Using CNN for detection of diseases

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Abstract. Since economic booming, people start to care more about their health including dietary structure and nutrition. Scientist announced that fish and chicken are the best meat among others based on high nutrition level and low fat percentage. However, It is proved that many diseases especially H7N9 are related to poultry farming. Those diseases not only lethal to chicken but also has certain chance to evolve to human transmittable illness. Unfortunately, industrialized large scale poultry farming increased the morbidity of the diseases which is enough for people to take concern of. After all this, the application of genetic engineering technology to poultry industry focused on increase productivity, which sadly reduce poultry healthiness. These lead to periodic poultry pandemic blast. This is endless periodic nightmare for poultry farming. Theoretically, Using image recognizing from artificial intelligent to detect diseases at first sign is possible with current research level. This paper will compare and record the changes of appearances of five common diseases and try to design an AI model to detect it. The main results are as follow: (Use conventional neutral network to judge whether the chickens are sick by checking the cockscomb, skin, feather and waste. Keep training the computer to correct the weight to let the accurate rate above 98%. Extract the data of the images by digitizing, and continually recognize the diseases through the help of the vets to realize back propagation to improve the accurate rate.)

1. Research background

Chicken is the source of high-quality protein. Chicken protein is rich in essential amino acids for the human body, and its content is very similar to the amino acid spectrum in eggs and milk, so it plays an irreplaceable role and position in the human diet. Due to its low-fat content, easy to digest, delicious taste, high protein content, higher nutritional value than pigs, cattle, lamb, and low price, chicken can be accepted by people of different cultural backgrounds and religious beliefs. At present, chicken has replaced the beef to become the world's second-largest consumption of meat. As one of the main products in poultry farming, eggs called “the world’s most nutritious breakfast” have many kinds of proteins and amino-acids, so they can protect the liver, prevent arteriosclerosis and prevent cancer. The increasing of the demand of chickens and eggs promote the development of poultry farming. Especially in recent years, the introduction of foreign advanced technology and the improvement of breeding management have greatly improved the poultry industry in China, and the chicken output has been increasing at an average annual rate of 5%~6%. According to the latest data from the USDA-FAS, China produced 13.34 million tons of chicken in 2015, accounting for 15.15% of global chicken production and ranking second in the world after the United States. The rapid development of poultry farming in China has brought a new opportunity as well as an unprecedented challenge to the poultry farming industry in China. As shown in Figure 1, the status quo of chicken production and consumption in China in the past 10 years. [1] The rapid development of poultry farming has become a pillar industry
in agriculture and rural economy, which plays a very important role in the stability of rural economy and society.

![The total production of chicken](image)

Figure 1. (The gross production of chicken)

Among the three largest meat producers in the world, poultry farming is easier and more popular because of its shorter growth cycle and smaller acreage requirements than pigs and cattle. Although there are many kinds of poultry and their growth cycles are different, their overall growth cycle is short. White feather chicken is the most widely bred chicken species in the world, and its growth cycle is generally about 42 days. In addition, poultry farming has no special requirements on the size of the farming house, and farmers can build different scales and sizes of poultry houses according to their own conditions. Therefore, under the dual effects of social demand and simple breeding conditions, more and more people and companies are engaged in poultry breeding, which leads to the continuous increase of chicken output, while the growth of pork and beef output tends to be flat or even reduced.

2. Research rationale

With the development of the poultry farming, more and more people begin to pay attention to the safety and sustainable development of the breeding industry. Healthy breeding has become the focus of people's attention and research, and health monitoring has been recognized by the industry. With the improvement of economic level, people pay more attention to their health and food safety. Many diseases has been proved to be related to the daily diet, especially the occurrence of zoonoses such as H7N9 and mad cow diseases. Besides, the application of genetic engineering technology to poultry has not only improved the efficiency of chicken production but also made individual poultry more vulnerable to diseases. The constitution detection of poultry, especially the young ones, is very important, which not only seriously affects the survival rate, morbidity and mortality of poultry, but also directly affects the economic benefits of enterprises. Some of the existing technologies cannot quickly obtain the health status of poultry, so that diseased poultry cannot be detected and treated as soon as possible. It may cause pathogen infection, ultimately affecting the economic benefits of poultry farming and food safety. In order to solve these problems, we need to come up with new methods for monitoring the health status of poultry, and it can obtain the health status of poultry quickly and accurately. This can provide protection for individual farmers and breeding enterprises, and are of great importance to the poultry farming.

3. The establishment of the system

3.1. Equipment

Camera computer

3.2. Software

Python, keras, tensorflow
3.3. Theory
To use image recognition, the computer needs to be built in a CNN network to analyze pictures. The camera is used to take pictures and send them to the computer. Then the computer will use python code to run and analyze the picture. The result will be percentage. Where 100% means the program has 100% confident the input image is a sick chicken. 0% means 0 confident.

The system will decompose pictures to 3 pixel matrix frames, each matrix corresponding to one of the three original colors, and each unit on the matrix corresponding is the density of color on this position on screen. By this way the picture can be represented by 3 matrices with random unit numbers. The units on matrix is equal to pixels of the screen. See Figure 2. Once the pictures transferred to data (matrix) the program will then minimize the data size by abandoning useless data. This process is convolution. The network is called convolutional neural network. [2]

![Figure 2](image_url)

**Figure 2.** This shows an area transferring the matrix

The distribution of data on the image represents the color distribution on the image. So that the ill chicken’s sign such as feces color and cockcomb color will be indicated by a group of data distributed in a range of special sequences on the matrix. See Figure 3, the matrix as input while the program will design a one to one and onto weight. [3] The weight is used to detect the specific sequence of data by product with the 1Xn vector made from rows of data matrix. The result will be one number. The number will go through a function to minimize the data and result output(classifier) in 0--100%.

