From Commands to Prompts: LLM-Based Semantic File System For AIOS

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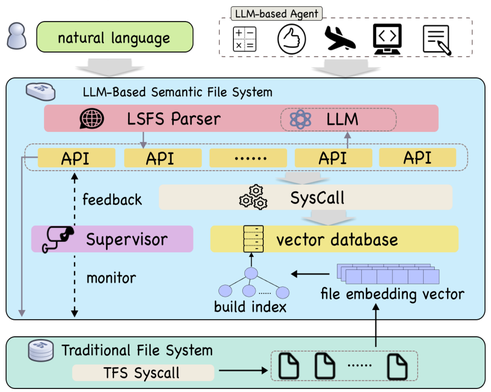
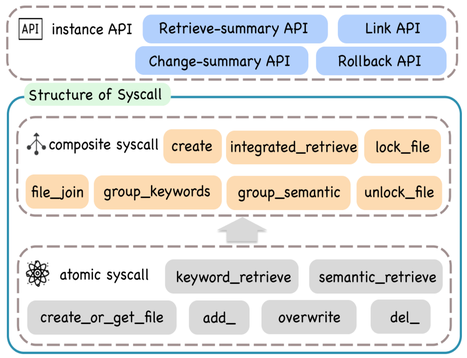
Abstract

LSFS is a prompt-driven file management in LLM Agent Operating System (AIOS). Unlike conventional approaches, LSFS incorporates LLMs to enable users or agents to interact with files through natural language prompts, facilitating semantic file management. At the macro-level, we develop a comprehensive API set to achieve semantic file management functionalities, At the micro-level, we store files by constructing semantic indexes for them, design and implement syscalls of different semantic operations.

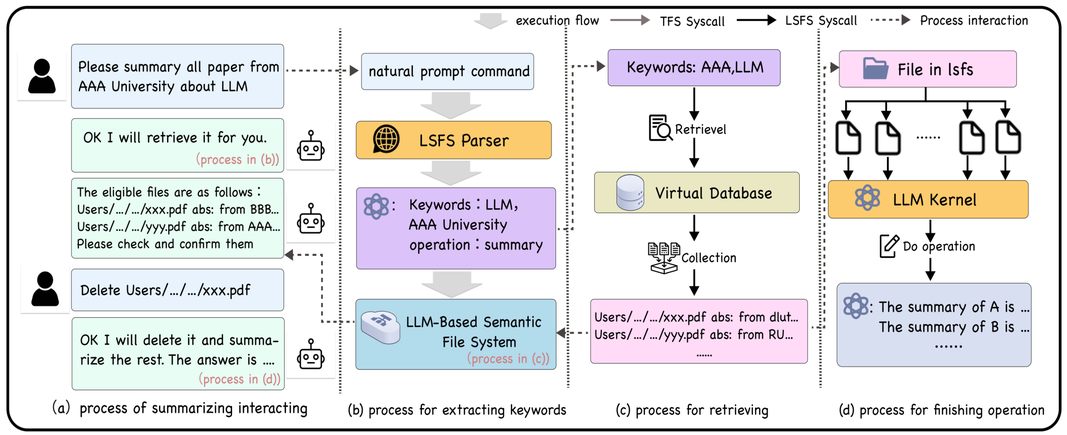
Structure of LSFS

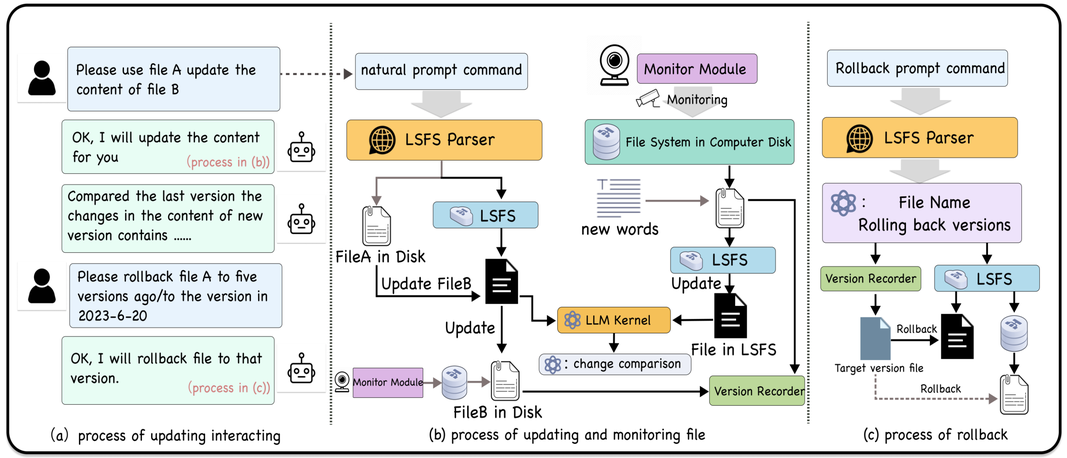
LLM-based File System like a mid-layer between user/agents and file system in computer. It organizes files as semantic vectors using a vector database while staying synchronized with traditional file systems during user interactions. LSFS comprises three hierarchical components, from largest to smallest: API, composite syscall, and atomic syscall.





Execution Pipeline of LSFS



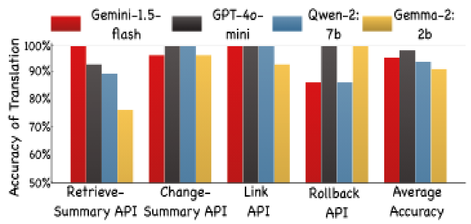


Operation Mapping

Function	Implementation in TFS	Implementation in **LSFS**
create new directory	mkdir()	create()
create file	touch()	create_or_get_file()
open file	open()	create_or_get_file()
read file	read()	create_or_get_file()
get file state and metadata	stat()	create_or_get_file()
delete directory	rmdir()	del_()
delete file	unlink() / remove()	del_()
write data	write()	add_()
overwrite data	write()	overwrite()
update the access time	utime()	update_access_time()
automatic comparison	—	compare_change()
generate link	symlink() / link() / readlink()	generate_link()
lock or unlock file	flock()	lock_file() / unlock_file()
rollback	snapshot + rollback	rollback()
file group	—	group_keywords() / group_semantic()
merge file	cat	file_join()
keyword retrieve	grep	keyword_retrieve()
semantic retrieve	—	semantic_retrieve()
hybrid retrieval	—	integrated_retrieve()

Experiment Results

LLMs backbone	# files	Accuracy of target file retrieval		Retrieval time	
		w/o LSFS	w/ LSFS	w/o LSFS	w/ LSFS
Gemini-1.5-flash	10	75.0%	95.0%(20.0%↑)	97.40(s)	14.39(s)(85.2%↓)
	20	77.3%	91.3%(14.0%↑)	213.69(s)	16.69(s)(92.2%↓)
	40	70.91%	93.4%(22.5%↑)	312.39(s)	23.86(s)(92.4%↓)
	120	35.2%	92.9%(164%↑)	605.59(s)	48.08(s)(92.1%↓)
GPT-4o-mini	10	80%	95.0%(15.0%↑)	61.14(s)	30.64(s)(49.9%↓)
	20	69.1%	91.3%(22.2%↑)	129.92(s)	40.39(s)(68.9%↓)
	40	69.2%	93.4%(24.2%↑)	239.49(s)	57.1(s)(76.2%↓)
	120	63.8%	92.9%(45.6%↑)	938.68(s)	88.93(s)(90.5%↓)



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