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Tactical Simulation Model at Battilion Level

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***Abstract*— Training in defence and law enforcement agencies is of paramount importance. Need to have near realistic training on maps and equipment with functionality akin to as obtaining in actuals is need of the hour for soldiers and other law enforcement agencies. An appropriate simulation model for training the commanders and operators, integrated seamlessly with maps, weapons and equipment will go a long way in resolving the training requirement of forces. Paper discusses development of tactical solution by integrating constructive and virtual simulation for painting an integrated synthetic environment for trainees. Infusion of AI for generation of additional soldiers and troops and equipment is also discussed.**

I. INTRODUCTION

In the context of the Armies world across, there are simulation systems those are available for training at the various levels like Division and Corps. These are purely constructive simulation models which train the commanders and staff officers in battle planning and execution but do not have any training value for the lower commanders and the troops. They are basically played on the computer terminals with maps displayed on them. There is a Control, Red and Blue land set ups as is required for any constructive simulation system.

At the lower end there are virtual simulators like the firing simulators and other weapon simulators. These are being developed by different organizations and the primary aim is to hone the skills of the soldiers in handling various types of weapons and equipment. It does not have any feature of combined training so that a tactical level of exercise could be conducted. This is true for the Indian Security Forces also.

The proposed model is combination of constructive simulation and virtual reality system with virtual simulation expanding into extended reality domain. Simulation is proposed to be pitched at battalion level with the provision of expanding the orbat to a battalion plus. The broad architecture will have a constructive simulation at the top with all the modules those have been explained before and at the field level there will be virtual reality based simulation system for the lower commanders and the troops. The troops getting trained in the virtual reality environment will have 3D view extracted from the map scenario that has been created in the constructive simulation domain. The Commanders in the constructive simulation domain (Battalion and the Company Commanders) will have the option of invoking the extended reality team at a particular time and at a particular phase based on the training requirement and the exercise planning. It will therefore be a seamless integration of the battalion level tactical constructive simulation model and selective virtual reality exercise at a limited scale for troops integrated to the overall tactical exercises. The feedback received from the virtual reality module will get incorporated in the tactical wargames and the progress of the exercise will be accordingly decided. Virtual reality module can be one or multiple in different time and space including in the red land domain.

II. CONSTRUCTIVE SIMULATION MODEL

This system will have traditional modules which will enable game setting and game play in the computer based map architecture. It will have requisite servers and network hardware to connect various terminals and to remotely connect to the virtual reality module. Exercise Control module will have the main servers from which the tactical exercise will be setup and progress of the game can be monitored. These servers will connect to various other terminals and remotely to the virtual reality modules as and when invoked. The various components will be as under:

A. Exercise Control

Orbat. At the beginning of the exercise, there will be a provision of feeding in the orbat of the playing and the non-playing entities. Integral and non-integral resources will be generated and added as part of the orbat so that they could be employed by the players and commanders during the exercise. Various types of equipment and logistic resources can also be added. However, there would be a limit to various type of resources that can be added based on the scope of the exercise and types of operations being practised. Tactical grouping of various types of units also can be done based on the exercise setting. Once the grouping has been finalised, various entities and subunits can be placed as per the exercise that is planned. Neighbouring units and formations can also be set up so that the exercise becomes realistic. Red Land orbat, weapon, equipment and grouping setting can also be done from this module.

Maps. There will be a map server that will have maps of various types of terrain where the training is to be imparted. These will be GIS based 3D maps in specific format which can be rendered on the player's terminals and also as visuals on the virtual reality display as per the required format. In resolving the various situations, the map terrain modules

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shall take into account all the terrain friction and restrictions so that outcome is realistically decided. Various types of entities will be displayed as icons in the constructive simulation based on the selection done by the control. The terrain detail will accordingly be displayed and the entities will get aggregated and de-aggregated according to the resolution. Movement control and terrain reaction module will be integral to the map server. When projected on to virtual reality scenario, it will render as 3D immersive map on the Head-Mounted Displays of the trainees. There will be provision for selection of various types of terrain and scenarios for exercise purpose or load any other map based on training requirement.

Display. Display on the screens of the Players's terminals will be user-friendly with control icons for various actions. The display will adjust as per the level of exercise planned and will have the facility of switching between 2D and 3D view. There will be provision of touch screen so that various icons can be dragged and dropped on the screen for various activities. On the virtual reality simulation module, the display will be head mounted with 3D vision.

