Abstract—Simulation based training system can play an important role in education. It provides fruitful configurations with low cost of maintenance and further development compared to the training and education in real world. There are many different systems based on simulation provided in past decades for different using environments. The existing work shows that simulation training system can provide prominent teaching experience and good teaching effect. In this paper, we present a special integrated simulation training system, which is called ISTS, for education in our police college. ISTS provides the virtual training through different configurations of the environment parameters according to the training requirements. At the same time, the training in real world can be combined with ISTS. The combination of the real experience and virtual training experience will improve better training effect. The investigation among the teachers and the students shows that ISTS can achieve its design target and provide significant improvement.

Keywords—simulation; training system; education; police college

I. INTRODUCTION

With the rapid advance in computer technology, the performance of the processors is increased in very fast speed in the past decade. Chip MultiProcessor (CMP) [1] and related technology makes the computers more powerful than before. Computer technology has also been used in education. Different tools are developed based on computer technology to provide convenient teaching environments with high efficiency and improve the teaching effect [2].

Simulation training system has been developed and used in education or the other fields for many years [3]. More designs and implementations are presented in recent years based on the computer technology. Engwall et al [4] presented their experience in how to develop a pronunciation training system based on computer assistance. They provided the feedback system between the training system and the users. Huang et al [5] focused on the interoperability issues in real-time war game system. They designed an analytical system for this war game system. And the experiments showed the feasibility of such analytical system. Lopez-Garate et al [6] proposed an intelligent feedback selection system, which was used in virtual reality based training simulators. The real-time feedback system presented in this work was designed to the training system to advise the students. There are also many other proposals and researches on simulation training system [7, 8]. The simulation can be used more widely in education and training in the future [9].

As the previous work has proved, simulation training system can play an important role in education and training. As a special profession, policemen have to deal with the different scenarios in real world. The professional skills are very important to them especially when they may face to the perils. However, the configuration of the real world for skill training is very expensive and there are also many dangers in such training system. Thus simulation training system can provide effective and safe training environment to policemen. [10] described their training methods on how to tackle the persons with mental illness. [11] presented a tutorial system for urban environments called ExpertCop. It could provide flexible configuration for the environments to the training. [12] analyzed the necessity of a commando training system and depicted the system which employed a wireless sensor network technology. [13, 14, 15] were also the discussions which focused on the simulation training system for policemen.

The existing proposals have provided effective solutions for simulation training system for police. Most of them focus on the training of single-skill specific skills. In this paper, we describe our simulation training system for police college, which arms to train the students in the college. This system is called ISTS (Integrated Simulation Training System). ISTS provides fruitful training service to the students. And the skills will not be separate and some of them will be combined to provide the integrated training in more complex environments. Different configurations can be selected according to the training requirements. The students can master the skills from easy to difficult and from simple to complex. Our investigation shows that ISTS can meet the needs of training in our college police.

This paper is organized as follows. Section 2 describes related work on simulation training system. Section 3 depicts the architecture of our simulation training system for our police college. The implementation of this platform is presented in Section 4. Section 5 provides the results and related analysis of the investigation on ISTS. In Section 6, we offer the conclusion and future work.

II. RELATED WORK

How to train the professional skills of the policemen is always an important topic. After simulation training system
was proposed as the optional approach, there are many such training systems and platforms presented. They are good references for the new designs and implementations.

ExperCop, which was a geosimulator, was designed for the criminal scenarios in urban environments [11]. The main target of ExperCop was to train police officers on how to allocate the police force better in complex situations. The learners could improve their capability of police force allocation through the feedback of ExperCop. [12] designed a automated commando training system. This system employed a wireless sensor network (WSN) as the basic infrastructure and RFID technology was also used along with the WSN. Such system could improve the efficiency of the commando system through the training.

[15] focused on a special training topic, which armed at how to train the skill of fire fighting. The users would fight with the virtual fire scenarios which were created through virtual reality technology. This system used an open source game and simulation engine as the core of the simulated environments. A simulation training system on this topic could be safe to train the skills. [16] discussed on the simulation training for crime risk assessment and presented Riskman, which was a simulation training architecture. The users of Riskman were trained to master the capability of how to deal with the high risk situations. A game engine was also adopted in this system, which was written in scripting language. It consisted of several components to provide different functions for the simulation.

As the existing work shows, computer-assisted simulation training system can improve the training effect in police training. According to these design references and the requirements from our police college, we also design a simulation training system for the students. Such a system is called ISTS (Integrated Simulation Training System). ISTS takes the advantages of simulation training system as well as takes the requirements of the students into account. The students in the college have the requirements of skill training. However, the training system in real world is too expensive and it is unsafe for these novices. ISTS can provide safe training platform and the students can master the skills easier as well. In this paper, we will describe ISTS in detail.

