Artificial Intelligence based Fast Facial Recognition with High-Quality Small-Scale Data

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Abstract—**The bottleneck of the deeper applications of artificial intelligence is the lack of high-quality small-scale data. Using the integration of image processing and artificial intelligence technologies a system is developed to provide full automation based on the data supported by data provider. In order to implement an efficient objective recognition system, both hardware and software should be well considered and fully integrated. Various methods and tools of machine learning and artificial neural networks are explored to find out a workable and appropriate solution. This research is focused on building up a portable system to recognize face based off small scale but high quality data. Furthermore, a consensus-based one-stop application platform to help AI projects get training data fast and easily through smart contract and to generate wealth value for personal data through data mining is under construction.**

Keywords- Facial recognition; Image processing; Artificial intelligence methods; Automated system

I. INTRODUCTION

Vision is one of the most valuable functions for an intelligent system to sense the surroundings and interactive with other targets or persons in an effective and natural way. Image processing and machine vision as hot topics have been explored by many researchers and scholars around the world working in areas of computer science, automation engineering, biomedical engineering, mechanical engineering and electrical engineering [1-5]. With the newest development of artificial intelligence methods and their applications in science and technology, most of the decision making process and the interaction with the environment will be executed with no and very little human involvement. Furthermore, the continuous breakthrough of artificial intelligence methods makes potential capability to produce anthropomorphic results [6-8]. Actually, the definition of AI is changed with the development of AI. For example, 20 years ago, recognition of traffic plate and recognition of finger printing were treated as high-tech. But nowadays, they cannot even represent AI. Currently AI techniques focused on statistics and search, such as Monte Carlo Search Tree, or focused on connectionism, such as neural network. AI has strong computing power, deduction ability, searching ability, recognition power and predication ability. However, it lacks of characteristics of emotional and consciousness, which makes AI not as smart as cat or dog from people's perspective.

As a primary modular of artificial intelligence methods, artificial neural network (ANN) played an important role for non-linear modelling, process prediction, pattern classification and matching based on abstraction and simulation of human nervous system with weighted directed connection which represents the bio-physical connection of human's neurons [9-11]. The major role of neural network is to train and derive the complicated, nonlinear and dynamic mapping between input singles and output singles without an explicit mathematical discerption. This process could be treated as modelling a black box with collected sample data for training. Due to the powerful learning ability and rapid development of hardware, presently ANN as a method has been widely accepted for various real-life applications [12-14]. With the seamless integration between image processing and artificial intelligence methods, plus the high-quality small-scale data, the process of real-time classification and recognition will be more efficient and the results are expected to be more reliable and robust.

II. OBJECTIVE

Security is an important issue for home, office, factory, and public space. IF building up a small scale but high quality secure system, sub-objective should be carefully conceded. The scope of this research is to build an image processing based security system utilizing open source hardware and software. The purpose of open source is that the proposed project should be editable by third-party. The third party can be even someone who is not familiar with AI tools, but should be capable to apply it for specific situation to fit the detailed requirement. Because the system is built from scratch, so service and devices are needed to train and run some models, a raspberry pi 3.0 model B board is applied to train model and store data. Raspberry pi 3.0 model B as an effective tool for computing is equipped with a camera module to grab the data information for training and for the forthcoming real-time test as well.

Following figure shows the logic flow about how to prepare the relative data for training and testing purpose.

The model training is conducted in a looping. If the training is not sufficient, it will go back to the initial status to finish the re-training based on extra data which are provided by the supplier. Then, it goes through the logic flow again until the final condition is satisfied.

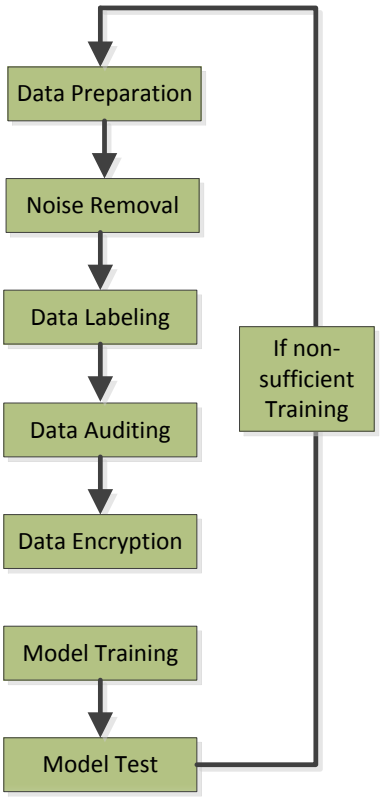

Figure 1. Logic flow

III. EXPERITMENTAL SETUP

The topology of the facial classification system can be easily configured based on the well setup and selection of machine learning and ANN models. In order to collect sufficient image of faces with high-quality and sustainability, the provided data is with different privacy levels. For example, data is encrypted, data is semi encrypted, and data is fully accessible. Besides, Use and Ownership must be predefined. Different models such as CNN, LSTM, Recurrent ANN, can be considered in this scenario.

