The TRIZ Analysis of controling autonomous intelligent car

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Abstract

Raspberry pie and tensorflow are used to realize the autonomous driving of the intelligent car on the track. The Raspberry pie is a small computer about the size of a credit card, which could be used as desktop computers to tackle daily missions, including word processing, spreadsheets production, media center or even running games. Based on DistBelief, Tensorflow is the second generation of artificial intelligence learning system, developed by Google, which can transmit complex data structure to artificial intelligence neural network for analysis and processing. TensorFlow is the calculation process of tensor flowing from one end of Flow Graph to the other end, whose name comes from its operating principle, specifically, Tensor means n-dimensional array, Flow indicate that the calculation is applying data Flow graph. TensorFlow can be used in many areas of machine learning and deep learning, such as voice recognition or image detection. It has made various improvements to the deep learning infrastructure DistBelief, which is developed in 2011. It can run on a variety of devices, e.g. a smartphone and a server with thousands of data center. TensorFlow will completely open source and be available to everyone. Therefore, training the intelligent car and achieving automatic driving can be used by using the raspberry pie and TensorFlow.

Keywords

TRIZ, Raspberry pie, intelligent car.

1. Analyzing the Raspberry PI Control Autonomous Driving Intelligent car

The basic principles of raspberry PI to control the self-driving intelligent car are that the combination of artificial operation and intelligent recognition, deep learning through the neural network model, and simple and separable material selection.

Colored tape was used to plan the runway, and the raspberry pie was used for manual operation, so that the car started running on the runway. Data is captured by the camera equipped on the car.

Cameras on the car will take pictures of the track path of the car, and produce about 50,000 photos. Then we select about 30,000 photos to be used in deep learning and memory analysing on PC in the later stage. Finally, we simulated the autonomous driving under the real road condition.

2. The Principle of the Self-Driving Intelligent car

Principle 1: Segmentation

The raspberry pie and cameras have various pin ports and screw ports, which are easy to assemble and disassemble, which reduce the coupling of independent parts of objects.

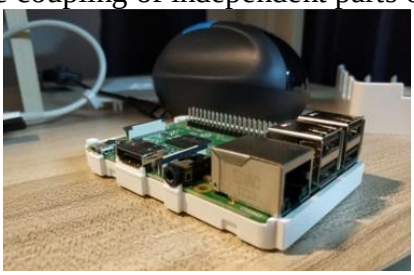

Fig. 1. The principle of Segmentation

Principle 3: Local Quality

The raspberry pie has a collection of various interfaces, which can be used easily to by multi-threaded programming.

Fig. 2 The principle of Local Quality

Principle 4: Unsymmetry

By using asymmetric design to increase the friction of the car on the ground, the car can drive freely on a variety of roads.

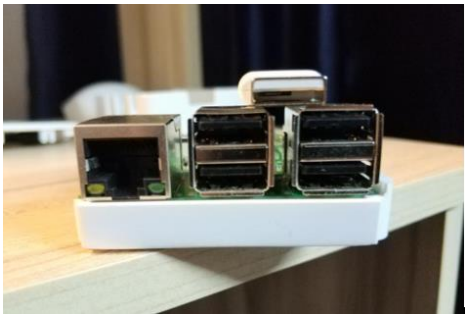

Fig. 3 The principle of Unsymmetry

Principle 5: Consolidation

The various interfaces on the raspberry PI and the connectors of various devices are coupled and correlated to realize data transmission.

Fig. 4 The principle of Consolidation

Fig. 5 The principle of Suit

Principle 7: Suit

The battery in the car is placed in the battery box, which is easier to maintain.

Principle 10: Pre-operational

The raspberry pie is pre-integrated with chips and interfaces on the circuit board, so it is easier for users to operate. Before the step of deep learning by using the neural network to achieve automatic driving, data collection is conducted on the road, and manual operation is also combined to pre-operate the car.

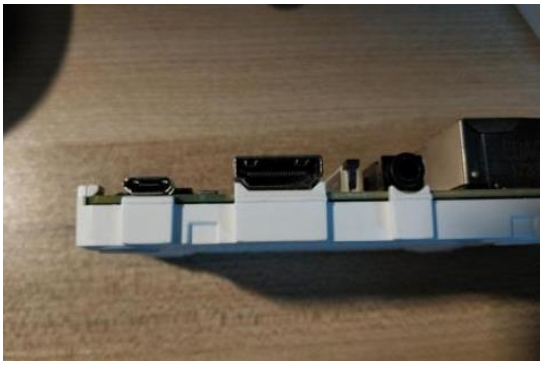

Fig. 6 The principle of Pre-operational

Principle 11: Precompensation

When the car's battery runs out, it can be powered up in real time by using pre-installed power interface of the raspberry PI's to connect to the lightweight charger.