III. SYSTEM ARCHITECTURE

A. Design Principles

Policemen will face different situations in their tasks and they may be in a very dangerous situation. This requires the police proficiency in their professional skills. For a student in police college, he is a potential policeman and he should learn the basic knowledge for his vocation and master the necessary skills. ISTS is provided for the training of the students. In our design, the students should be trained step by step. Thus we first set three principles for the design and implementation as the follows.

**Principle 1: Step-by-Step Principle.** There are many different skills for a policeman to master. Some of them are basic skills and easy to master; whereas some may be advanced ones and difficult to master. At the same time, advanced skills may learn based on the master of the basic skills. The students should learn these skills one by one and progressively. ISTS should have the capacity to provide hierarchical configurations to meet the requirements of the students in different levels.

**Principle 2: Integration Principle.** In real world, the different skills may be used in mixed mode. It means that in most situations, a single skill may not meet the need and the students should learn how to use his skills jointly. ISTS should provide the different settings of the environments to the students. Thus they can have the practice of different skills from single one to combined ones. Moreover, the training in ISTS can be integrated with the training in real world.

**Principle 3: Scalability Principle.** We try to provide sufficient services to the students in ISTS. However, with the progress of the skills, some skills may be improved and some new skills may emerge for the new situations in real world. That is to say, there will be some changes from the training requirements in the future. Thus ISTS should be scalable for such changes. Suitable scalable interfaces are necessary in ISTS.

The first two principles are used in the design from the perspective of training. The third principle, Principle 3, is proposed for the new emerging requirements of skill training. ISTS must abide by the Principle 3. Our design will conform to the three principles.

B. Training Contents

The design of ISTS is based on the training analysis of our college. We have summarized the experience in teaching. And we have also constructed some computer-assisted systems for our training. They also provide the design experience to us. According to the analysis of different aspects, the training contents in ISTS are designed first as shown in Fig. 1.

The training contents can be divided into two parts: basic skill training and advanced skill training. Basic skill training consists of laws and regulations, search training, battle training and shooting training. The students will learn the basic laws and regulations related to their future work first as the basis. And then, the students will learn the skills of shooting, battle and search. However, in basic skill training, the students will be trained for one skill after another. The training of different skills will be separate. These skills will be used in advanced skill training. If the students can not master these skills, they can not begin the advanced skill training.

![Figure 1. Training contents in ISTS](image-url)
Advanced skill training consists of two different types: the simple scenario and the complex scenario. Before the students enter this training, they must have a good grasp of the basic skills in advance. Simple scenario is provided for the students who complete the basic skill training and but have no experience in simulation scenario. They have to use more than one skill in the training. The difference between the simple scenario and the complex scenario is that complex scenario will provide more complex configurations of the environments or the other factors. For instance, the students may face to some criminals in a simple environment as simple scenario training. But in complex scenario training, hostages may be the shield of the criminals. The students have dealt the scenarios with different difficulties.

Obviously, the training contents can also be divided into three levels according to the difficulties in training. The basic skill training is the level 1 for the skills in this level are all basic skills. Simple scenario training is the level 2. In this level, some factors will added into the configurations of ISTS. The students have to think how to complete their training based on the basic skills. The simple scenario training will provide the students some experience in dealing with the cases. The complex scenario training is the level 3, which is the most difficult. The scenarios provided by ISTS are same to the ones in real world. The students have to deal with the complex environments like the real police.

The students will receive the hierarchical training gradually. After the step by step training, they will master the basic skills first and then learn how to deal with more complex situations.

C. ISTS Architecture

Based on the training contents and analysis requirements, we design the ISTS architecture as shown in Fig. 2. ISTS architecture has four subsystems including Hardware System, HCI (Human-Computer Interaction) System, Scenario Engine and Analysis System.

![Figure 2](image.png)

The four subsystems of ISTS provide different services for the training. Hardware system is the basic support in the hardware level. ISTS needs to create scenarios in real-time and the users need real-time responses from ISTS as well. And the different parts of ISTS may distribute in different physical places. Thus ISTS should have powerful hardware system. Scenario engine is responsible for the operations including the configuration, creation, deletion and recording etc of the different training scenarios for the training of all the skills. As we can see from Fig. 2, the training contents can not be represented in scenario engine directly. When the students start their training, the scenarios with different difficulties will be created according to their training levels. HCI system is provided to the users for the interaction between the users and ISTS. ISTS provides different training to the students and thus it also provides different user interfaces to the students as well. Analysis system is used to analyze the training statuses of the students. The training data will be collected during the training. After the training, the data can be used for analysis and it is helpful to improve the future training.

Fig. 2 also represents a hidden part which traverses all the subsystems of ISTS. This part is called the scalable interface as shown in the dashed box in Fig. 2. These interfaces will be used for the future expansion. It is designed according to our Principle 3.