All input components and output components of the proposed system are connected to the terminals available on the Raspberry Pi. The vision function will send images directly back to the Raspberry Pi. The HMI can be connected either to the HDMI terminal or USB port. 5 Volts at 2 Amps are provided as power standard. Remote access function is also available through the Ethernet port and Wipi module.

The neural network usually can work in several sequential layers including input layer, hidden layer, classification and output layer. Each layer should be well designed to capture relative information and deliver it to following layer. It is focused on various characteristics to train and test the program for successful determination at a high confidence level. Relative models are applied to train. To attain the desired accuracy a database of about 50 images are used. The artificial neural network is trained to improve the successful rate. The motion detection program was tested using the original setup. The size of the search window that defined the object in motion had to be adjusted to account for any issues.

A main program was built that integrated and utilized all modules of the program. The computing system for data training had minor issues running the more intensive neural networks, running out of memory if a classification could not be easily resolved. This problem occurred infrequently and did not have a large impact on the overall operation.

IV. TEST

The current setup of the device is meant purely for capturing data samples and performing analysis on them, as well as testing and comparing the effectiveness of several machine learning techniques. When the user starts up the device they are presented with four options. The first option is to allow the user to capture samples to expand the current database.

If all required samples have been acquired the user can then choose the second option, which is to process these new images. The image processing begins on new samples that have not been analyzed which are determined by referring to a document that saves the progress of the image processing event at each stage. A reference image will be shown to the user and then the user will provide the system with an id of the object. The program will then complete the extraction of 14 features of the object and save this data to a file that will be referenced during the training phase.

The objective classification system has the following functions:

1. Designed frame allows proper navigation to different models utilized.
2. Image capture, image processing, and testing can be considered as three sub-modules.
3. Find out a target
4. Analysis the target
5. Recognize that object.
6. Repost the discovery.

The proposed visual system can then notify the user of the progress of the system with a certain confidence level of the identification, such as the successful rate and failure rate.

Some constraints must be considered even if the system is built up based on an open architecture. The constraints help to limit the search scope of possible solutions.

In this proposed system, the following constraints will be well considered.

1. The entire system must be affordable with low cost
2. The entire system must be open source in format of open hardware and open software.
3. Hardware should be compatible interfaces with various attachments.
4. System must be robust enough.
5. System must be easy to use.
6. System must be easy to upgrade.
7. System must be easy to decompose.
8. System must be portable and wireless.
9. System must carry long battery life.
10. System must be easy to connect with other system to form more advanced function.
11. System must be easy to implement with limited time frame.
12. System must be reliable to deal with noise.

In addition to some existing algorithms such as EigenFace, FisherFace, LBPH and regular CNN, the applied co-evolutionary ANN is also considered to improve the overall quality.

For the applied co-evolutionary ANN, not only the structure of the ANN must be well evolved, but also the number of nodes and the weights are improved simultaneously to pursue the best result.

For the final implementation, totally around 100 images are used for training, and 20 images are collected for testing. Figures shown following are a training sample and a passing test example, respectively. In this scenario, the results of several training methods are compared as follows. The successful rate varies depends on the change of the environment, the quality of the image, and the number to images that are used for training, especially in a large scale data training scenarios. More compressive experiments will be considered to compare the performance of several representative methods.

EigenFace: 75%
FisherFace: 75%
LBPH: 80%
CNN: 90%
Co-evolutionary ANN: 95%

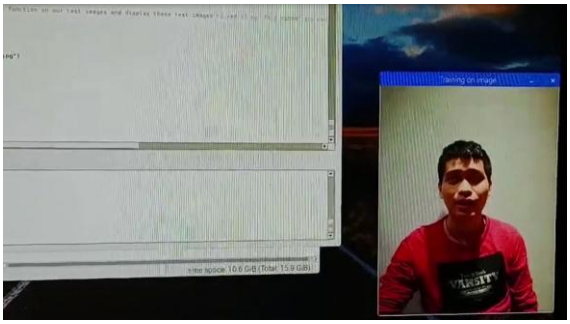

Figure 2. Traning sample (note: the portrait is only used for research purpose)

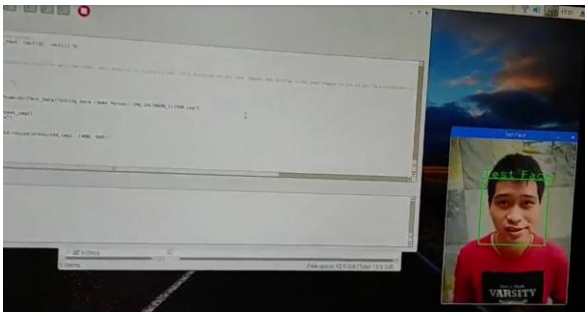

Figure 3. Testing Sample (note: the portrait is only used for research purpose)

V. CONCLUSIONS

Using the training data provided by end-user, it was able to successfully recognize the target with relative high accuracy. Further experiment will be considered to optimize the scale of data required to train the model. The compare the performance of each model, it is suggested that more implementations base off more persons to improve the robustness and applicability of the proposed system.

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