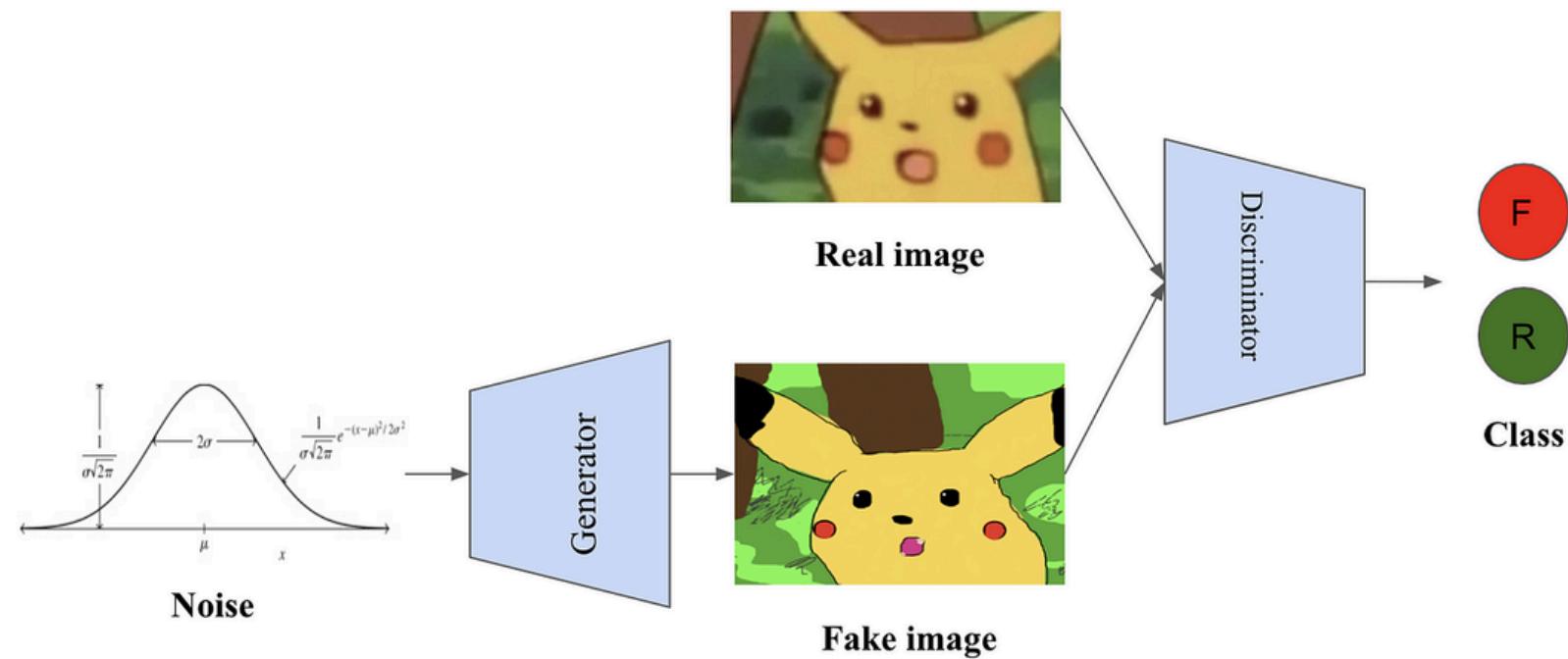
## GAN (Generative Adversarial Networks)

GAN is composed of two neural networks - a generator and a discriminator. The generator creates new data, while the discriminator tries to distinguish the generated data from real data. Through this adversarial process, GAN can generate highly realistic new data, such as photorealistic face images or style-transferred images.

Shorten, C., & Khoshgoftaar, T. M. (2019). Image Data Augmentation for Deep Learning: A Survey. *Journal of Big Data*, 6(60).

# Advanced Data Augmentation Techniques

Solution



GAN (Generative Adversarial Networks)

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Through this adversarial process, GAN can generate highly realistic new data, such as photorealistic face images or style-transferred images.

# Thank You!

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# Source

<http://www.monews.co.kr/news/articleView.html?idxno=94318>

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<https://www.segye.com/newsView/20201213507754>

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진샘, 진실.(2016).의인화를 통한 거북목 증후군 예방 디바이스 디자인.한국HCI학회 학술대회,(),500-503.

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- 한지예, 박진호.(2020).CNN기반의 학습모델을 활용한 거북목 증후군 자세 교정 시스템.한국콘텐츠학회논문지,20(7),47-55.
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<https://www.joongang.co.kr/article/25113725>

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<https://v.daum.net/v/k9C7TIKH0P>

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[https://m.ktv.go.kr/program/again/view?  
content\\_id=664307](https://m.ktv.go.kr/program/again/view?content_id=664307) <https://www.newspim.com/news/view/20211203001087>

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박성근. (2020). 스테레오 카메라의 축척계수와 번들조정을 이용한 3차원 위치 결정 [석사학위논문, 남서울대학교]. <http://www.riss.kr/link?id=T15854358>

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<https://github.com/nagadomi/nunif>

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# Source

\*Ying, X. (2019). An Overview of Overfitting and its Solutions. *Journal of Physics: Conference Series*, 1168, 022022.

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\*Aquino, N. M. R., Gutoski, M., Hattori, L. T., & Lopes, H. S. (2017). The Effect of Data Augmentation on the Performance of Convolutional Neural Networks. In \*Proceedings of the 16th Brazilian Conference on Intelligent Systems (BRACIS)\* (pp. 1-8). Federal University of Technology - Paraná. DOI: 10.21528/CBIC2017-51.

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Shorten, C., & Khoshgoftaar, T. M. (2019). Image Data Augmentation for Deep Learning: A Survey. *Journal of Big Data*, 6(60).

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<https://kr.mathworks.com/discovery/convolutional-neural-network.html>

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## Convolutional neural network란? | 꼭 알아야 할 3가지 사항

Convolutional neural network가 무엇이고 왜 중요하며, MATLAB을 사용하여 CNN을 어떻게 설계, 훈련 및 배포할 수 있는지까지 자세히 알아볼 수 있습니다.

 mathworks.com