PROJECT DOCUMENT

Active RSOs: Knights Racing, RCCF, NGE

Version No.	Description	Active as of:
1	Things in Version: • Project Scope and Goals	2/21/2023
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Electronic Continuously Varying Transmission

Undergraduate Project and Research

Team Leads:
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Lead Aids:
Sam Shackton, Gianni

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Knights Racing Representative: Devon Lister
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NGE Representative: Adrianne Gutman
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I. Abstract and Acronym List:

Document Abstract:

This document will contain project information in regards to the goal of creating an ECVT for the Knights Racing Baja Team. The document will cover project goals, limitations, deadlines, build planning, research phase resources, build planning, active participants, funding, and the plan of action for data acquisition and testing.

Acronym List:

ECVT = Electronic Continuously Varying Transmission
CVT = Continuously Varying Transmission
RCCF = Robotics Club of Central Florida
NGE = Next Gen Engineering
DAQ = Data Acquisition
POA = Plan of Action

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II. General Project Information

Project Title:	ECVT with Knights Racing, Robotics Club of Central Florida, and Next Generation Engineering

Description:	This project will be tailored around the goal of creating an ECVT to outperform the current CVT on the Knights Racing Baja vehicle

Vision:	Provide Knights Racing with a high performance ECVT built to encompass the different races within the Baja SAE competition
Parallel Goals:	Create a template for Knights Racing to be able to repeat/rebuild this project to be able to tailor the concept to different engines and/or chassis

Milestones	Success Criteria	Dependencies/Risks	Due Dates
Summer of 2024	Functioning ECVT	Dependency: ECVT performance/longevity	May, 2024

Project Constraints:	Limited research and previous project iterations available pertaining to this ECVT application. Research phase is imperative to be able to stay within the project's available funding budget

III. Work Breakdown Schedule

This section is dedicated to work breakdown based on the weekly schedule of this project. As of document version1, there is not enough planning and project understanding in order to set hard deadlines aside from the time constraint of aiming for next year's competition.

Week 2: February 21, 2023

Tuesday, February 21, 2023 - Meeting
Scope: Meet with the project team and develop a better understanding of the current project scope as well as how we plan on progressing throughout the research phase. Brainstorming ideas of ECVT application and mounting is still in place and no system/component testing has been initiated yet.
Time: 6:30 pm || Location: RCCF Technology Lab
Attendees: Devon, Dwight, Adrianne, Sam, Gianni, I feel bad but I forgor her name :/

Overall Tasks to be completed throughout before the next meeting:

- Independent member research on the multiple methods a linear actuator can be internally or externally applied to the pulley system

Week 3:

Tuesday, February 28th, 2023 – Meeting
Scope:

Summer 2024
Baja SAE competition – project deadline

IV. Project Inspiration & Application

Section Overview:

This section is dedicated to the foundation of this project and why it was brought into fruition. It will cover the project scope, foundational mechanics of a CVT found in the Knights Racing Baja vehicle, the limitations of the standard CVT system, the limitations of the transmission system due to the Baja SAE rulebook (designated for competitions), and the benefits of transitioning to an ECVT. Through this project, the participating RSOs intend on improving the Baja vehicle by overcoming these limitations.

Project Scope:

Provide Knights Racing with a high performance ECVT built to exhibit higher performance than the current transmission system on their vehicle within the different races of Baja SAE competition. The RSOs will operate under the parallel goal to document the process so that future generations of participants within Knights Racing, RCCF, and NGE can rebuild, elaborate, and improve the ECVT for different engines designated by the competition rulebook.

The primary goal of increasing the vehicle performance will encompass the benefits of electronically manipulating the gear ratios within the CVT, which may also encompass increasing fuel efficiency (during the endurance race) via an overdrive feature. Furthermore, this project intends on being able to remove the engine as the limiting factor of the vehicle's speed, power output, and overall capabilities.

How a CVT Works:

As preface to this paper and the contents within it, an explanation of the current CVT we are using will be given so that the set goals are easier to understand.

A CVT is a continuously varying transmission that is able to change seamlessly through a continuous range of gear ratios and the ratio will vary depending on vehicle speed, engine rpm, and load. The goal of a CVT is to deliver the best power with the best efficiency.

Components:

The CVT we use has three main components. The primary clutch, the secondary clutch, and the belt. Within these components there are fly weights and spring constants that are interchangeable and variable depending on how the CVT is set to operate. The primary clutch has two sheaths (we will refer to them as pulleys throughout this document), one stationary and one moveable pulley. The stationary pulley is connected to

the engine output shaft and the moveable pulley will move in order to engage the belt based on constraints set within the CVT system. During acceleration the secondary pulley is actuated by the engine/primary and during deceleration, braking, or driving through an area that increases the rolling resistance, the secondary is actuated by force from the road. The moveable half of the pulleys move depending on the fly weights and spring constant set within the system. Depending on the fly weight and spring set into the system, the CVT will deliver a certain ratio range. Through these variations of the primary and secondary pulley, the system trades speed and power depending on the conditions effecting the centrifugal motion of the moveable sheaths on the CVT system (rpms, torque feedback, and load). The figure below dictates the basic relation between these two pulleys and the belt

