



## Facial Expression Recognition Method Based on Convolutional Neural Network

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### ABSTRACT

Deep learning algorithms are a subset of machine learning algorithms that aim to discover multiple levels of distributed representations of input data. Recently, many deep learning algorithms have been proposed to solve traditional artificial intelligence problems. Now days, deep learning has been extensively studied in the field of computer vision and as such, a large number of related methods have arisen. Today, different algorithms and models of neural network–based research have made their place among the classification of images. The main purpose of these algorithms is to train the machine in artificial networks in a way that ultimately has a diagnosis close to the human brain. Among a variety of neural networks, CNN's channel neural networks usually offer good accuracy in the classification of images. In this article, in the first episode, we will discuss 4 deep learning methods: Convolutional neural network (CNN), Restricted Boltzmann Machines (RBMS), Autoencoders and Sparse coding, which after determining the necessary assumptions and applying a preliminary pre–training using the channel neural network algorithm we need Convolutional to perform a general preprocessing on the entered samples. Therefore, a preprocessing is performed on all data and preprocessed samples are stored in a separate location and then the rest of the processes are applied to these samples. Then, we use deep learning to identify faces and reveal them, and deep learning algorithms to reveal different subjects.

**Keywords:** Neural Network, Convolution, Deep Learning, Facial Revealing, Artificial Intelligence.



## INTRODUCTION

Artificial intelligence can be called machine intelligence and machine code capability, which aims to simulate and understand human behavior<sup>1</sup>. Artificial intelligence or machine intelligence should be considered as a vast area of conflict and the reflection of many old and new knowledge, science, and technology<sup>2</sup>. Not only its base and main ideas should be looked at in philosophy, linguistics, mathematics, psychology, neurology, and physiology, but also it has many applications in computer science, engineering sciences, biology and medicine, communication sciences and many other sciences<sup>3</sup>. Artificial intelligence in medical science is more important today due to the development of knowledge and the complexity of the decision-making process, the use of information systems, especially systems, in support of artificial information decision making<sup>4</sup>. Artificial intelligence is a system that can react similar to intelligent human behaviors, including understanding complex conditions, simulating thought processes and human reasoning methods, and responding successfully to them, learning and have the ability to acquire knowledge and reasoning to solve problems<sup>5</sup>. The development of knowledge in the field of medicine and the continuity of decisions related to the purification and development—in other words, human life—has attracted the attention of experts to the use of decision support systems in medical affairs<sup>6</sup>. Therefore, as we mentioned, the use of different types of intelligent systems in medicine is increasing, which today the effect of intelligent systems in medicine has been studied<sup>7</sup>. Artificial intelligence is the intelligence that a machine shows in different circumstances<sup>8</sup>. Most of the writings and articles related to artificial intelligence have defined it as "knowledge of recognition and design of intelligent factors"<sup>9</sup>. An intelligent factor is a system that increases the chances of success after analysis by recognizing its surroundings<sup>10</sup>. John Makarty, who used the term artificial intelligence in 1956, has defined it. Researches and searches for "knowledge and engineering of intelligent machine manufacturing" to achieve the construction of such machines are related to many scientific disciplines, such as computer science, psychology, philosophy, neuroscience, administrative sciences, control theory, possibilities, optimization and logic<sup>11</sup>. Artificial intelligence was raised by

philosophers and mathematicians such as Bull, who presented laws and theories about logic<sup>12</sup>. With the invention of electronic computers in 1943, artificial intelligence challenged scientists of the time<sup>13</sup>. In these circumstances, it seemed that this technology would be able to simulate intelligent behaviors<sup>14</sup>. Despite the opposition of a group of intellectuals with artificial intelligence who viewed its usefulness with hesitation, only after four decades, we witnessed the birth of chess machines and other intelligent systems in various industries<sup>15</sup>. The name artificial intelligence was invented in 1965 as a new knowledge<sup>16</sup>. However, activity in this field began in 1960<sup>17</sup>. Most of the primary research work in artificial intelligence was on performing machine games and proving mathematical issues with the help of computers<sup>18</sup>. In the being, it seemed that the narrators would be able to carry out such activities only by taking advantage of a large number of discoveries and searching for problem-solving pathways and then choosing the best way to solve them<sup>19</sup>. The term artificial intelligence was first used by John Makarty, which is referred to as the father of "science and knowledge of the production of intelligent machines"<sup>20</sup>. Mr. John Makarty is also the inventor of one of the languages of artificial intelligence programming called Lisp<sup>21</sup>. With this title, one can find the identity of intelligent behaviors of an artificial tool. (Man-made, unnatural, artificial) while AI has been accepted as a general phrase that includes intelligent and combined calculations (composed of synthetic materials)<sup>22</sup>. We can approximately use the term Strong and weekend AL to introduce system classification<sup>23</sup>. ALs are studied in common disciplines such as computer science, psychology and philosophy, according to which it creates intelligent behavior, learning and compromise, and usually the advanced type of and remains and computers are used<sup>24</sup>. VP-Expert, Prolog, Clips, Lisb, are programming languages<sup>25</sup>. The Turing test is a test introduced by Alan Turing in 1950 in writings called "Machine Computing and Intelligence"<sup>26</sup>. In this test, conditions are provided that a person interacts with a machine and asks enough questions to investigate the intelligent actions of the machine<sup>27</sup>. If at the end of the experiment it is not able to detect which it has been interacting with humans or with machines, the Turing test has been successfully performed. So far, no machine has successfully come out of this test<sup>28</sup>. The attempt of this test is to detect the intelligent integrity of a system that tries to simulate humans<sup>29</sup>. We can describe artificial intelligence this way: Artificial

