Progress Report

Project Name	*Multiple configuration hybrid hydraulic transmission demonstrator*
Report compiled by	*Jose M. Garcia*
Reporting period	*01-01-2012 to 09-31-2012*

Section One: Summary

This progress report describes in section two the major activities accomplished for the current reporting period. According to the grant proposal submitted in 2011, most of the activities proposed have been completed in time. The goal of exposing students to fluid power systems and components has been reached successfully, as half of the students involved in this project were able to find internships with fluid power companies last summer. Close collaboration with faculty from the Electrical Engineering department has allowed this project to evolve into a research project that will not only serve undergraduate students but also graduate students in two engineering departments at IIT. Plans are underway to develop a second prototype at Purdue.

Section Two: Activities and Progress

First: Two undergraduate students in the mechanical engineering program were recruited to work on the hydraulic hybrid prototype. These two students commenced to work on the project in the spring semester of 2012. The students and the project organizer decided that a go-kart frame was the best option and the most appealing to show students how a hydraulic hybrid transmission works. Students researched possible alternatives and found an economical new kart frame. The selected frame was acquired in mid-March. See pictures on the appendix.

Second: Further discussion resulted in the decision to power the vehicle using batteries and electric motors to power the pump and also for a direct drive option. An electric drive would eliminate the problem of having toxic fumes in closed rooms like a classroom or laboratory. The students researched the electric components and began sizing their system from February to March.

Third: The students decided that the vehicle should have limited speed but sufficient power to demonstrate the benefits of using hydraulics. It was decided that the system would have a direct mechanical connection from one electric motor to the rear axle and an indirect connection from a second motor trough a hydrostatic transmission to show the concept of a parallel hybrid system or a series hybrid system. (See attached schematic).

Fourth: Sizing of the hydraulic system was done based on the safe driving characteristics discussed in early March. A Hydraulic pump and motor were acquired in late April. The electric components were selected and acquired in April.

Fifth: Once the components arrived the students worked on laying out and defining the connection diagram of the electric system that was going to be used to power the pump and direct drive. This was the last activity of the semester.

Sixth: A third student joined the project during the summer term, her task was to investigate and select a suitable electronic control unit that would be used to manage the system. The original two students worked on designing brackets and adaptor plates for mounting all the components. These activities were carried out during the summer. A fourth student from the Electrical Engineering department began simulation of the hydraulic system in mid-June. Professor Mahesh Krishnamurthy from the Electrical Engineering Department advises the students with the development of the controller software and the electrical drives.

Seventh: All the mechanical components were installed and all the hydraulic connections were completed by the end of August. The last student to join the team (fourth student) decided to use this project as his masters' project. After talking with two hydraulic component manufacturers, Parker Hannifin agreed to donate an IQAN controller for the project.

Eight: The master student is currently developing the software to run the electric motors and start testing the hydraulic system. All sensors (pressure and speed) were physically mounted on the system and will be incorporated in the controller software before the month of October.

Section Three: Institutional & Project Issues

Dr. Jose M. Garcia started a new position in the college of technology at Purdue University as an Assistant Professor. Dr. Mahesh Krishnamurthy moved the kart to his laboratory and is currently serving as the thesis advisor for the master student. Dr Garcia visits IIT every month and meets with both of them in their laboratory. Dr. Garcia also video conferences with the master student on a weekly basis.

Section Four: Outputs and Deliverables

At the end of the year we expect to have a running prototype so that students taking fluid power courses at IIT can use it to learn about hydraulic transmissions, parallel and series hydraulic hybrid drive trains.

The master student will spend the spring semester troubleshooting and making measurements of the system. His goal will be to document possible energy savings for electric vehicles using a parallel hydraulic drive.

Section Five: Outcomes and Lessons Learned

The two students that started the project got offered summer internships with fluid power companies in the Chicago area. All four students involved in this project got exposed to fluid power components and systems for the first time. Furthermore, they learned how to size the components of a system based on the job requirements. Once the demonstrator is completed it will be used in the fluid power class MMAE 418 and Aerospace laboratory class MMAE 415. It may also be used in the Electrical engineering department to teach hybrid electric drives.

Section Six: Evaluation

The proposed design was presented at SAE' s Commercial Vehicle Exposition in Rosemont Illinois on October 3, 2012. Preliminary background research shows that this is the first vehicle to use an electric-hydraulic hybrid drivetrain.

Section Seven: Risks, Issues and Challenges

So far, the greatest challenge has been to advise the current student from a different institution, luckily the relative distance between both universities is short and all parties have committed to maintain close communication through email, Skype and in monthly visits. Another potential challenge is to finish the project before the end of the first year. The master student currently working on the project is also taking classes at IIT. He is learning time managing skills that will allow him to finish the project before the academic year.

Section Eight: Collaboration and Support

- Industry collaboration: Hydraforce and Parker-Hannifin have donated components to build the hydraulic system.
- Interdisciplinary collaboration: This project has expanded from the mechanical engineering department to the electrical engineering department at IIT. An additional goal is to impact as many students in both academic institutions as possible (Purdue and IIT).

