An Electrical Go-Kart For Project Based Learning Platform

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Abstract: *The paper deals with the electrical go-kart as a teaching tool and a research platform. The teaching tool tries to improve the students motivations both on ecological vehicles and on applied sciences. The increasing motivation is due to the technical and experimental studies and also to an educational challenge ending the academic year. An association devoted to the educational go-kart applications is managing this go-kart challenge. Born six years ago, this association has grown locally and is setting up an interface between the administration and all academics. New members from French Institutes of Technology, high schools and engineer schools are getting enrolled in year after year. Groups of teachers, researchers, corporate managers and students involved in go-kart technical applications are sharing their knowledge and experiments thanks to the association website. A similar experience is also carried out in an American Institute of Technology. The first part of the paper focuses on the educational aspect and shows how it is possible to manage such ambitious project thanks to the synergy of members and academic structures. The second part of the paper provides some technical applications outlines. The aim is to ease the forthcoming team into the group and share knowledge and technical experimentations and to make students more sensitive to electrical vehicles.*

Keywords: go-kart, ecological vehicle, project based learning, power electronics, embedded electronics, sustainable development.

1. Introduction

It is a well known world phenomenon that students are less and less interested by sciences and technologies. Their teachers have to find new ways to make students more sensitive to these subjects. The electrical engineering domain is one of the subjects detailed here. The subject covers applied sciences such as electronics or power electronics, but also hard sciences as mathematics or computer science. The starting

point of the experience detailed here was to find a more attractive tool to motivate students in the electrical engineering domain and its connection with mechanics. The students involved in the project are coming from three different academic structures. The first group comes from high schools and vocational schools. The second is from Institute of Technology and the last from engineer schools.

The students are supervised by teachers and researchers from different domains as mechanical engineering, electrical engineering, computer science, automation and applied mathematics.

To be efficient as far as possible, the best size of groups is fixed to five students for one supervisor generally relayed by the technical staff.

The go-kart is the common teaching platform[1,2]. The main objective of this project based learning approach is to apply all the knowledge in real situations while participating in fun races with go-karts. In addition, discovering sustainable development, acquiring skills on electrical vehicles, stepping into the future, finding placements not to mention jobs, in relationship with these activities are side objectives.

Section 2 detailed the teachings aspects. A presentation of the e-kart association is given. Its website states the essential interface between the members. Non members can also discover all work done without any connection to the main documentation. The section indicates how the synergy between academics, companies and other associations is useful to organize and manage the e-kart challenge. The different trails of the challenge are also detailed in that part. Section 3 outlines the technical applications of the go-kart platform. The thread of this part has been chosen with respect to the age of the participation team in the challenge. While electrical engineering application is the main subject of this part, the management aspect is not neglected. Section 4 draws some conclusions and proposes further developments.

2. The teachings environment

This part deals with the electrical engineering domain. Main subjects are treated and applied by students on a go-kart platform. The students involved in the project are from high schools, Institutes of technology or Engineer schools. Their course level correspond to the bachelor of technology degree.

A scientific association born six years ago, named the e-kart association (www.ekart.com) is devoted to promoting the electrical vehicle as a teaching/researching support. Managing the e-kart challenge, setting an interface between companies and administration are other tasks of the association. Motivating teachers and students working in synergy is the goal. The Figure 1 shows its evolution. The black dots indicate the number of members on the range 0 to 300. The stars show the number of academics in the same scale. The small squares count the numbers of go-karts involved in the challenge.

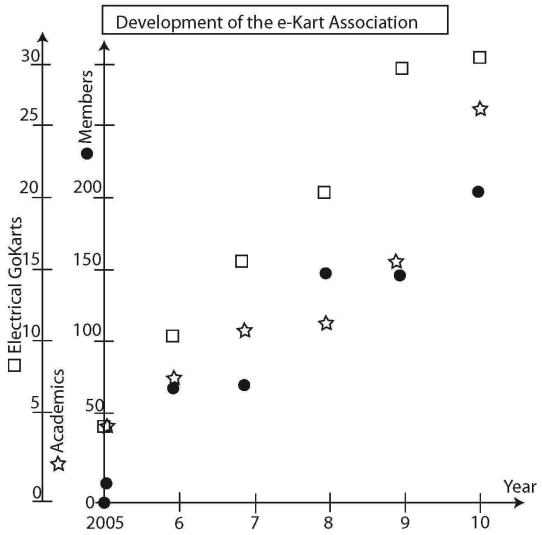

Figure 1. Development of the e-kart association

Figure 2 indicates the location the different team members on a schematic hexagon of France.