Combat Resolution and Decision. This is one of the most import component of the simulation training module that decides how the game will progress and what will be outcome of various engagements. This module will included functions action and effect of various types of weapons and equipment modelled. Based on the engagement, the module decides the outcome in terms of casualties of men and equipment in each side. This uses complex analytical models for each weapon with its range, trajectory of fire, rate of fire, lethality, effect of fire etc. Model also takes into account terrain, obstacles, cover, protection of target and retaliatory action before arriving at a decision. Presently, these rules and models are fed in the module based on which the outcomes resolutions are suggested by the system. Effect of fire due to long trajectory standoff weapon, artillery and air are separately modelled and so is the close combat between opposing forces. Based on the outcome of any combat resolution after engagement, the number of weapons, troops, equipment, and other assets are automatically adjusted and the combat potential of forces is calculated for further progress of the operations. Traditionally all the rules are hardcoded and the outcome are generated accordingly. In the proposed model, the Combat Attrition Module (CAM) will be AI based self-learning model that will keep learning from the outcome that is accepted by the control and accordingly improve its decision making capability. Based on the decision given by the CAM, the players will get the visual and textual cues and accordingly they will plan their next course of action. The entities which are represented by virtual reality based actual soldiers, will also act as per the scenario that they see on their display and combat resolution will be carried out based on their actions.

Time. Control will have the option to progress the exercise as per its training plan. It may run the game fast at certain phase which may not be critical and at other times exercise may be played in real time so that deliberate resolution of movement and combat can be achieved.

Requests. Players will have the option of asking for various types of bids and information as happens in real operations. The players will be able to ask for intelligence information, satellite data, patrolling data, air surveillance sortie etc. Besides this, they can ask for additional bids in terms of troops, equipment and weapons. Control will act as superior headquarters for the players and decisions in this regard will be taken by them.

B. Blue Land (Trainee Audience)

This will be the body of officers and men that will be the target audience for training. At the battalion level there will be Commanding Officer, Company Commanders, Platoon Commanders and other appointments of the unit. When the game is expanded to Battalion plus format, there will other units and coordinating HQ. There will be terminals for additional forces also if incorporated in the game. Each appointment will have separate terminal and they will be set up as 'operations rooms' as it happens in operations/ exercise. Communication between various commanders and the troops will take place as will happen in actual operations. Each commander will have a view of his operational area on the map and where and how his troops are deployed. His visibility will be limited to what will be in actual operations based on actual exercise constraints. After the exercise setup has been done, Blue Land will start the game by setting up the orbat, collection of intelligence, planning, and conduct of various types of operations. Red Land will react based on the actions of Blue Land. Blue Land can be set up for both defensive and offensive operations based on the aim of the training planned. It is expected that the lowest resolution of this level of tactical simulation system will be section level. However, special weapons and other support weapons can be represented independently.

Aggregated Model. Architecture of the game will be aggregated wherein there will be capability in the system to go down to the individual soldier and weapon level and go up to section level as and when required. Whenever the virtual reality module is invoked, the resolution will automatically come down to soldier level. This type of aggregated model gives flexibility to the trainees to set and exercise at any level starting with a section to Battalion plus level.

Movement. Movement of the troops and vehicles of the Blue and Red Land will be as per the actuals depending on the intensity of the operations, weather, time and terrain friction. Control will have the option of speeding up the move time if it feels that it may not affect outcome of the exercise and important lessons are not lost.

Situational Awareness. All the trainees will have situational awareness as would be available to them during

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the operations/ exercises. It will be based on communication, intelligence from various sources, patrolling activities, terrain etc. This will keep on changing as per the progress of the operations.

Residual Combat Force and Reinforcement. Combat resolution at each stage of the operation will be done by the CAM module and accordingly the residual combat potential of the forces will be decided. Reorganization of the forces, reinforcements, and additional bids can be accordingly made to the control.

C. AI-based Red Land

Traditionally Red Land is allocated some amount of resources and they are made to play the game as per the exercise setting. Therefore, there is a need to earmark terminals for Red Land players and they are required to be manned. Till some time back this was a necessity but today Red Land can be replaced by an AI-based model which can give realistic responses to the actions of the Blue Land. The AI module will be a self-learning which will learn on its own to create responses that are as realistic as produced by the actual players. Presently there are no wargames and trainers in India that are using AI. AI will help reduce the number of terminals and participants. There will be scope for human intervention from the control as and when needed if the Red Land action is to be modified or overruled to decide on a particular course of action for the exercise. The role of Red Land will change if the Blue Land is to defend wherein, Red Land automated forces (AI module) will generated options for offensive action based on defensive posture of Blue Land. As has been discussed before, DARPA has worked out the OneSAF concept of semi-automated forces that could replicate as real soldiers and perform combat task alongside the trainee soldiers/ entities or the as Red Land forces. This concept can be used in this system also which will add to the realism and save on to a number of terminal and manpower resources which are otherwise not needed for training.

