UNIVERSAL INFANTRY WEAPONS TRAINER

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The Universal Infantry Weapons Trainer (UIWT) provides a modern approach to training U.S. Marine Corps infantrymen, under simulated battlefield stress conditions.

UIWT is a portable indoor trainer that can be located at the required training site, to minimize training time lost to travel. Training can also be conducted in adverse weather conditions, and at any hour of the day. Realistic simulation of battlefield targets are provided by motion picture film. Weapon recoil and blast noise are also simuated. Immediate feedback on trainee proficiency is available, as well as a permanent record of score.

The system utilizes frame-locked motion picture projectors. One projects the visual battlefield scene and another an invisible target which is animated to correspond with the correct aiming point for the target's motion and speed. An infrared receiver is located on the weapon to be simulated. The infrared detector has four quadrants. The data from the four quadrants are processed by a read-only memory (ROM) circuit to determine the trainee's proficiency which is fed back immediately to the training station. This system provides score information in the form of hit, or nine areas of near miss.

Figure 1 is a system block diagram for the UIWT training. The simulator has two projectors and is connected by a selsyn circuit for coordinating the film frame drive. The two projectors provide coordinated projections of a background scene and an invisible infrared aiming spot.

The necessary lead of the infrared aiming spot, for proper aim to hit the target is hand animated on the infrared target spot film.