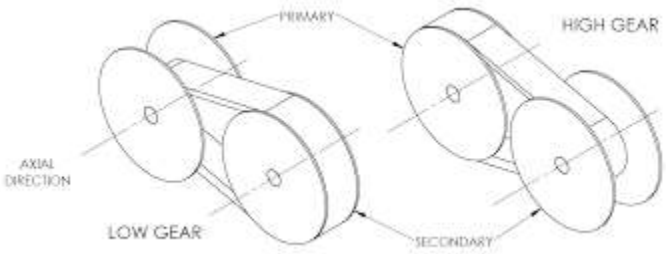

Fig 1. CVT Pulley Relations

Due to the Baja SAE rulebook, these mechanical components (the flyweights and spring constants) are unable to be manipulated during the competition. Meaning that the current CVT can only offer a limited ratio range during the competition. The current CVT is adjusted to best encompass the conditions of all of the components of the Baja SAE competition, this is done through testing different iterations of spring and flyweight combinations to try and find the most balanced combination. This is a time-consuming process that requires disassembling the CVT and relacing components each season to tune towards each new engine and chassis.

To conclude, the CVT currently offers a wide but limited variation of seamless gear shifting. The CVT will automatically adjust towards the input of the physical forces being acted upon it, but these physical components are unable to be modified to encompass a better ratio towards the specific demands given throughout different sessions of the seasonal competition. Although this system is widely used across the BAJA SAE competition, our team sees a large pocket for improvement upon the current transmission system and wishes to be able to open a larger range of gear ratios to the vehicle and reduce the time spent on retesting the balance of mechanical components each season.

Vision for ECVT application

With these limitations of the current CVT in mind, the benefits of transitioning to an ECVT become clearer and more applicable. Within the current automotive industry the key advantages of an ECVT that convert to our end goal application include:

1. Improved fuel efficiency: ECVTs can improve fuel economy by maintaining the engine at its most efficient speed, which reduces fuel consumption.
2. Smooth acceleration: ECVTs provide seamless acceleration, with no noticeable gear shifts or jolts. This makes for a more comfortable and enjoyable driving experience.
3. Lower maintenance costs: ECVTs will increase the longevity of the components within the transmission system. Ex, longer belt life
4. Improved performance: ECVTs can deliver more torque to the wheels, which can improve acceleration and overall performance.
5. Removes engine limitation: the ECVT will be able to manipulate the gear ratio to the point where it remove the engine as the limiting vehicle factor and place the limiting factor on the driver's capabilities

Overall, ECVTs provide a more efficient, smoother, and more reliable driving experience, which can result in lower operating costs and a higher performance competition vehicle.

V. Research Phase

Section Overview:

This section will include the different situational goals we have in mind as the reasoning behind them, components the team intends on researching, software that will be used throughout this phase, system performance priorities, and our current plan of action.

Situational Cases

Between the start and end of this project, the team foresees different outcomes of the final product produced. The best outcome we are aspiring for is

VI. Purchased/Manufactured Items

Section Overview:

This section will contain a chart and breakdown of our budget and the funding by phase. As of version 1, we do not have a current spending plan or a hard budget to work with. Therefor, more information will be posted once more knowledge and a fined tune POA of the ECVT system set up is acquired.

Funding:

The funding of the project will be delegated by the Knights Racing Baja team. As of right now there is a rough estimate of a $2000 budget. However, the team may embark on pursuing a sponsor so that a more in-depth analysis and part acquisition can be accomplished.

VII. Assembly

Section Overview:

This section will contain the projected assembly of the system in the Baja Chassis. Since the actuating and overall ECVT components have not been finalized there is not a supplemental amount of material to fill this section.

Expected Assembly:

As of version1, the team has developed the idea of externally attaching linear actuators to the frame of the Baja car. The benefits of choosing an external attachment is that part acquisition is more cost efficient compared to creating a system of attachments from the inner thread of the engine output shaft to the ECVT.

VIII. Final Product

Section Overview:

This section will contain all of the purchased items and their intended assembly on the Baja vehicle. This section will also go over the teams impressions of our final system. Our impressions will include where we believe future iterations can improve upon, the key factors of our system, and the complications that should be looked into by future RSO participants.

As of version1, we do not have a final product and there is no information to be noted in this section.

IX. Data Analysis and Adjustement

Section Overview:

This section will contain information pertaining to the acquisition of the ECVT data on the Baja vehicle. The data will encompass the performance comparison of our precious CVT iteration and the transition to the ECVT. Furthermore, the key points of data analysis will be described and broken down so that it is digestible for future RSO participants to understand. With this break down, future participants should be able to manipulate their ECVT towards their data in order to create a peak performance transmission to compete throughout the years of competition.

As of version1, there is no data to be analyzed.

X. Communication Plan

Section Overview:

This section contains the contact information of all the key members that participated within the project as well as any relevant personnel.

Template:
Personnel || Affiliation || Role
Email:
Notes or additional comments
Role examples: RSO representative, RSO co-representative, ____ application lead

Adrianne Gutman || NGE || **NGE Representative**
Email: gutmana@knights.ucf.edu
Note: can also contact my discord at Lifecaster#2554

Dwight Howard II || RCCF || **RCCF Representative**
Email: dwight9998@gmail.com
Note: he a chill guy

Devon Lister || Knights Racing || **Knights Racing Representative**
Email: devlis@knights.ucf.edu
Note: has a gnarly caffeine addiction

Chris House || Knights Racing || Baja Data Acquisition Subsystem Lead
Email: housecj@knights.ucf.edu
Note:

XI. Extra Elements

This section should provide any additional information that the group wants to share related to the project.