intelligence is the study of how computers can be compelled to do things that humans are doing right or better at the moment<sup>30</sup>. Most of the writings and articles related to artificial intelligence have defined it as "knowledge of intelligent agent design"<sup>31</sup>. An intelligent agent is a system that increases its chances of success by recognizing its surrounding areas<sup>32</sup>. John Mckarty, who used the term artificial intelligence in 1956, has called it "the knowledge and engineering of intelligent machine manufacturing"<sup>33</sup>.

In general, the existential nature of intelligence is in the sense of collecting information, inducing and analyzing experiences in order to achieve knowledge or to present decisions<sup>34</sup>. Basically, intelligence is based on the use of experience in order to solve the received problems<sup>35</sup>. Artificial intelligence of science and engineering is the creation of intelligent machines using computers and modelling the understanding of human or animal intelligence and finally achieving the mechanism of artificial intelligence at the level of human intelligence<sup>36</sup>. Artificial intelligence of science and engineering of creating the intelligent machines using computers and modelling to understanding of human or animal intelligence and finally achieving the mechanism of artificial intelligence at the level of human intelligence<sup>37</sup>. As an outcome, despite the presence of highly efficient and powerful computers in the present era, we have not yet been able to disembark intelligence close to human intelligence in creating artificial<sup>38</sup>.

### Advantages of Neural Network

The advantages of neural networks: Adaptive learning, self-organization, real-time operators, error tolerance, classification, generalization, stability-flexibility<sup>39</sup>. Neural networks have different ways of solving the problem. ordinary computers use an algorithmic method for problem solving, which follows a set of unambiguous guidelines to solve the problem<sup>40</sup>. These commands are converted to high-level language and then into machine language that the system can detect<sup>41</sup>. Neural network consists of layer components and weights. The behavior of the network is also dependent on the connection between the members<sup>42</sup>. In general, there are three types of neuronal layers in neural networks:

- **Inlay:** Receiving raw information that has been feed to the network.

- **Hidden layers:** The performance of these layers is determined by the intrusive and weight of the connection between them and the hidden layers. A hidden unit activated when the weights between the inland and hidden units determine.
- **Exclusion layer:** Convolutional neural networks.

Deep models can be divided into two groups: probable graphical models and neural network models<sup>43</sup>. Probation models are trying to find a set of random variables that describe a distribution on the entry data and in these models the goal is to estimate a set of parameters that accurately quantize the index<sup>44</sup>. In non-probability models, the aim is to learn several levels of distributed representations of input data<sup>45</sup>. Autoencoders are among these non-probable models that not only learn a decoding map but also learning an encryption map which representation (encoding) for a set of data<sup>46</sup>. In probable models, the goal is to find the maximum likelihood of the entry information. But in non-probable models, the goal is to achieve the minimum reconstruction error. when we use images of real necessities and scales, we will face a challenge for two reasons. First, the images have high dimensions. Therefore, algorithm should be able to receive information on this scale and not face computational complexity problems. Second, in images of objects can appear in any place of the approval, therefore, the desired representation should be inverse to the displacement of the place of objects in the Figure (1).