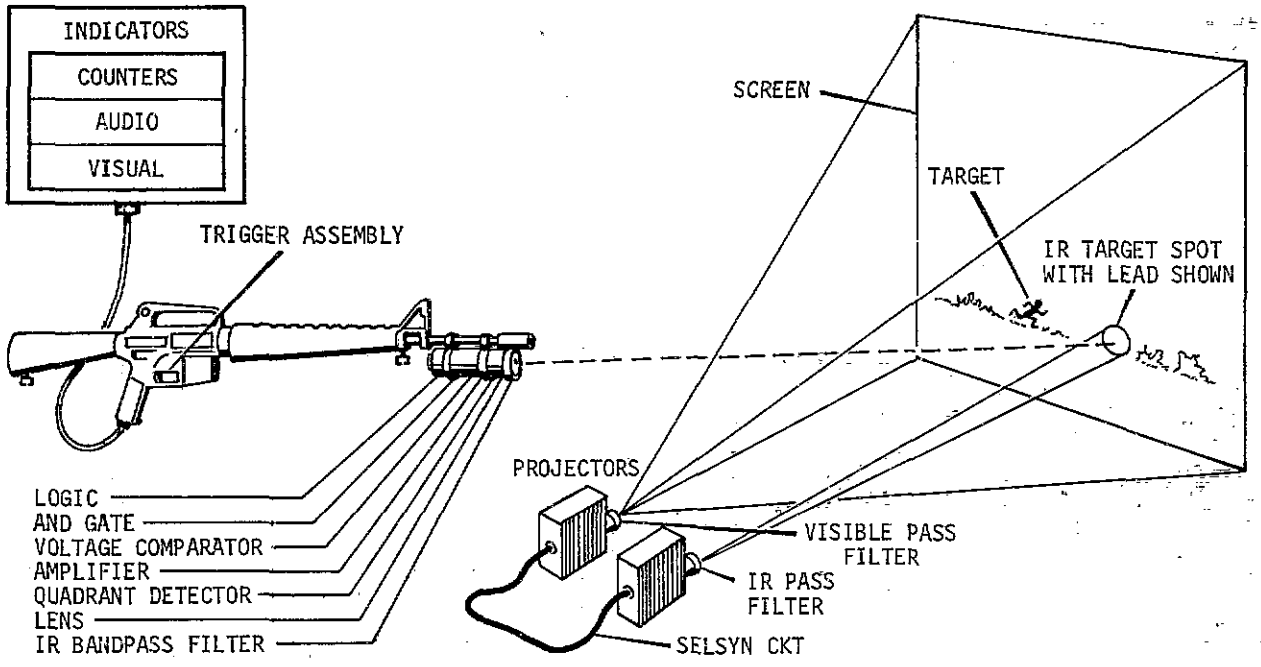

Figure 1. SYSTEM BLOCK DIAGRAM

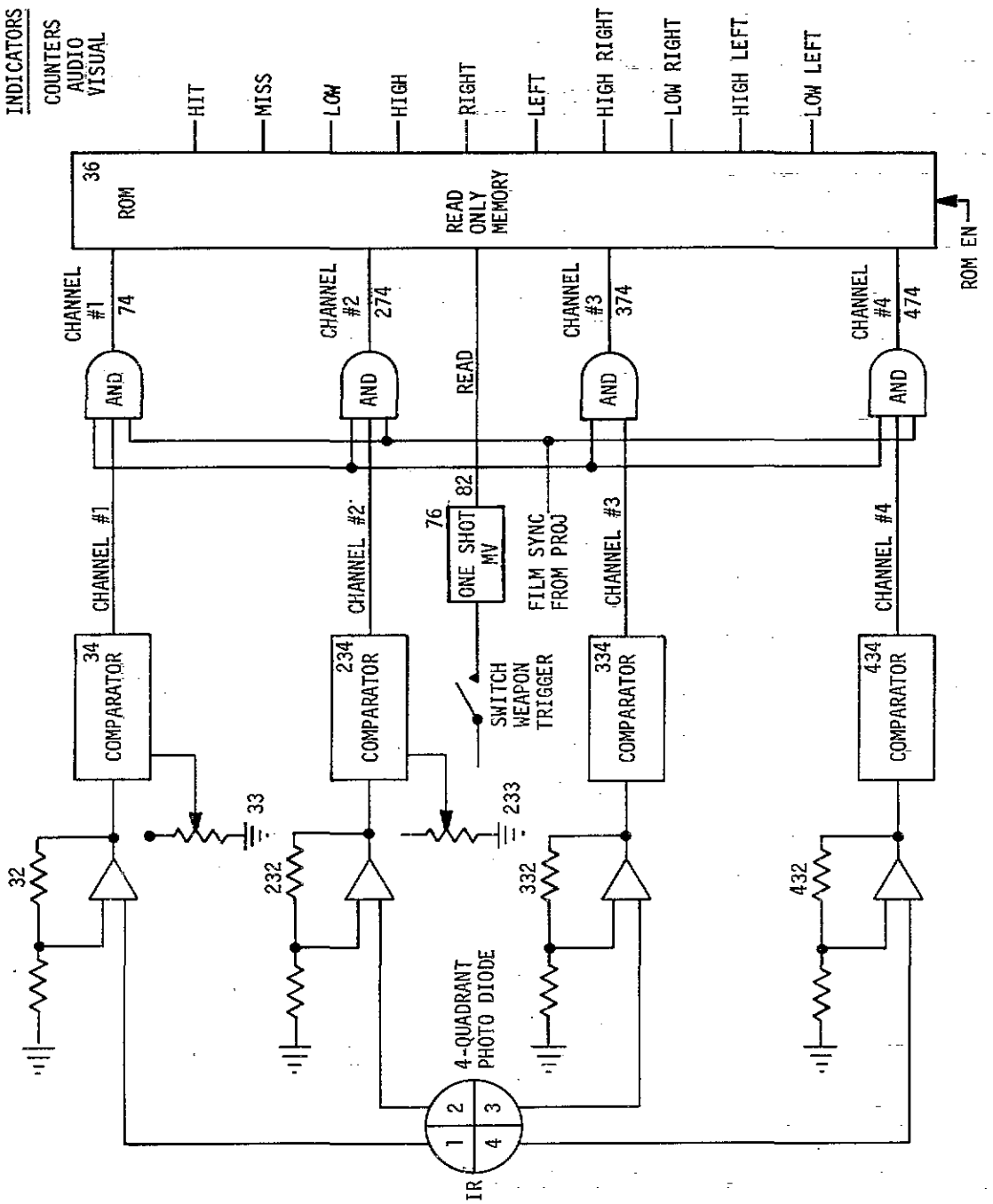

Figure 2. Electronic System

The trainee is able to see the background scene, including the moving man, but is not able to see the infrared spot representing the aiming point for proper lead in training with the weapon. Attached to the barrel of the weapon is an infrared receiver. The receiver circuit includes a four quadrant detector, amplifiers, voltage comparators, and logic system. The indicators comprise a counter, an audio system, and a visual display system. A focusing lens and a bandpass filter are provided to collect and pass the infrared aiming spot to the quadrant detector.