D. After Action Review

After action review is one of the important components of the complete simulation and wargaming system. This module will allow the players/ trainees to review the actions taken by them and the outcome therein during the game play. Based on this, payers can draw lessons and come with better plan and course of action for future exercises. This facility is available in most of the simulation and wargaming systems. However, there is need to adopt an internal automation and analysis module based on AI which can carry out in depth analysis and bring out lesson which otherwise could not have been possible normally. Printout can be taken for further reference and the complete exercise can be recorded and replayed.

III. VIRTUAL SIMULATION AND INTEGRATED ARCHITECTURE

Virtual reality today has transcended into the more sophisticated domain of immersive extended reality. This technology can be exploited to create a realistic virtual environment that will have immense training value both in standalone and virtual-constructive integrated simulation mode. As has been explained before, Extended reality will be mix of Virtual, Augmented and Mixed reality. Therefore, for planning a pre-operations training a synthetic environment can be created with near realistic terrain and physical environment using VR-XR simulation continuum. To bring in even more realism, various terrain features and other operational instruction can be displayed on the screen using AR. This will immensely enhance the training value of the system and trainees will be able to quickly learn how and what to do in various situations.

A. System Details

Hardware. There will be a server that will host the appropriate software to render 3D terrain. Besides this, there will be another server that will have connectivity to the remotely located constructive simulation server and also connect to the Head-Mounted Displays that the trainees will be wearing.

Feedback. Visual, sound, smell, motion, jerk etc effects will be used so that the simulation is realistic. These can be achieved by various CGI, optical cameras, acoustic, 3D motion platform, haptic devices and other similar type of sensors.

Network. This module will have the capability to connect to constructive simulation server and hence it should have access to suitable high-speed network media for real-time simulation and rendering of maps. Besides this, it should also have the capability of remotely connecting to the Head-Mounted Displays of the trainees and rendering the battle scenario.

Synthetic Environment. Virtual reality engines can convert maps to 3D immersive environment that can be virtually navigated. Intelligence will have to be inbuilt in the system so that there is feedback from the terrain. Facility will be there to load specific terrains where training is to be carried out. Besides this, there will be pre-loaded maps and terrains in the system. Display will be on the HMD of the troops which will be immersive and realistic. Trainees will visualise obstacles, friendly and enemy forces and terrain in 3D configuration.

Use of Equipment and Weapons. It is expected that the trainees will use dummy weapons and equipment that will be akin to their own or their integral weapons and equipment which will be suitably modified for simulation exercise. These will operate as actuals and effect of fire and use of equipment also will be realistic. Various sensors, motion, sound effects will be employed, as has been discussed before

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to create realistic simulation.

Augmentation. With augmentation technology, the experience of exercising and training value can be greatly enhanced. Various terrains features can have identification overlays as needed. Besides this, various orders and instructions can also be displayed on the screen as per progress of the operations. Trainees can have virtual menu which they can use and access on the fly.

B. Integrated Architecture

Integrating virtual simulation with constructive simulation will accrue exponential benefits. Virtual simulation gives the hands-on training experience to the trainees in real realistic environment. It is expected that with constructive simulation, the system should be able to host at least three sections as a virtual extended reality simulation module. These sections can be combined to form a platoon or they can be employed separately as different sections in different locations as part of different platoons. This module can have the following configuration.

Standalone Mode. This is the mode in which the virtual reality module is not connected to the constructive simulation server and the exercise played on it is independent. The server will have the option of loading 3D format maps which can be then rendered onto the Head-Mounted Displays of the trainees. The weapons and equipment that are used by the trainees will be connected to the system and will function as per the rule of the game. They will cause effect of fire on the target as would be in real operations based on the models that have been created. All the weapons and equipment that a platoon uses will be modelled in the system. Control will have the option of creating an objective area that can be CI ops or for conventional operations based. The module will have movement, combat resolution, and decision components as will be there in the constructive simulation module. This standalone module will be of great help for pre-operation rehearsals. It will give a walk-through rehearsal to the troops in the terrain in which they are going to operate and also the target area can be modelled realistically and operation can be practised so that the operation can be executed efficiently. Various options for the operations can be rehearsed and outcomes can be compared so that the best option can be selected for actual operations.

Networked Mode. In this mode, the virtual reality module will become part of the constructive simulation as has been discussed before. The control or the Blue Land Commander will have the option of selecting the time and phase of the game in which the virtual reality module is to be invoked. This can be pre-decided or can be decided on the fly by the commander based on the progress of the operation and training requirements. Troops can be employed as complete platoon or can be divided into three sections and employed separately. The server at the virtual reality end will connect to the constructive simulation sever and render the 3D map and the battle scenario to the troops in the virtual reality module as per the progress of the battle. Actions done by the troops in the virtual reality module will be visible to the higher commander in the constructive simulation and feedback from the one module will seamlessly flow to another module in real-time.

