Project Proposal

Project Proposal	April 2017	Note:

Student to complete this section					
Steyn	**L.**	**Mr.**	**04496486**		
Design of a holonomic five legged robot			**Study leader: Dr D le Roux**		
Class group: Afrikaans	**Project number:**		DLR5	Revision number:	0
Type of project: Design	Degree programme enrolled for: Electronic Engineering				
Student declaration: I understand what plagiarism is and that I have to complete my project on my own.	Student signature		Date		

Declaration by language editor (proofreader)	
I have been allowed adequate time to read this document carefully and to make corrections where necessary (date received indicated below). To the best of my knowledge, correct formatting, spelling and grammar are used throughout the document.	
A. Kock (language editor)	Date

Declaration and recommendation by study leader		
1. Have you (the study leader) been allowed adequate time to read and comment on the Project Proposal?	Yes	No
2. Is the Project Proposal a <u>correct</u> and <u>complete</u> description of what is required?	Yes	No
3. Is the Project Proposal <u>clear</u> and <u>unambiguous</u>?	Yes	No
4. Recommendation: Do you recommend that the Project Proposal be approved?	Yes	No
Dr D le Roux (Study leader)	Date	

This section to be used by the Project lecturer					
Content /20		Attended lectures:	Yes	No	
Subtract for editing errors / 10		Language editing adequate:	Yes	No	
Final mark /20		Approved? (If "No", a revision must be submitted):	Yes	No	Prof. J.J. Hanekom

1. Problem statement

Motivation. The steering systems used on conventional passenger vehicles all suffer from a phenomenon called the parallel parking problem [1]. This restricts the vehicle's movements to forwards and backwards while slightly turning the front wheels. The vehicle is therefore capable of moving in arcs but never sideways. The alternative to this type of movement is holonomic movement, this allows the vehicle to move in any direction from a stationary position - even sideways. The motivation for this project is using a five-legged approach to solve the parallel parking problem while still being able to move over the bumps and small obstacles that a normal vehicle would be able to cross.

Context. One approach to achieve holonomic movement in vehicles is to swap the cylindrical wheels found on most vehicles for spherical wheels [2]. While this solution solves the parallel parking problem, it introduces a new restriction of only functioning properly on relatively flat surfaces.

Technical challenge.

Limitations.

2. Project requirements

ELO 3: Design part of the project

2.1 Mission requirements of the product

The requirements of the product that would determine whether the project is successful can be summarized in the list below.

- The robot should be able to move in any direction from a stationary position.
- The robot should be able to rotate about its own axis while remaining in the same position.
- The robot should be controlled remotely by using a smartphone application.
- The robot should use five legs to execute any of the required movements.
- The robot should be able to move on both smooth and coarse surfaces to improve on the spherical wheel concept.

2.2 Student tasks: design

The tasks that are vital to ensuring that the product meets the mission critical requirements are listed below.

- The mathematical analysis and design for the movement of the legs should be done on paper.
- The design should then be implemented in a graphical mathematics package such as Python for further refinement.
- Once the algorithm design is sound, electronic design can commence in a simulation environment such as LTSpice.
- Everything can then be implemented in electronics using a microcontroller and support electronics together with some driving circuitry.
- A smartphone application should be developed to remotely control the robot.
- Each subsystem should be tested for isolated functionality as well as interaction with other subsystems to make sure all requirements are met.

ELO 4: Investigative part of the project

2.3 Research questions

The investigative question addressed in this project is whether design of a holonomic robot with a legged approach solves the problems apparent in the spherical wheel approach. Can a holonomic five legged robot move on a variety of surfaces?

2.4 Student tasks: experimental work

The experiments that will be conducted to address the research questions above are listed below.

An experimental setup to test the ability of the robot to move on a variety of surfaces is required.

- The robot will be placed on both smooth and coarse flat surfaces to perform the same manoeuvres.
- The robot should be able to perform these manoeuvres with a similar degree of difficulty and in similar time.

Another experimental setup is required to test the robot's ability to handle small obstacles and bumps.

- The robot will be placed on a surface with bumps and small obstacles such as rocks.
- It should be able to execute the same set of manoeuvres mentioned in the experimental setup above in similar time.

3. Functional analysis

4. Specifications

4.1 Mission-critical system specifications

SPECIFICATION (IN MEASURABLE TERMS)	ORIGIN OR MOTIVATION OF THIS SPECIFICATION	HOW WILL YOU CONFIRM THAT YOUR SYSTEM COMPLIES WITH THIS SPECIFICATION?

Table 1. Mission-critical system specification

4.2 Field conditions

REQUIREMENT	SPECIFICATION (IN MEASURABLE TERMS)

Table 2. Field conditions

4.3 Functional unit specifications

SPECIFICATION	ORIGIN OR MOTIVATION

Table 3. Functional unit specifications

5. Deliverables

5.1 Technical deliverables

DELIVERABLE	DESIGNED AND IMPLEMENTED BY STUDENT	OFF-THE-SHELF

Table 4. Deliverables

5.2 Demonstration at the examination

6. References

[1] J. Reeds and L. Shepp, "Optimal paths for a car that goes both forwards and backwards," *Pacific Journal of Mathematics*, vol. 145, October 1990.

[2] K. Tadakuma, R. Tadakuma, and J. Berengeres, "Development of holonomic omnidirectional vehicle with omni-ball: spherical wheels," *Intellegent Robots and Systems*, vol. 2007, November 2007.