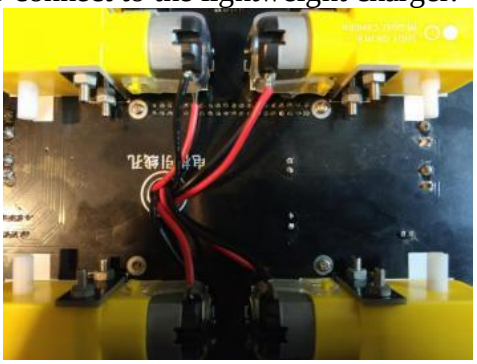

Fig. 7 The principle of Precompensation

Principle 14: Spherize

The internal gear structure of the car motor increases the driving capacity of rotation.

```
#define Trig  28
#define Echo  29
#define LEFT  11
#define RIGHT 10
#define BUFSIZE 512

#define MOTOR_GO_FORWARD   digitalWrite
#define MOTOR_GO_BACK    digitalWrite(4
#define MOTOR_GO_RIGHT     digitalWrite
#define MOTOR_GO_LEFT    digitalWrite(4
#define MOTOR_GO_STOP    digitalWrite(1
```

```
while(1)
 {
 //有信号为LOW  没有信号为HIGH
 SR = digitalRead(RIGHT);//
 SL = digitalRead(LEFT);//
 if (SL == LOW&&SR==LOW){
  printf("BACK");  //前面有物体时小车后退？？？ms 再转弯
  back();
  delay(300);
  //后退500ms
  left();//左转400ms
  delay(601);
```

Fig. 8 The principle of spherize

Principle 15: Dynamic

After compiling the program, the intelligent car can adjust its driving route to avoid collision by detecting the surroundings of the track.

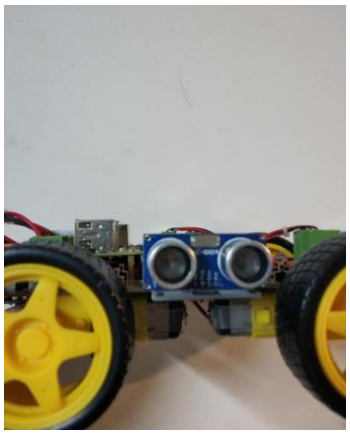

Fig. 9 The principle of dynamic

Principle 17: Dimension Change

The car is designed with multi-layer structure, the upper layer is the raspberry pie host, the middle layer is integrated circuit board, and the lower layer is motor.

```
# 设定速度，满电时速度太快，图像处理速度跟不上
# 直行快一点，转向慢一点
speed1 = 60             # 直行速度
speed2 = 50             # 拐弯速度
# 轮子定义
```

Fig. 10 The principle of dimension change

```
GPIO.setmode(GPIO.BOARD)                    # 设置模式
GPIO.setup(backMotorinput1,GPIO.OUT)        # 此端口为输出模式
GPIO.setup(backMotorinput2,GPIO.OUT)        # 此端口为输出模式
GPIO.setup(frontMotorinput1,GPIO.OUT)       # 此端口为输出模式
GPIO.setup(frontMotorinput2,GPIO.OUT)       # 此端口为输出模式
GPIO.setup(backMotorEn,GPIO.OUT)
GPIO.setup(frontMotorEn,GPIO.OUT)
```

Fig. 11 The principle of dimension change

```
def car_move_forward():
    GPIO.output(backMotorinput1,GPIO.HIGH)
    GPIO.output(backMotorinput2,GPIO.LOW)
    backMotorPwm.ChangeDutyCycle(speed1)
```

Fig. 12 The principle of dimension change

Principle 18: Vibration

The car can be programmed to control the running frequency of motor ,which is to change the speed of the car.

```
backMotorPwm = GPIO.PWM(backMotorEn,100)        # 配置PWM
backMotorPwm.start(0)                           # 开始输出PWM
# 当使能端口输入低电压时，电机驱动板将不对电机输出电流，电机将不工作。
# 当使能端口输入高电压时，让前轮转向电机正常工作。
```

Fig. 13 The principle of Vibration

Principle 19: Periodic Action

In the program, the pulse frequency and duty cycle can be pre-seted by adjusting the parameters of GPIO.PWM to control the voltage.