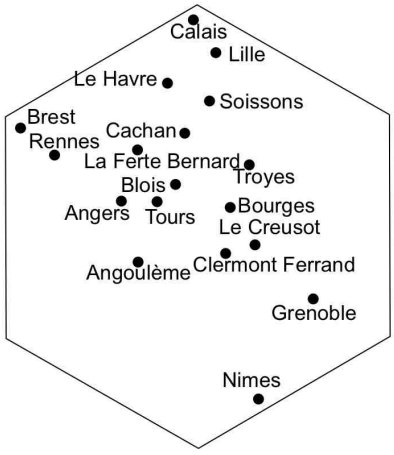

Figure 2. The location of the team members

For any team, the e-Kart challenge starts and

ends in an academic year. It consists of three steps. The first one drives students to a theoretical study on a chosen subject. Those subjects are detailed forward. The second step is done in connection with companies in order to obtain specifications sheets of components or devices for experiments. The last step brings students to do trials, experiments and measurements if any and prepare for the e-kart challenge. That is to write a final report uploaded to the association website (http://www.e-kart.fr), to prove in front a jury all work done, to design posters and make runs with others members. The figure 3 shows the members at the last e-kart challenge.

During one academic year, the students supervised by teachers-researchers have to choose a topic which they will focus.

Depending on the students'skills and preference, the domains can be embedded electronics, power electronics, mechanics, security, sustainable development, saving energy, motorizing, computer science, wireless communication and automation. A few examples of that kind of applications are given forwards. They also have the opportunity to make contacts with companies for sponsoring or acquiring specifications sheets of devices. Thus, they need to organize themselves to improve the project. Helped by supervisors, the project is setting an example of management. Documentation uploaded year after year on the association website offers helpful added technical elements and experimentations. This documentation is shared by the members of the association and is useful for the jury of the challenge validating the work in a real situation.

The e-Kart teaching challenge is now located in the middle of France with practical motorway and train access. For a few years a local association has offered a huge help in the logistic domain by finding local sponsors including administration and defining accommodation for the members. The challenge itself consists of some trials such as endurance run, fifty meters acceleration run and obtaining the best time lap run. To keep the motivation going, many awards are offered to the teams. The best report, the best poster, the best design, the best mechanics realization, the sustainable development and security tools are some awards examples. Recently the design of a kart for disabled persons and the use of electric bikes based on existing bicycles were added to the challenge.

3. Some technical applications outlines

The second part is a more technical part. Any work described in the following can be downloaded by members from the association website. It describes both the thread of the technical part and the team involved in the project.

Figure 3. The e-Kart challenge at Vierzon on 2010, May

Some technical examples of projects and their realization has been done on a speed variator and remote measurements (http://troyes10geii.e-kart.fr), a Zigbee study (http://bethune62geii.e-kart.fr), a mechanical device to adjust an electrical motor (http://senart77geii.e-kart.fr), a study of the battery performances (http://anjoukart.e-kart.fr), a pocket kart (http://tours37geii.e-kart.fr).

The reader will discover forward more details on the works done in the electrical go-kart environment and some pictures that show the realization.

A Quality management

To start projects on go-karts, and to apprise students on safety considerations, a third year team composed of two teachers and ten undergraduate and vocational students focused on quality management (http://e.kart.jules.vernes.fr/). Based on the 5S's management method the team built a battery locker (see figure 4).

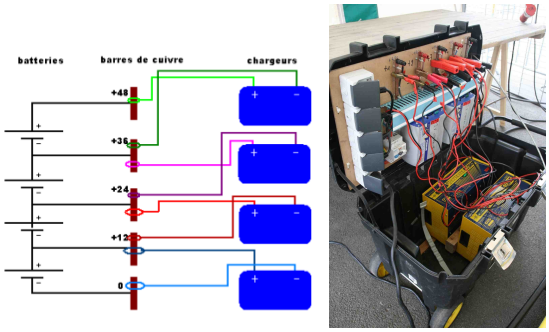

Figure 4. A battery locker

B A continous variation tork study

A team composed of one supervisor and two students coming from an engineer school devoted to Industrial Systems Engineering and in collaboration participates to the challenge through a group of students from a close Institute of Technology. The teacher's aim was both to discover the environment of the technical aspects of the challenge and to realize a study on a continuous variation torque. This device will be build and installed later on the electrical go-kart(http://anjoukart.e-kart.fr/).
The figure 5 shows an example of calculus for the radiices of the variable-diameter pulleys of the CVT. The figure 6 proposes the results of the theoretical calculation with a spreadsheet software.