Figure 2 illustrates details of the electrical circuit. It shows a four quadrant detector having four associated receiving channels. Channels 1, 2, 3, and 4 are connected through a common logic to the separate scoring indicators comprising lights (visual), tape recorder (audio), and counters (recording). The individual quadrant sensors 1, 2, 3, and 4 of the quadrant detector are connected through the respective channels to the ROM logic system. The ROM is programmed to energize one of ten different outputs in accordance with the input signals received from channels 1 through 4. The AND gate provides an output to the ROM logic only when three input signals are received. One of the remaining two signals is obtained from a one shot multivibrator upon squeezing, and thus closing the weapon trigger switch. The other input required to the AND gate is a synchronization signal obtained via the film in the projector such that the AND gate will be activated only when the film frame movement is in a stopped condition to avoid error otherwise introduced.

The remaining channels 2, 3, and 4 comprise identical elements, arranged in the same manner as channel 1 except that they are connected respectively to quadrant sensors 2, 3, and 4 as indicated.

Considering the operation of the channels and taking channel 1 for first discussion, when the incoming infrared beam does not hit quadrant sensor 1, there is no output and the output from the amplifier is substantially zero. The output from the comparator is thus zero and the output from the AND gate is also zero. This zero voltage corresponds to a digital zero input to the ROM. In the same manner, a miss of quadrant sensors 2, 3, and 4 by the beam causes a digital zero input into the ROM via the channel 2, 3, and 4 inputs. The resultant digital input, 0000, addresses the ROM to provide an output on the MISS lines to indicate a miss on each of the indicators.

When all quadrant sensors are hit, all four comparators put out a digital one level voltage and a digital one input is passed via the AND gates as inputs to the ROM. Such an input of digital 1111 addresses the ROM to provide an output on the HIT lines which energize the hit portions of indicators. When one or more but not all of the quadrant sensors are hit, various digital inputs are developed to address the ROM and the ROM is programmed to energize the various output lines indicated in accordance to the received input digital number.

Programming of the ROM is:

Quadrant Sensors Hit	ROM Digital Input	ROM Output Lines Energized
0000	0000	MISS
1234	1111	HIT
0034	0011	LOW
1200	1100	HIGH
0230	0110	RIGHT
1004	1001	LEFT
0200	0100	HIGH RIGHT
0030	0010	LOW RIGHT
1000	1000	HIGH LEFT
0004	0001	LOW LEFT

The above provides a total of ten hit and miss output signals representing locations which can be applied to visual, audio, and recording indicators.

The visual indicator comprises an arrangement of lights easily read in relation to the ten outputs provided by the ROM. Thus, under the condition of a complete miss, all of the perimeter lights are energized when a miss is recorded. The hit output is connected to a light at the center of the lights arrangement indicating a direct hit on all four quadrants. Similarly, the low, right, left, etc. lights are energized.

In the audio indicator a tape recorder is provided which has ten individual tapes which may be energized. Each tape repeats a word or sequence of words representative of the score such as hit, miss, low, right, etc.

Advantage of the recording indicator is that it provides a record for later review of

each student's score, the accumulative score of a group, and any specific fault which appears to be repeated and requires efforts to correct in training.

An advantage of the audio indicator is the assistance given the trainee to tell him what he is doing wrong while he is still firing, and without the need to take his eyes off the target.

The indicator system provides an advantage in giving an immediate feedback of the score to the instructor, audio as well as visual, shot by shot, such that the instructor can also watch the trainee to see what is causing error and thus be in a position to give immediate corrective instruction.

Recoil is simulated by electrically operated solenoids in the butt of the rifle. A rifle bang is also simulated by a tape recorder.

The visual display for the system uses two high brightness 16mm projectors which are frame locked. A cinerama configuration can be used, where the pictures are taken with two cameras simultaneously and side by side, and projected in the same configuration. A third projector displays the animated target using anamorphic optics to cover both visual displays. The visual display is filtered to remove wavelengths above 0.7 microns, while the infrared target display is filtered to remove all visible wavelengths.

Except for the addition of filters to the projectors and a bar to hold the original photography cameras in their side by side cinerama relationship, all equipment and processes used are standard and commercially available. This is especially true of the cine processes, including the target animation process, which is available from many animation laboratories.

In our 60° wide test display we have used the cinerama configuration because of its relatively high visual quality. However, depending on how many people are to be trained at one time, the visual quality desired and other factors relating to the user requirements, a variety of possibilities exist including relatively inexpensive displays up to 180° wide.

The system has been successfully breadboarded.

ABOUT THE AUTHORS

MR. ALBERT H. MARSHALL is a Physicist in the Physical Sciences Laboratory at the Naval Training Equipment Center. He holds Masters degrees in both Physics and Electrical Engineering. He is working on the applications of semiconductor lasers to training devices and has invented a number of weapon fire simulation systems.

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