Fig. 14 The principle of Periodic Action

Principle 26: Copying

The car uses the infrared ray to detect obstacles while using the camera to collect data.

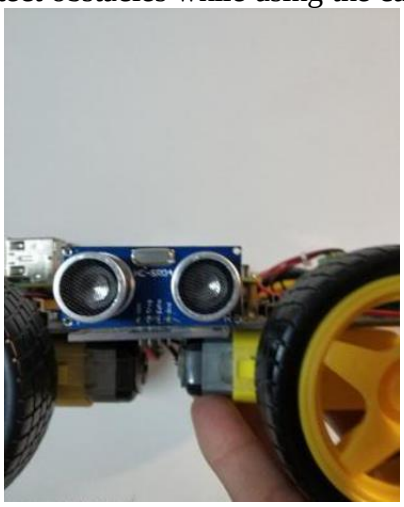

Fig. 15 The principle of Copying

Principle 28：Replacement of Mechanical System

The car uses ultrasound to detect roadblocks.

3. The Innovation of Self-Driving Intelligent Cars

3.1 Voice broadcast

Combining the voice recognition technology with the feedback principle, the voice of user is converted into text, which is fed back to the car and the direction of the car is controlled by identifying the key words of the text.

Based on voice recognition algorithm of hidden markov method (HMM), we modeled the statistical model to the time sequences of voice signal structure. The speech signal is an observable time-varying sequence, a stream of parameters of the phoneme emitted by the brain based on grammatical knowledge and verbal needs (unobservable states). HMM reasonably imitates this process and describes the overall non-stationarity and local stationarity of speech signals. It is an ideal speech model. By selecting the recognition unit, we classify Chinese into two categories: consonant, unit sound, complex vowel, and complex nose, while it is classified into initials and finals according to the syllable structure. According to the syllable structure, Chinese can be classified into initials and finals. Sometimes, the vowel containing the tone is called the mother. A single tuned or a syllable is formed by the initials and the syllables. A syllable of Chinese is the syllable of a Chinese word, that is, a syllable. Words are composed of syllable words, and finally words are composed of words and

the user's voice is converted into words, and the direction of the car is controlled by identifying the keywords.

3.2 Patrol system

According to the principle of emergency action and facial recognition principle, urgent actions such as alarm, ringing, etc. are taken for the entry of strangers.

Through Apple's patent faceprint (face imprint) in facial recognition technology, the theme and title of the unique photos are analyzed, and then the collected data is used to create a "faceprint". The created faceprint can be combined with others. The photos are matched to finally identify who the person on the photo is. A faceprint is a subsystem of a feature vector that recognizes an object, so faceprint can actually be used to identify non-face things, such as buildings.

To perform face recognition in selected digital photos, the face detection/recognition software generates a set of features or faceprint, which can describe the personalized details of the face in detail.

The resulting faceprint is then compared with other faceprints to determine whether these faceprints match or not(or similar enough). If the desired faceprint is found, the face detection/recognition software determines that the person in the current photo is the person whose faceprint information already exists in the data. During photo analysing, the management application compares faceprint with other faceprints that have been generated and stored on local or remote servers. If two pieces of data are found to match, the software labels the person. The reliability of faceprint matching mainly depends on the face recognition technology. In the matching process, there will be a corresponding score. If the score is lower than the critical value, it will be judged as a mismatch between the two. We patrol the designated path and inputed the facial photos of staff and employees. When other strangers enter, the camera will take pictures and recognize the photos. If the photos do not match the face in the faceprint library, the alarm will be given.

Fig. 16 facial recognition

3.3 Risk early warning

According to the principle of versatility in the principle of deep learning and innovation, the use of the camera is diversified, which can not only be applied to the patrol system, but also be used to identify dangerous situations and objects and carry out early warning.

Through the deep learning of neural network, reasoning is carried out according to logical rules. First, it informatization into concepts and symbols, and then logical reasoning is carried out in serial mode according to symbolic operation. The process can be written as a series of instructions that a computer performs to identify and warn of dangerous objects or situations such as controlled knives or fires.

4. The Improvement of Self-driving Intelligent Car

The trolley line, camera, circuit boards and other components are exposed, which takes certain risks, and the appearance of the car is not beautiful. It can be improved by using the principle of segmentation: decomposing a system or object into independent subsystems or sub-portions, ie adding a separate hood model can be mounted on the trolley or removed and separated. The hood not only protects the internal structure, but also enhances the aesthetics, making a system and objects easy to assemble and disassemble. This increases the degree to which the objects are independent of each other, and even if the damage is lost, the risk of overall damage is greatly reduced.