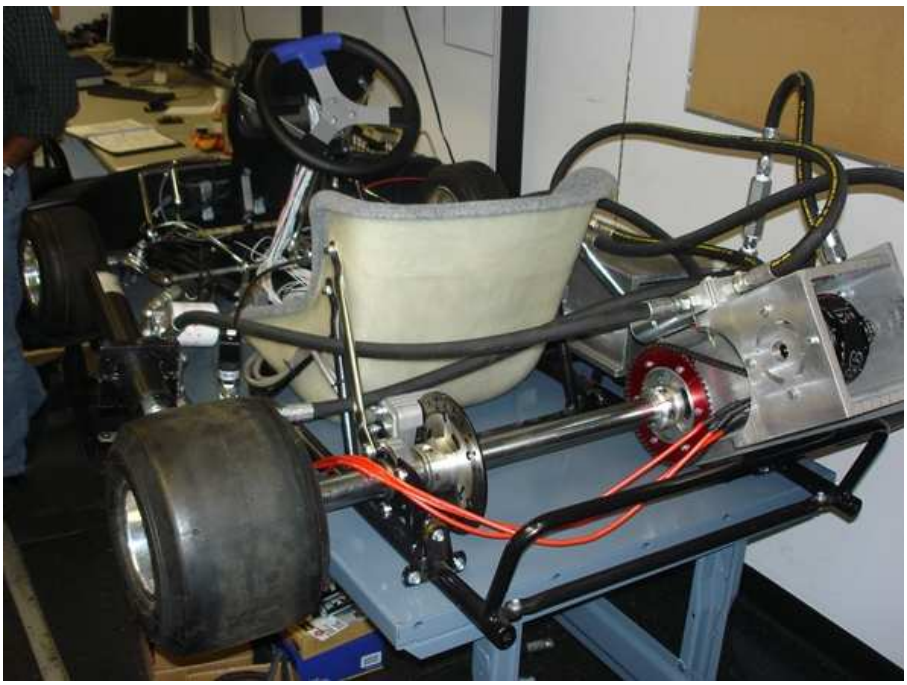
Section Nine: Next Steps

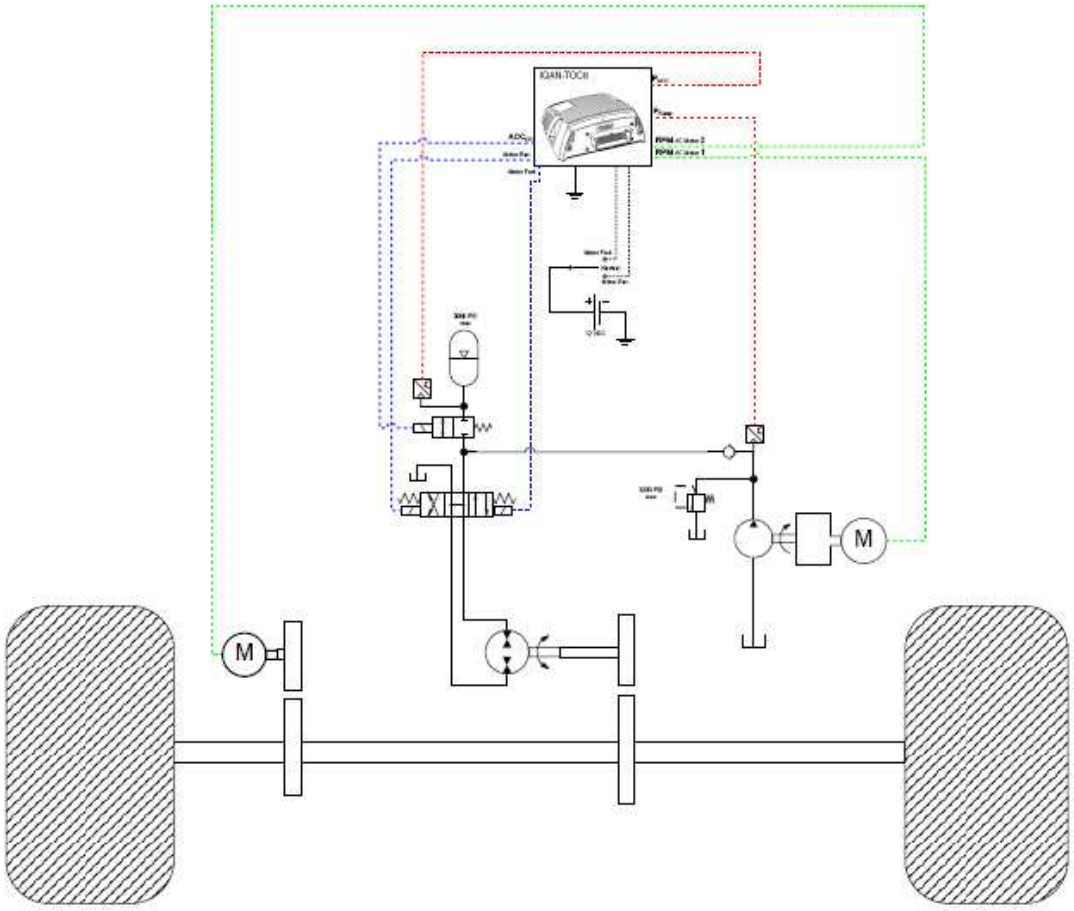
- Complete assembling and connecting the electronic controller and sensors on the vehicle.
- Test the vehicle and will perform measurements to estimate the electric power saved thanks to the hydraulic hybrid system
- Develop model based simulations to compare with the vehicle performance
- Incorporate the demonstrator vehicle in laboratory courses for the undergraduate programs in both departments
- Build a second prototype at Purdue for class use

Total Grant	**$ 5,000**	**Duration of project**	**12 to 18 months**
Reporting Period	**Months 1 to 9**		

Appendix

Prototype pictures:

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