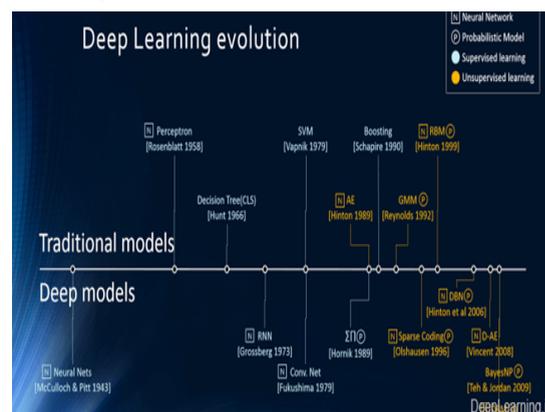


Fig. 1. deep learning evolution

### Convolution Layer

In these layers, the CNN network uses different kernels to convolve the input image as well as the middle feature map, creating different

feature maps<sup>47</sup>. One of the most interesting methods of managing convolution layers is the Network in Network (NIN) method, in which the main idea is to replace the convolution layer with a small perceptron neural network that consists of several layers all connected with nonlinear activation functions<sup>48</sup>. In this way, linear filters are replaced with nonlinear neural networks. This method results in good results in the categorization of images in Figures 2 and 3.

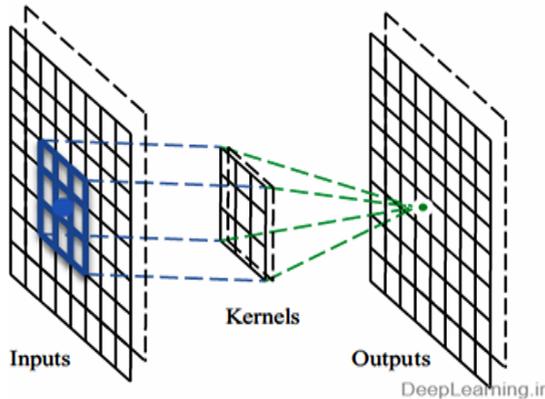


Fig. 2. Convolution layer operation

**Pooling Layers**

A pooling layer is usually placed after a convolution layer and can be used to reduce the feature map size and network parameters<sup>49</sup>. Like convolution layers, pooling layers are unchanged (stable) due to the consideration of neighboring pixels in their calculations. Pooling layer implementations using max pooling function and Average pooling function are the most common implementations<sup>50</sup>. In Fig. 7, you can see an example of the Max pooling process. Using a max pooling filter with sizes of 2x2 and stride 2 creates a feature map with a size of 8x8, an output of 4x4.

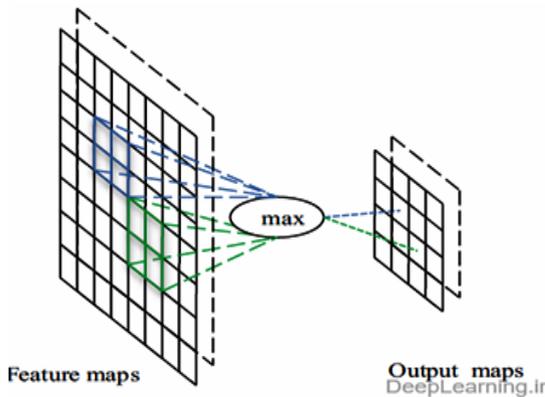


Fig. 3. Max pooling operation

**Max Pooling Operation**

Boureau, provided a detailed theoretical

analysis of max pooling and average pooling efficiency. Scherer made a comparison between the two operations and understood that max pooling can cause faster convergence, better generalization (generalization improvement) and excellent selection of univariate features<sup>51</sup>. In recent years, various rapid implementations of different types of CNN have been performed on the GPU, most of which use Max pooling operations<sup>52</sup>. Pooling layers among the three layers of convolutional networks are the only layer on which the most study has been done<sup>53</sup>. There are three famous methods related to this layer, each of which follows different goals<sup>54</sup>.

One shortcoming of max pooling is that relative to overfitting the training set It's sensitive, and it makes generalization difficult<sup>55</sup>. With the aim of solving this problem, Zeiler proposed a stochastic pooling method in which the definitive pooling operation with a stochastic procedure it will be replaced<sup>56</sup>. This stochastic procedure is the random selection of values within each Pooling area based on a polynomial distribution<sup>57</sup>. This operation resembles standard max pooling with lots of copies of the input image, each of which is deformed<sup>58</sup>. They have a small place. Stochastic nature is useful for preventing overfitting problems and therefore it has been used in this method<sup>59</sup>. It is possible to increase the efficiency of a convolutional neural network by combining several different types of Pooling layers, each developed with a different purpose and method<sup>60</sup>.