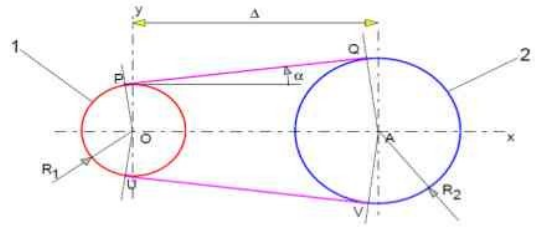

Figure 5. The schematic of variable-diameter pulleys for CVT

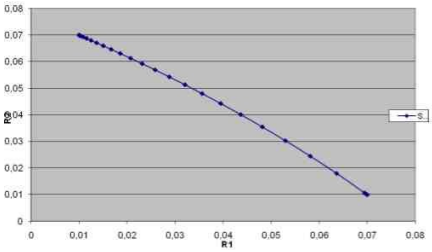

Figure 6. Representation of R1 vs R2

C Ultracapacitor for go-kart

A team composed of one teacher/researcher and nine undergraduate students worked on a go-kart with focus on ultracapacitors. The supervisor offered recent knowledge on these components and participated as a jury member of the e-kart challenge. During a summer student engineering workshop, the students worked on the go-kart seen as a research platform and educational tool. The aim was implementation of a series battery/ultracapacitor drive system with regenerating braking (see fig.7,8).
(http://web.mit.edu/first/kart)
They demonstrated the potential advantages, first-order model, and successful implementation of a series battery/ultracapacitor drive system for a lightweight electric vehicle [3].

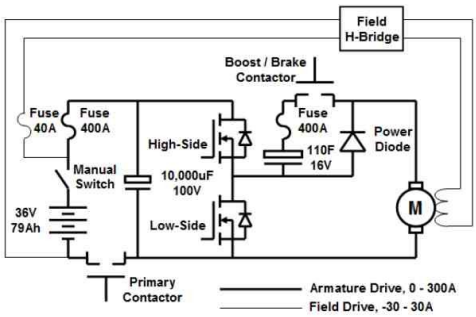

Figure 7. The electrical schematic of the experimental go-kart

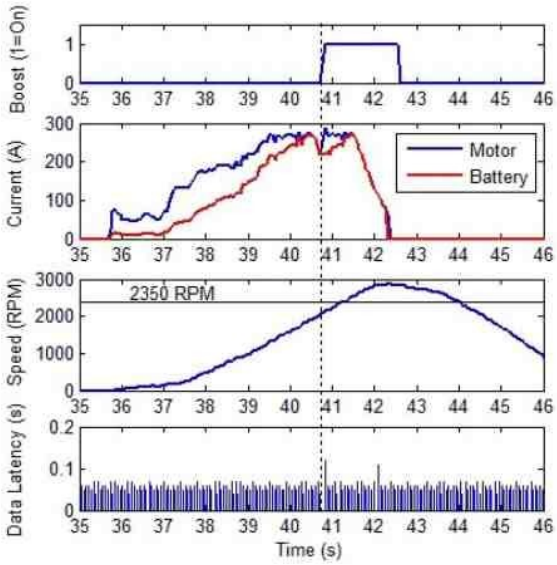

Figure 8. Recovered ultracapitor energy provides a boost

D Go-kart warning equipment

A team composed of two supervisors and four students coming from an Institute of Technology participates in the challenge. Those students come from a Vocational bachelor's degree in guided transportation maintenance (http://lille59geii.e-kart.fr/). The project realized by the group was to install warning equipment on an electrical go-kart. They focus on front and back lights warning. A study on LEDs has been done one year before the design of the LED based warning lights. Figure 9 shows the realization of the 4093 cmos integrated circuit that feed the LEDs.

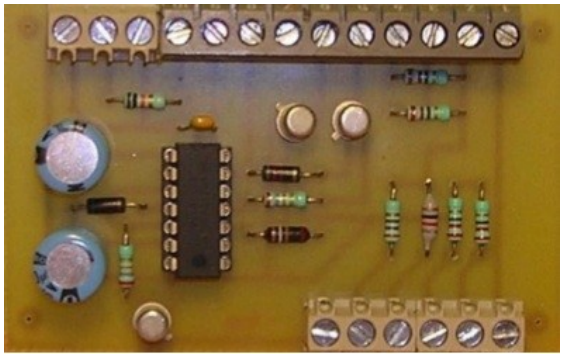

Figure 9. The 4093 cmos integrated circuit for lights warning

E Dash board

A team composed of one teacher researcher and four students in second grade in their bachelor of technology course worked on a dashboard installed on go-kart and its avatar on a PC. The objectives was to do in real time the measurements of some useful parameters in the kart as battery voltage and current, distance, temperature, time, lap time and the recording of all these parameters. The solution applied to the kart was to use a FPGA device and its programming tools. Such a work was made possible thanks to a company devoted to military and aeronautics domain. The result is presented on figure 10.