IV. SYSTEM EXPLOITATION BY BATTALION COMMANDERS

The proposed simulations system will act as an excellent tool for training of Infantry Battalions. It is not expected to be portable as it will have the servers and networks system and therefore will be established at the Simulations Nodes in various stations. From the perspective of an Battalion Commander, the simulation systems should be able to train officers and men in maximum types of operation of wars and contingency operations. For a Battalion Commander, the various types of activities that could be carried out on the proposed system are as discussed in the succeeding paragraphs.

A. Individual Training

Battalion Commanders have the responsibility of training their troops in confidently handling their weapons and equipment. The proposed system will have the option of independently invoking the virtual reality module in standalone mode. It will have the option of interfacing various types of weapons that have been modelled and configured in the system and troops can be trained in handling and operation of the same. Weapons can be changed and training can be expanded. There can be situations when there will be a requirement of training individuals on the handling of special weapons. These weapons can be specially modelled in the system for the purpose of training.

This module will be similar to the existing weapon simulation systems that are being used in various Armies. However, the major difference will in the use of HMD, better technology and immersive 3D environment experience. However, many of the field craft drills will have to be practiced physically as simulation of the same would not be prudent.

B. Small Team Training

The virtual reality module will have the feature of getting configured for small team operations training in standalone mode. Training can be planned by the control which will involve setting up the task and loading of the map. Team will have the Head-Mounted Display and specific weapons as configured. Loaded map will be displayed as 3D immersive visuals in the HMD of the team. Enemy forces and enemy action will be synthetically generated by the system. Team will tactically operate in the 3D synthetic environment and carry out all battle drills to achieve the desired task. Team members can communicate with each other and effect of

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action of each member is felt by others.

C. CI/ CT Training

Armies have Counter Insurgency/ Counter Terror (CI/CT) simulators. However in isolation they are not effective. The proposed simulation system will also have a CI/CT module that can be configured for small teams to carry out CI/ CT operations training. This will be played in a hybrid mode of constructive and virtual simulation with options to select various training scenarios. It will have the dual purpose of skill honing and practicing on the CI/CT drills. Control will have the provision of selecting various scenarios and interjecting impromptu situations to add to the training value.

AI can be widely used in this type of simulation to create realistic behaviour of insurgents/ terrorists. UrbanSIM is one such simulation system which uses AI in CI/ CT scenario. The AI technologies that were selected in UrbanSIM address specific challenges in simulating the complexities of urban environments and in guiding users in learning the skills of counterinsurgency operation[1]. As the actions of the terrorists and insurgents are intuitive and not rule based, AI based reaction model will be more appropriate.

D. Offensive and Defensive Operations

The system will have the capability of training the troops in both offensive and defensive operations. For this purpose, all the combat rules will have to be hard coded in the system. As combat situations can be dynamic and unpredictable, a large number of rules will be extrapolated by the system based on AI. Commanders/ players will have their terminals to plan and progress their operations as done actually during operations. Requirement of flanking troops and enemy will be made up by AI based automated forces like OneSAF. NLR ltd of Netherland also has proven, with their R&D programme, the use of machine learning techniques to generate credible behaviour of synthetic role players. As per them "We will demonstrate that we can generate such Computer Generated Forces (CGFs), even in the absence of actual behavioural data or when we have sparse data from different sources. We will demonstrate that users can naturally interact with such CGFs. Finally, we will ensure that the behavioural models can be used and re-used in the simulations of the Ministry of Defence."[2]

Maps of the expected area of operation can be uploaded and the training can be set up. This will offset the requirement of looking for those training areas which are akin to actual areas of operations. All types of operations like defensive, offensive, canal, DCB, and mountain operations, etc can be exercised. The system will have the option of selecting a preloaded map or a map of a particular area can be loaded externally and training can be conducted on it. As and when needed, 3D visualisation can also be carried out of the terrain. A whole world architecture will facilitate loading of any map and rendering it on any terminal on the fly.

E. Dual Task

Invariably it is seen that formations and battalions are in dual-task role and therefore they have to prepare for their secondary role along with the primary role. In such a scenario, at times it becomes difficult for the units to train for their dual task role. With the proposed tactical trainer, the Infantry Battalion can load the map of the dual task area and set up exercises as per the planned operation, and get the commanders and troops trained.

V. CONCLUSION

Training at the tactical level is considered to be the most important as this is how the militaries operative worldwide. However, it is seen that while Indian Army has the individual weapon and equipment trainers, there is no simulation facility where battalion level tactical training can be done. The Proposed model shall prove to be a great training asset to home the skill of the soldiers, Commanders and infuse confidence in them to operate as a team.

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