The connection between the camera and the trolley is too long, so that it is too long to cause the car to ruin the camera in some geographical environments, which should be improved. The improved method relies on the principle that the principle of separation is the first method of separating the principle: the "interference" part of an object is separated, that is, the components connecting the camera and the car are removed, and the camera is embedded in the front of the car.

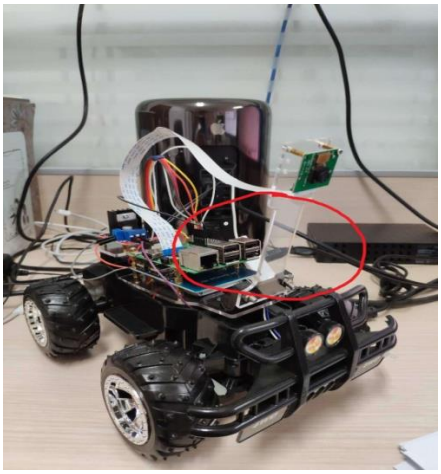

Fig. 17 camera

Below the chassis is the installation of four small motors to drive the four wheels, which takes certain risks. In the geographical environment with water stains, it is easy to cause a short circuit, thus damaging the circuit board and making the car scrapped. So using the principle of suits can improve the situation, that is, put an object or system in another object or system: when making the chassis, add an inner groove that accommodates four motors to the chassis, and wrap the small motor among them, this problem can be solved.

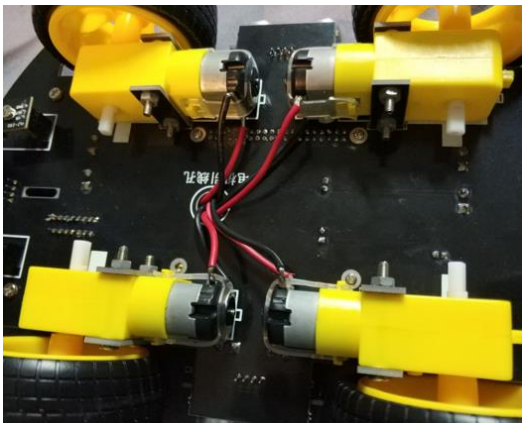

Fig. 18 motors

The chassis of the car is flat and the climbing ability is not strong. To improve the situation, you can use the principle of dimensional change to adjust the object or system to tilt or change direction: let the front section of the chassis lift slightly, so that the car can be graded on the slope. In the larger case, the downstream blade is more than enough, and the friction chassis will not occur when climbing the slope.

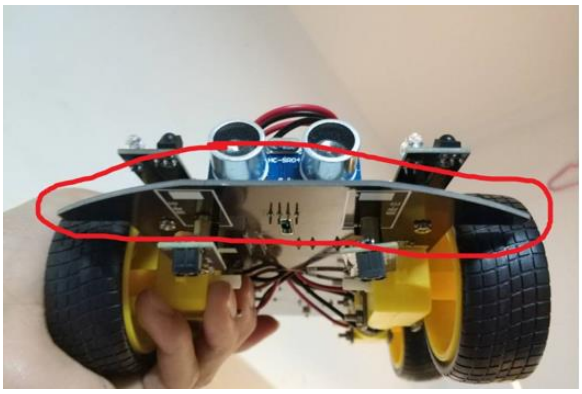

Fig. 19 chassis

5. Summary

The Raspberry Pi smart car is a multi-functional car made by using Raspberry Pi, integrated circuit, artificial neural network and deep learning. It still has a very broad development space to improve. We have carried out innovative invention analysing based on TRIZ, and here based on innovative ideas.

References

[1]Xujia Cai,Haigang Liu,Guancheng Chen,Yongxiang Li,Yue Zhuang. Camera intelligent car design and control algorithm research [J]. Industrial control computer,2018,31(12):98-101.

[2]Aikun Xu,Yilin Kang,Zichao Ji,Lv Duan,Ke Liu. Design of two-wheel tracking balance vehicle based on raspberry PI camera [J]. Single chip microcomputer and embedded system application,2018,18(12):74-77.

[3]Shaozhi Liang. Simple intelligent car design and production [J]. Electronic test,2018(21):46-47.