IV. IMPLEMENTATION

In this section, we will depict the implementation of ISTS according to the design of ISTS architecture. We will present the four subsystems respectively.

A. Hardware System

Hardware System has three components including the computer network, the servers the clients. The computer network used by ISTS is the network of our college. This network is LAN (Local Area Network) and it can also connect to Internet. As an extension, wireless network is also employed as a supplement for the original LAN.

In this structure, we provide three server types: Database Server, Training Server and Backup Server. Database Server is used to store the necessary data of ISTS such as the configuration parameters of the environments, the information of the teachers and the students and the training replays. Training Server is used for the training. The scenarios will be created and maintained in this type of server. Thus Training Server must have high performance for these scenarios. Backup Server is used as the backup storage of the important data of ISTS.

The users can use different types of clients to enter ISTS for training. Multi-users are supported by ISTS. We have constructed special training center for the training in ISTS. The students can have training in this center with the guidance from the teachers. Such training is carried out in class. The students may also have their own computers and they can use ISTS through the network anywhere.

Mobile devices are also taken into account at first. However, such devices only have very limited resources and they can not provide enough computation for ISTS especially the scenario training. Now, mobile devices can be used in some simple functions of ISTS such as the learning of laws and regulations, and the information query through ISTS.

B. HCI System

ISTS is a platform which will provide training service to the students. What is the most important is the user experience in ISTS. The teachers and the students will use ISTS. And ISTS should provide suitable to all the users.
HCI System is the interface between the users and ISTS. The users will act as virtual persons in ISTS for the training. The design of HCI System has great impact on the training effect.

According to our experience and the feedback from the teachers and the students, different types of UIs (User Interfaces) are provided to the teachers and the students according to the training types in this system. The types of UIs and the mapping from UIs to the subsystems of ISTS are both shown in Fig. 3.

The users will log in ISTS through the standard UI and they can use the analysis system to query their training statuses and analyze their training data. The users can also switch to scenario UI through standard UI. They can use scenario engine for the training. The configuration can be set through configuration UI and the users can have training after scenario engine creates the corresponding scenarios.

In fact, the students with different training levels will have different scenario UI. If a student just begins his training, he can only configure the environments of basic skill training. He must master these basic skills first. The teachers will judge whether he has passed the basic training through the analysis system. If he passes, the teachers will update this student’s level to a higher one. And then this student can have simple scenario training. If and only if this student passes his training of simple scenario training, his level will be upgraded again and he can have complex scenario training. So though ISTS can provide a training platform, the teachers will still play a major role in the level changes.

Our design is based on the available devices. When the teachers and the students have training in ISTS, they use the traditional human-computer devices and some special devices for the training. Though the students have to be trained step by step, the students can have enough experience through the responses from ISTS. Such experience will help them to master the skills efficiency.

C. Scenario Engine

Scenario Engine is the most important subsystem of ISTS. In this subsystem, ISTS creates different scenarios for the users. The structure of this engine is shown in Fig. 4 (a).

There are four parts of Scenario Engine: Scenario Configuration, Scenario Generation, Scenario Training and Training Recording. Scenario Configuration is provided to the users. They can provide their own scenarios for the training through Scenario Configuration. As mentioned above, the scenarios can not be configured and the levels of the users will restrain the scenario configuration. In our design, the teachers have the highest level (Level 3) and they can configure the complex scenarios.

Scenario Generation is used to generate the scenarios according to the parameters from Scenario Configuration. Some fixed scenarios are provided in ISTS for both basic skill training and advanced skill training. The skills in basic skill training are basic ones and the scenarios will be used frequently. Some simple scenarios and complex scenarios are typical ones and will also be used for many times. All of such scenarios will be marked as typical scenarios and they are easy to provide for the pre-generation. And the components of the scenarios will also be provided for fast generation.

The students will have training through Scenario Training. The scenario will be maintained in this part during the training. When the training is over, Scenario Training will destroy this scenario. During the training, Training Recording will collect and record the training data. Such data will be stored in Database Server and provided to the teachers and the students for the analysis.

Fig. 4 shows the whole work flow of Scenario Engine. First, the users login ISTS and then configure the parameters of the training through Scenario Configuration. Then Scenario Generation will generate the corresponding scenarios according to these parameters. After the scenarios are generated, the users can have training under such environments. During the training, Training Recording will record the training data. And at last, after the training, Scenario Training will destroy the scenarios.

D. Analysis System

Analysis System is very important for the users. Though the students can have some experience through the training in ISTS, the shortcomings of their actions in the training should be found out as well. Analysis System will provide the corresponding data for the analysis of the training.