**Fully Connected Layer**

After the last Pooling layer, as can be seen in Fig. 8, there are all-connected layers that convert 2D feature maps into one-dimensional feature vector to continue the feature representation process Figure 4.

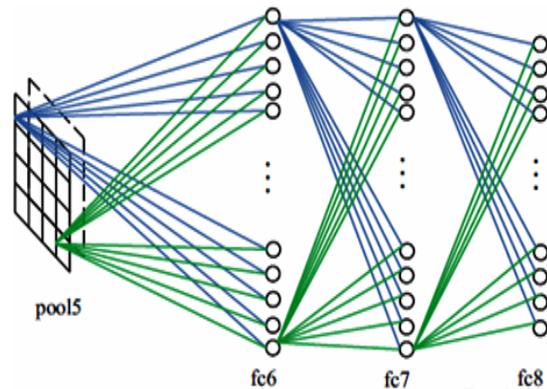


Fig. 4. Operation of fully connected layers located after the last pooling layer

The ally connected layers act like their counterparts in traditional artificial neural networks and contain approximately 90% of the parameters of a CNN network<sup>61</sup>. The ally connected layer allows us to present the network result in the form of a vector of a certain size. We can use this vector to categorize images or use it to continue further processing<sup>62</sup>.

Changing the structure of all connected layers is not common, but a sample was performed in transferred learning method in which the parameters learned by ImageNet were preserved, but the entirely connected last layer was replaced with two ally connected layers so that the network could adapt to the new visual recognition activities<sup>63</sup>.

### Theoretical Understanding

Although very good results have been achieved using deep learning methods in the field of computer vision, the underlying theory that causes these good results remains unclear. And there's still no understanding of what architecture works best than the other<sup>64</sup>. It is very difficult to decide what structure, or how many layers or how many processing units in each layer are suitable for a particular task and activity<sup>65</sup>. Also, these methods require special knowledge to select reasonable values such as learning rate, regularize power, etc.<sup>66</sup>. The design of architectures has been based on roughness and ad-hoc method<sup>67</sup>. Of course, Chu has proposed a theoretical method for determining the number of optimal feature maps, but this theoretical method is only used for extremely small receptive fields<sup>68</sup>. In order to better understand the architectures of Zeiler neural network architectures also provided a visualization technique method known for convolutional neural network architectures that provided a view of what was happening within a convolutional neural network<sup>69</sup>. This method, by specifying interpretable patterns, could provide facilities for improving architectural design. Similar technique by Yu<sup>70</sup>. It was also presented. Aside from visualizing features (displaying features), R-CNN attempted to explore CNN's learning pattern<sup>67</sup>. In this method, the researchers tested the efficiency by layer during the training process and found that convolution layers learned most of the overall characteristics and had the highest display capacity of the neural network, while the all-connected layers are domain specific<sup>68</sup>. In addition

to analyzing the properties of convolutional neural network, Agrawal. further investigated the effects of using popular strategies on the efficiency of convolutional neural network such as fine-tuning and pre-training<sup>69</sup>. And he presented objective understandings based on evidence for the use of models in computer vision issues<sup>70</sup>.

## RESULTS AND DISCUSSION

### Applying Deep Learning to Identify and Reveal the Face

CNN's deep learning algorithms and overlapping neural networks have been able to create many applications in the field of computer science and machine vision. Also, it has been used, in the field of facial recognition, subject identification and subject pursuit, as well as in semantic divisions. Subject revealing is one of the most important applications in the field of computer vision in deep learning algorithm, data banking and neural network are two important parts. Data bank is the foundation of deep learning algorithm, so that the number and volume of data bank will affect the accuracy of the neural network output and the selection of a suitable neural network and its optimal structure also affect the resulting accuracy.

CNN algorithm is used as the main method for object vector extraction. Another advantage of that is relatively more effective training for large CNN, which can supervised manage high-volume data such as ILSVRC data trained as a background, and then apply special and specific settings to obtain better results for smaller data banks such as Pascal. The power of R-CNN has improved the time of identifying the subject on the network. However, the time spent to find the proposed method is a long time. Therefore, operations related to identifying and finding the requested area have been converted into an operating node in these networks.

The Table 1 and Fig. 5–15 shows an average accuracy average or map for the said methods.

