COMP2221 Systems Programming Summative Coursework Report

[001138180]

1 Summary of Approach & Solution Design

The memory management system is implemented as a robust, fault-tolerant allocator that operates solely within a single coniguous memory block provided by the rover's operating system. The design places a strong emphasis on integrity, data validation, and safe-failure behavior - ensuring resilience to bit-flips and partial writes - rather than prioritising raw run-time performance.

The solution uses an implicit free list, where all metadata is stored in redundant Header and Footer structures within the Heap itself, avoiding the use of any standard C library allocation functions.
All returned payload pointers are strictly 40-byte aligned (`MM_ALIGNMENT 40u`). This is enforced in `mm_init` by calculating the first 40-byte aligned address for g_heap and adjusting `g_heap_size` accordingly and is verified in `mm_malloc` and `validate_payload_ptr` relative to `g_heap_base`.

Each memory block uses a 40-byte `BlockHeader` and a 16-byte `BlockFooter`. The header includees redundant size fields (`size` and `inv_size`), integrity check key (`canary`), a full metadata `checksum`, and a unique resilience field, `size_xor_magic (size ^ BLOCK_MAGIC)`.

Faults are handled by isolation. If `validate_block` detects corruption, the alloctor does not follow corrupted pointers but instead quarintenes the damaged block using `quarantine_block` (setting `FLAG_QUARINTINED`) permanently removing it from the allocation pool.

The allocator uses a Best-Fit allocation strategy, implemented via a linera scan of the entire implicit free list. This approach minimises external fragmentation and safely skips quarantined or corrupted blocks.

2 Analysis of Solution

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3 Use of Generative AI, Tools, or other Resources

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4 Additional functionality

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References

[1] J.S. Bridle, *Probabilistic Interpretation of Feedforward Classification Network Outputs, with Relationships to Statistical Pattern Recognition*, Neurocomputing—Algorithms, Architectures and Applications, F. Fogelman-Soulie and J. Herault, eds., NATO ASI Series F68, Berlin: Springer-Verlag, pp. 227-236, 1989. (Book style with paper title and editor)

[2] W.-K. Chen, *Linear Networks and Systems,* Belmont, Calif.: Wadsworth, pp. 123-135, 1993. (Book style)

[3] H. Poor, *A Hypertext History of Multiuser Dimensions*, *MUD History,* http://www.ccs.neu.edu/home/pb/mud-history.html. 1986. (URL link *include year)

[4] K. Elissa, *An Overview of Decision Theory*, unpublished. (Unpublished manuscript)

FORMATTING INSTRUCTIONS FOR WORD (DELETE)

TABLE 1
UNITS FOR MAGNETIC PROPERTIES

Symbol	Quantity	Conversion from Gaussian and CGS EMU to SI [a]
Φ	magnetic flux	1 Mx $\rightarrow 10^{-8}$ Wb = 10^{-8} V·s
B	magnetic flux density, magnetic induction	1 G $\rightarrow 10^{-4}$ T = 10^{-4} Wb/m^2
H	magnetic field strength	1 Oe $\rightarrow 10^3/(4\pi)$ A/m
m	magnetic moment	1 erg/G = 1 emu $\rightarrow 10^{-3}$ A·m^2 = 10^{-3} J/T
M	magnetization	1 erg/(G·cm^3) = 1 emu/cm^3 $\rightarrow 10^3$ A/m
$4\pi M$	magnetization	1 G $\rightarrow 10^3/(4\pi)$ A/m
σ	specific magnetization	1 erg/(G·g) = 1 emu/g $\rightarrow$ 1 A·m^2/kg
j	magnetic dipole moment	1 erg/G = 1 emu $\rightarrow 4\pi \times 10^{-10}$ Wb·m
J	magnetic polarization	1 erg/(G·cm^3) = 1 emu/cm^3 $\rightarrow 4\pi \times 10^{-4}$ T
χ, κ	susceptibility	1 $\rightarrow 4\pi$
χ_ρ	mass susceptibility	1 cm^3/g $\rightarrow 4\pi \times 10^{-3}$ m^3/kg
μ	permeability	1 $\rightarrow 4\pi \times 10^{-7}$ H/m = $4\pi \times 10^{-7}$ Wb/(A·m)
μ_r	relative permeability	$\mu \rightarrow \mu_r$
w, W	energy density	1 erg/cm^3 $\rightarrow 10^{-1}$ J/m^3
N, D	demagnetizing factor	1 $\rightarrow 1/(4\pi)$

Statements that serve as captions for the entire table do not need footnote letters. E.g. Mx = maxwell, G = gauss, Oe = oersted; Wb = weber, V = volt, s = second, T = tesla, m = meter, A = ampere, J = joule, kg = kilogram, H = henry.

References

The list of cited references should appear at the end of the report, listed by order of appearance in the paper. The required style is to note citations in individual brackets, followed by a comma, e.g. "[1], [5]" (as opposed to the more common "[1, 5]" form.) Citation ranges should be formatted as follows: [1], [2], [3], [4] (as opposed to [1]-[4]). When citing a section in a book, please give the relevant page numbers [2]. In sentences, refer simply to the reference number, as in [3]. Do not use "Ref. [3]" or "reference [3]" At the beginning of a sentence use the author names instead of "Reference [3]," e.g., "Smith and Smith [3] show ... .".

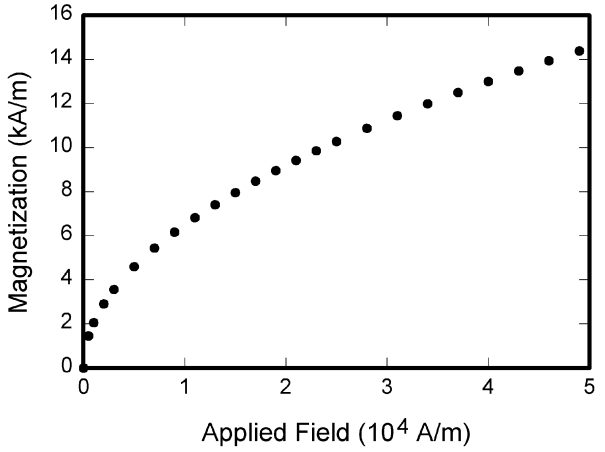

Fig 1. Magnetization as a function of applied field. There is a period after the figure number, followed by two spaces. It is good practice to explain the significance of the figure in the caption