LLM-based Few-shot Action System for NPCs in Virtual Reality Game

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1. Introduction

In this paper, we address the challenge of enabling believable NPCs in Virtual Reality (VR) games using Large Language Models (LLMs). Current NPCs in VR primarily focus on conversational abilities, lacking intelligent action planning. We propose a few-shot learning-based action system that allows NPCs to perceive the 3D world, understand player intentions, and plan/execute physical actions without extensive retraining.

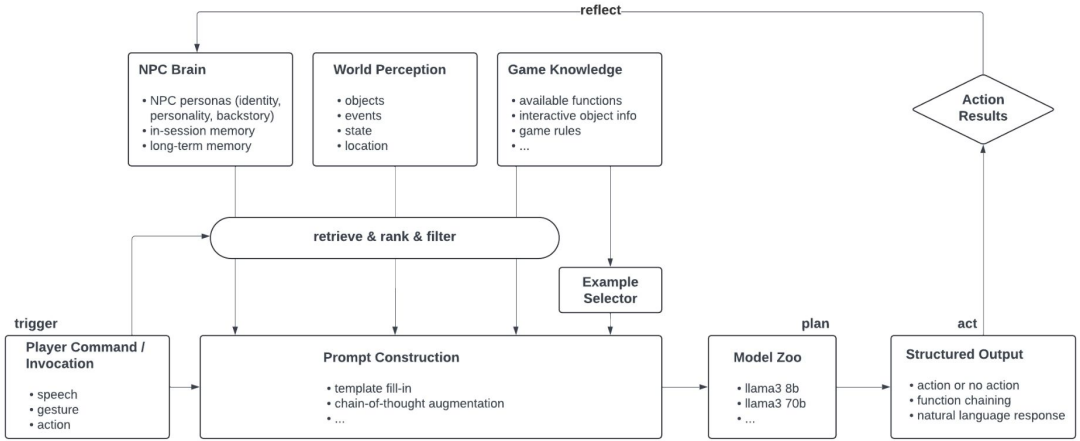
2. Related Work

Traditional NPCs use rule-based systems or GOAP (Goal-Oriented Action Planning) for behavior generation. Recent work has incorporated LLMs for conversational agents but rarely for action planning in VR. The VOYAGER project introduced GPT-based agents for Minecraft but did not focus on multi-agent VR NPC interactions. Our work expands on this by targeting action invocation in immersive VR environments.

3. Proposed Design

Our system has six key components:

1. Dynamic World Perception: NPCs access real-time data about objects, states, locations, and events.
2. Game Knowledge Injection: Rules, affordances, and valid functions are dynamically provided.
3. NPC Memory Injection: Uses both short-term (session) and long-term memory, plus NPC persona.
4. Prompt Construction: Combines world perception, memory, rules, and few-shot examples into structured prompts.
5. Model Zoo Utilization: Uses Llama-3 models to produce structured action outputs.
6. Structured Output: Generates function call sequences, chaining, and natural language replies.



4. Experiments & Evaluation Plan

The experiment setup involves implementing a prototype of the proposed LLM-based action system for NPCs within the Meta Horizon World environment, using a Meta Quest headset. The system was tested with approximately 120 unique game scenarios that varied in environmental conditions, player commands, and interactive objects. An example scenario includes objects like a green target, red target, tree, and player, with commands such as “Put the gun on the table, then go to the red room and pick up the apple.”

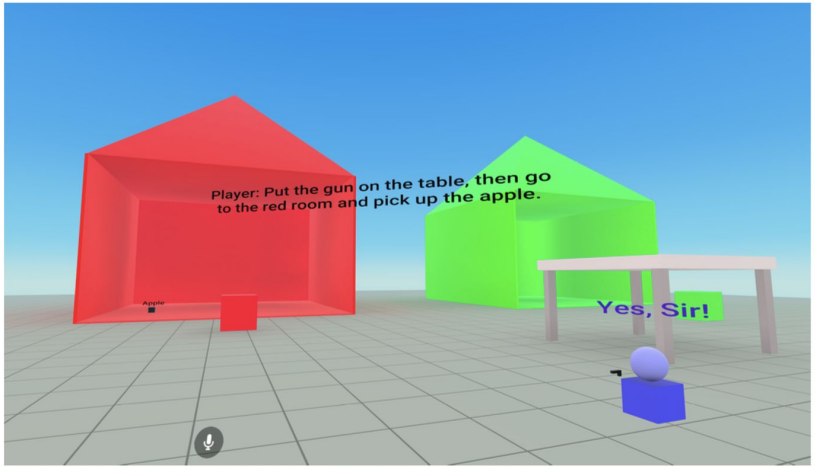


Figure 2. Example test setup for the basic prototyping experiment. The end-to-end playtest is done in Meta Horizon World with a Meta Quest headset [21].

4. Experiments & Evaluation Plan

The prototype evaluation involved iterating on different prompt designs and formats including JSON, YAML, and XML. Accuracy was measured with models Llama3-8B and Llama3-70B, showing the highest accuracy of 86.4% using the JSON format. Additionally, the experiment evaluated the impact of few-shot learning examples on performance, response latency, and action quality, including function chaining. Plans for enriched experiments include testing the model's ability to handle real-time environment changes, multi-step tasks, and voice-based user commands.

TABLE I. MODEL ACCURACY WITH DIFFERENT PROMPT FORMATS.

Format	*Model*	*Accuracy*
JSON	llama3-70B	86.40%
JSON	llama3-8B	70.91%
YAML	llama3-8B	76.40%
XML	llama3-8B	69.10%

5. Conclusion & Future Work

Our prototype confirms that LLM-driven action systems are feasible for VR NPCs with few-shot learning. We plan to compare our system against traditional methods like GOAP, address hallucination with response grounding, enhance privacy using fuzzy memory modules, and conduct user studies to further refine NPC interactivity in VR games.

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