![Figure 3](image_url)

**Figure 3.** This indicates the image changing into numbers that classified by the function

The normalization is to normalize data to central for better accurate results. See Figure 4, normalization will put data into the same coordinate. So picture size and item position on picture would affect less on the final result. [4] The method the program uses is batch normalization. Batch normalization helps prevent gradient vanishing or exploding and make activation function less possible to saturate.
Figure 4. The process of normalization.

See Figure 5, the program can use many different activation functions for the weight but in this case the program is using Relu, since the input data should be large and none similar. The cause of picture none similarity is chicken are moving dynamically. [5] Moreover, for fast detection the program should be sensitive to any form of color changes. So Relu functions fit the current need of the program. It does not cause gradient vanishing or gradient exploding easily when programs do backward propagation. It’s higher efficiency since negative results all “0” to avoid useless data, while the positive result is in linear relationship so it does not saturate.

Symptom= sign

Figure 5. The details and various kinds of activation functions

To minimize the data while keeping the identities of target number sequences. See Figure 6, the program will first convolute the original input matrix to the convolution layer. to do it, the program will slide a smaller size scope called the filter over the original layer and form a new smaller layer.

Convolution Layer

Figure 6. The details and explanation of convolution layer
Since convolute will shrink the data so the program will also do a pooling layer to back up the data. Once result data is lost the program can go to the previous pooling layer for backup instead of running all data over. The program in this paper using max pooling. Max pooling is to get the highest number among each sub matrix and form a new matrix.

The program will be training with plenty of ill chicken pictures where pre-labeled by doctors with correct results. The program will use backward propagation to train its weight for more accurate results. The best adjustment of weights is calculated from gradient descent. Program will continue training until all pictures will get 98% confident results.

3.4. Code as follow

```python
import Dense, import Dropout, import Flatten,
import numpy from keras.models
import Sequential from keras.layers
import BatchNormalization,
import Activation from keras.layers.convolutional.
import Conv2D, MaxPooling2D from keras.constraints
import maxnorm from keras.utils
seed = 23
from keras.datasets import cifar10
(m_train, n_train), (m_test, n_test) = cifar10.load_data()
m_train = m_train.astype('float32')
m_test = m_test.astype('float32')
m_train = m_train / 255.0
m_test = m_test / 255.0
n_train = np_utils.to_categorical(n_train)
n_test = np_utils.to_categorical(y_test)
class_num = n_test.shape[1]
model = Sequential()
part B :
model.add(Conv2D(32, (4, 4), input_shape=n_train.shape[1:], padding='same'))
model.add(Activation('relu'))
model.add(Dropout(0.4))
model.add(BatchNormalization())
# repeat part B for convolution network size 64, 128 and 256

      model.add(Flatten()) model.add(Dropout(0.2))
model.add(Dense(256, kernel_constraint=maxnorm(3)))
model.add(Activation('relu'))
model.add(Dropout(0.2))
model.add(BatchNormalization())
model.add(Dense(128, kernel_constraint=maxnorm(3)))
model.add(Activation('relu'))
model.add(Dropout(0.2)) model.add(BatchNormalization())
model.add(Dense(class_num))
model.add(Activation('softmax'))
epochs = 25 optimizer = 'adam'
model.compile(loss='categorical_crossentropy', optimizer=optimizer, metrics=['accuracy'])
numpy.random.seed(seed) model.fit(m_train, n_train, validation_data=(m_test, n_test), epochs=epochs, batch_size=64)
scores = model.evaluate(m_test, n_test, verbose=0)
```
4. Conclusion
The poultry is most popular meat. It high protein content make it a healthy choice. The chicken is easy to farm and require minimum fund and equipment to start the business. Chicken also have the highest feeds to meat exchange rate among all meats. It maturate cycle is also short. To apply artificial intelligent technology such as “using convolution neural network for illness detection” will bring fascinating revolution to this industry. Convolution neural network already been proven, with continuing training of thousands of examples. It is possible to get an 98% accuracy on item detection. This means the application of convolutive neural network is not just theoretical. Moreover, with nonstop applying of the artificial intelligent system, it will grow smarter and smarter. By prediction, the application of AI for farming, especially meat farms, will be popular in the future. On the one hand, the application of artificial intelligent will reduce human force needed in farming cycle. Which reduce labour cost. On the other hand, artificial intelligent can be more efficient and fast to react on illness detection. Which minimize the loss of meat farming. This is only benefits from economy side, on the other side, applying of artificial intelligent can help improve situation of animal to human transmittable diseases. Such as H7N9 or mad cow diseases. Currently, the key problem is, the occurrence of illness for meats is exponentially increase with farm size. More detail, with consumers growing needs for high quality meats, the meats farm is definitely developing. Then the chance of human transmittable animal diseases spread among society is definitely increase too. The use of artificial intelligent can prevent this issue by fast and accurate labour free detection of diseases. Plus, cloud technology allow farmers to share their illness data bases. With larger data bases, the convolute neural network can work more efficient and accurate.

5. References
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