Each student can query his information through Analysis System. Analysis System will provide the training data in detail. And the training records are also provided to the users. The students can improve their training through the analysis based on the training data and the training records. The
teachers can help the students for the improvements through Analysis System too.

The following is a case study for the analysis of a student who has completed shooting training. This student first logsins ISTS, and then completes the shooting training. The training can be carried out in class or out of class. When he completes the training in class, the teacher can provide necessary assistance in the analysis. The mistakes he has made during the training can be found out by the teacher and himself. This student can improve his shooting skill in the future training. When the student has the training out of class, Analysis System will tell him the statistics of his shooting training. He can analyze the data and records by himself. Though there may be some difficulties for him to analyze, he will think why there are some mistakes and can obtain from the teachers with these problems.

Analysis System must obtain the data from the other subsystem of ISTS. The relationship between the Analysis System and the other subsystems of ISTS is shown in Fig. 6.

![Figure 5. Relationship between the analysis system and the other subsystems of ISTS](image)

As shown in Fig. 5, Scenario Engine will store the data to Database Server of Hardware System. Scenario Engine will also obtain data from Database Server for the scenarios. Database Server will provide the basic data to Analysis System. And some analysis results will be stored back to Database Server. The users can query the information in analysis system through HCI System. Obviously, Scenario Engine is the key source of the data.

V. FEEDBACK AND ANALYSIS

What we focus on is the feedbacks from the users including the teachers and the students. The investigation has been done among the users to help us to improve ISTS. The questions in the investigation are listed in Table 1. A total of 83 persons have participated in the investigation including 79 students in three classes and four teachers. They will give scores to the different questions (from 0 to 100) and can write down the suggestions as well.

The score distribution is shown in Fig. 6. The users have endorsed ISTS as the training platform. Few users give failed scores in the investigation. Q4 is the worst case in all the questions. This question represents the speed of scenario generation. Obviously, the scenario generation is the weakness of ISTS. According to our analysis, there are two reasons. One is that the scenario generation is too complex and should be improved. And the other one is that we may need to improve the performance of our network or the servers.

![Figure 6. Score distribution](image)

![Figure 7. Satisfaction investigation](image)

TABLE I. INVESTIGATION ASPECTS

<table>
<thead>
<tr>
<th>No.</th>
<th>Aspect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>Operability of HCI System</td>
</tr>
<tr>
<td>Q2</td>
<td>Response time of ISTS (HCI System)</td>
</tr>
<tr>
<td>Q3</td>
<td>Response time of ISTS (Scenario Configuration)</td>
</tr>
<tr>
<td>Q4</td>
<td>Response time of ISTS (Scenario Generation)</td>
</tr>
<tr>
<td>Q5</td>
<td>Suitability of the scenarios</td>
</tr>
<tr>
<td>Q6</td>
<td>Improvements from Analysis System</td>
</tr>
</tbody>
</table>

Fig. 7 shows the result of satisfaction investigation. Most of the users are satisfied with ISTS. It is consistent with the results of the investigation on the questions in Table 1. Fig. 9 shows the using frequency of ISTS among the users. The result shows that most users will use ISTS frequent. And the two curves in Fig. 8 and Fig. 9 are similar for most users are satisfied with ISTS and they will use ISTS for the training.

The users have already provided some suggestions to ISTS. The main suggestions focus on three topics including: 1) the speed of scenario generation should be enhanced; 2) communication system should be improved; and 3) More training levels should be provided. The first topic can also be represented in Fig. 8. The second topic is surprising for we have never think communication system will be the problem of ISTS. Many users including the teachers say that communication system provided by ISTS can not work as
the one in real world. Some background noise should be added to the system and the voice should be able to response to the adjustment as soon as possible. We have taken this suggestion into account in the future improvement. The last topic is proposed by the students. They want to have some experience in high-level training without the corresponding level indeed as the tutorial. In our solution, we will provide some typical scenarios as the trial for the students in the future.

**VI. CONCLUSION AND FUTURE WORK**

The students in our police college should master many skills for their vocations. Simulation training system can provide a suitable platform as demonstrated by the previous work. In this paper, we present ISTS, which is an integrated simulation training system, for the students. ISTS has four subsystems, which can provide different functions for the training. The training are divided into basic skill training and advanced skill training. ISTS can control the training process according to the training levels of the students. Thus the students can master the skills step by step. And the scenarios provided by ISTS are similar to the situations in real world. Such scenario training will provide them the experience in different situations. According to our investigation, most users are satisfied with ISTS as their training platform.

However, there is a lot of work to do in the future. As the investigation shows, we have some problems. First, we must speed up the scenario generation to reduce the waiting time. Second, we will re-design the communication system. The background noise and some other factors will be added to it. And we will try our best to find out the potential defects. The new investigations are necessary after the improvements to obtain sufficient feedbacks from the users for the further optimizations.

**REFERENCES**