**Table 1: Results train**

	Loss Train	Psnr – Train	Psnr Test
CNN	2.08	23	23.09
Designed Network	1.16	25.98	23.43

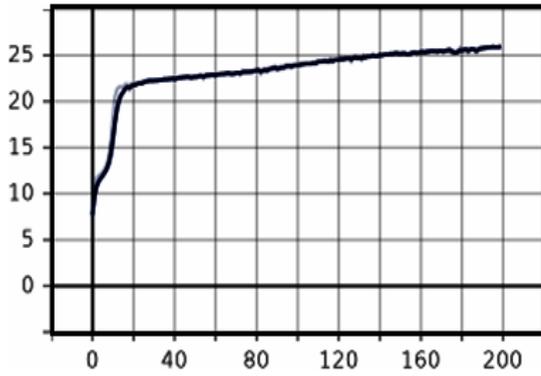


Fig. 5. PSNR Train

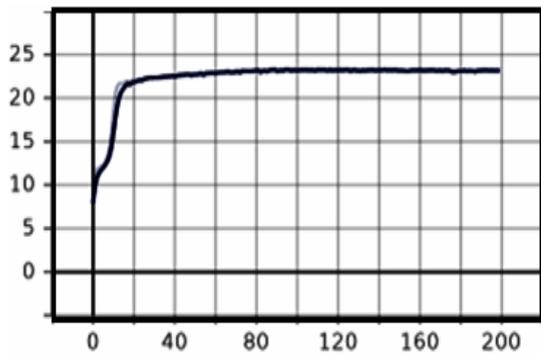


Fig. 7. PSNR Train

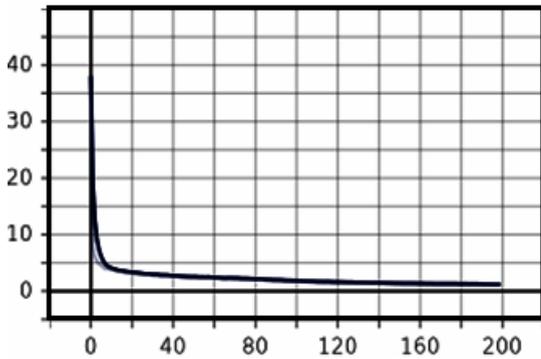


Fig. 6. Train Loss Figure

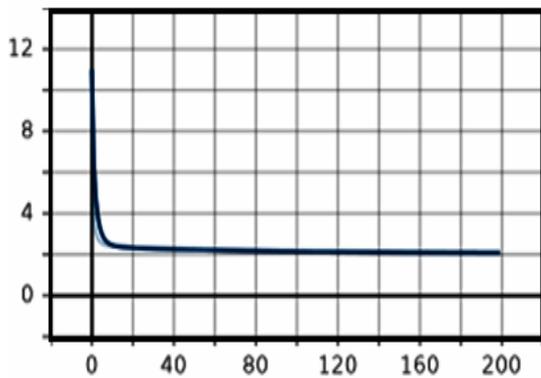


Fig. 8. Train Loss Figure

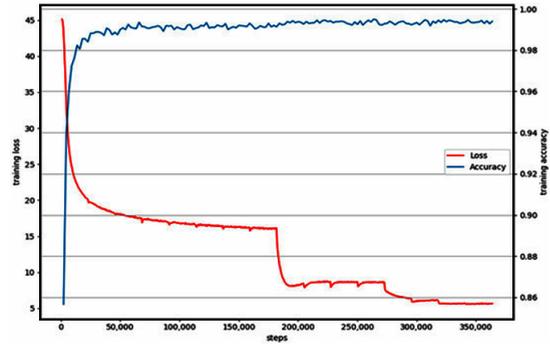


Fig. 9. The curves of training loss and accuracy on LFW of the baseline

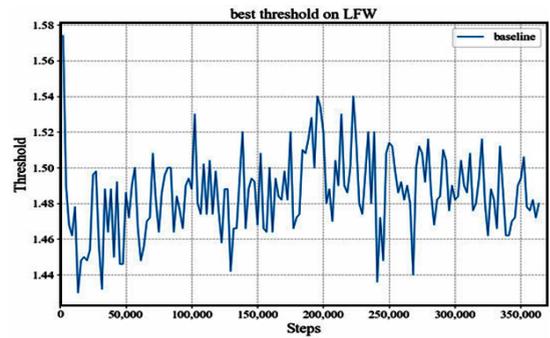


Fig. 10. The best threshold of the baseline on LFW during the training stage

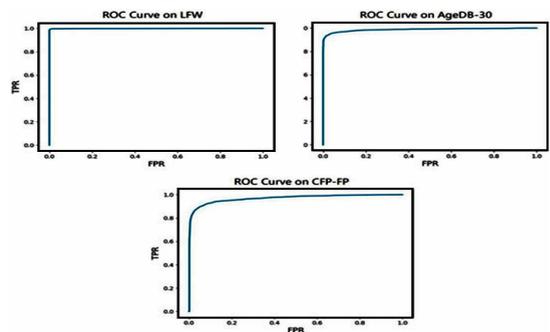


Fig. 11. The ROC curves of the baseline on LFW, Age DB-30, and CFP-PP

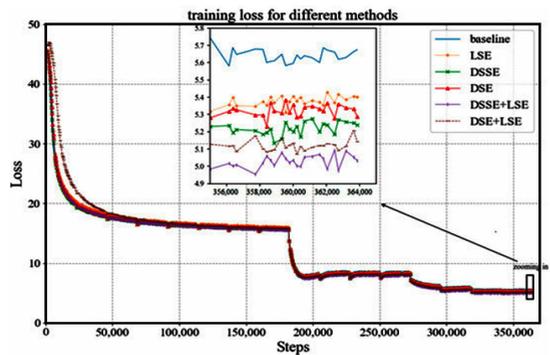


Fig. 12. Training loss curves of the models with different SE modules

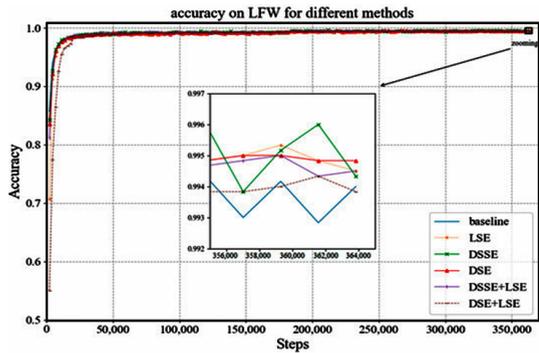


Fig. 13. Accuracy curves of the models with different SE modules

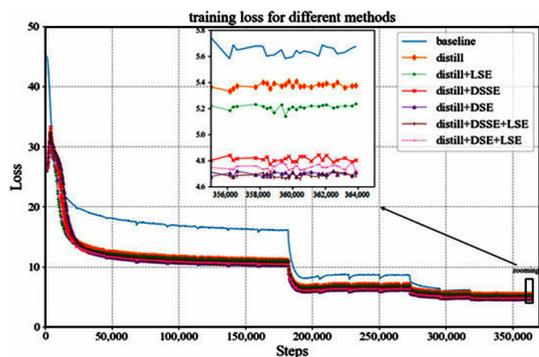


Fig. 14. Training loss curves of the models with different modules in the proposed training pattern

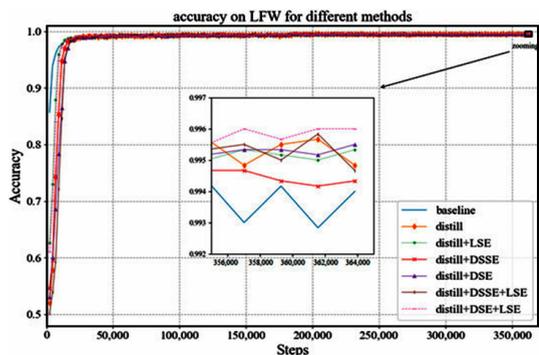


Fig. 15. Accuracy curves of the models with different modules in the proposed training pattern

**CONCLUSION**

Due to the high complexity and high dimension of data, the use of special image extraction methods has problems that increase computational complexity and reduce their speed. In order to overcome the large dimensions of data in image processing work, this has been put in place and, of course, feature reduction methods have been used so far. The purpose of these methods is to import the information from a larger space to a smallest one without losing important

information. Of course, in this process, choosing a method of property reduction is very important. Among the conventional methods for reducing the characteristics can be mention to the analyzing the major components and intelligent methods such as genetics and Casting methods noted. On the other hand, by selecting the appropriate classification of the mentioned feature extraction methods, they will create acceptable performance of facial recognition systems. Nowadays, deep learning methods have been considered to retrofit facial representations. For classification, powerful and learnable classification tools that are constantly progressing and improving are used. Among these methods, it is recommended to improve the learning process and deepen it with CNN neural networks with deep learning. It is expected that the combination of powerful medical instruments can increase the accuracy of diagnosis.

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#### Conflicts of Interest

The author declares that there are no conflicts of interest regarding the publication of this paper.

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