Figure 10. The dashboard installed on the go-kart

F A Fuzzy logic based battery charger

As defined in the syllabus of the bachelor of technology in the electrical engineering domain, four students and their supervisor specialist in the electronics domain worked on a battery charger for a go-kart.(http://aisne02geii.e-kart.fr/), Once the model chosen, simulation and experimentation of a classical current and voltage regulator, the students had the opportunity to discover the fuzzy logic controller for the battery regulation purpose. The comparison with the integral corrector first with an electrical simulation then with experimental results is proving the efficiency of the fuzzy logic regulation method.

The figure 11 provides experimental measurements of the battery current using a fuzzy corrector.

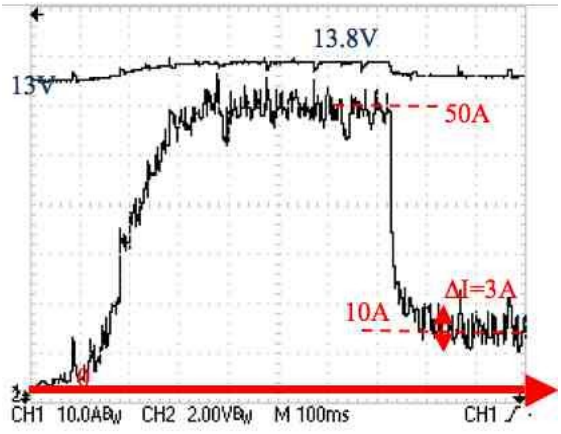

Figure 11. Experimental measurements of the battery current using a fuzzy corrector

G Remote go-kart

After four years participation at the go-kart challenge, a new team composed by one teacher–researcher and five students in their second grade in bachelor of technology course works on the embedded electronics on a go-kart(http://grenoble38geii1.e-kart.fr/). The aim was to install a wireless communication system in order to pilot the go-kart without a driver. The aim is to tackle all security aspects. The team installed the NI compactRio programmable automation controller equipped of the Labview Embedded software. Then, the present team had designed, realized, installed finally tested the system (see fig.12). The next and advanced project deals with a remote steering wheel.

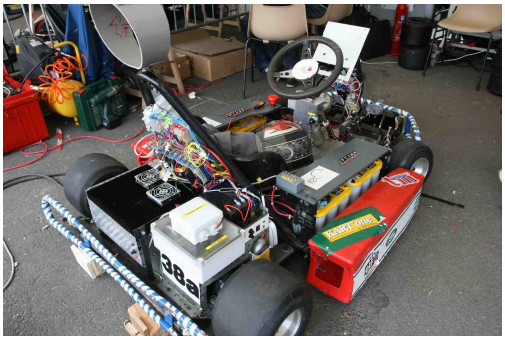

Figure 12. An embedded controller on a go-kart for wireless communications

H Applied maths

In relationship with applied sciences and

particularly those relative to electrical engineering, the authors have set a method to teach maths with a computer algebra program. The method in use for six years proved its success for increasing students'motivation. The method is named the DAR method an acronym for Discovering, Applying and Resolving. The practical works based on this method consist during three hours to model a problem then solve it using a computer algebra system. As an example, the problem of the radices representation of the variable-diameter pulleys of the continuous variation torque is solved using the method [4].

I Electrical go-kart for disabled persons

The root of everything about go-karts in particular and electrical vehicles in general started a few years ago in a French Institute of Technology. The subject taught at that time was power electronics. The electrical go-kart turned out as the ideal device both as a research platform and educational tool. Since that date many works has been launched with success in the direction of the management of an association, the maintenance of its website that is the most important communication tool, the useful meetings with partners and corporation, the organization of the e-Kart challenge and also some technical projects. Except new ideas, the final reports done by students are uploaded on the association website. Any member can download the documentation for convenience. Some examples of reports can be found on embedded instrumentation, asynchronous motor speed control or go-karts for disabled persons. This last subject deals with a system for fixing brake and accelerator commands on the steering wheel. It also gave the opportunity to participate to the Lepine Contest at the International Invention Show.

4. Conclusion

The papers shows how a project based learning on a electrical go-kart platform can motivate students to sciences and their applications. Year after year, the amount of students and teachers researchers is growing. The reasons are mainly due to the e-Kart challenge and the sharing knowledge and experimentation through the e-Kart website. Recently a local association located in the middle of France offered useful logistics in order to continue the works. New directions are now taken in that background as the kart design for disabled persons and the realization of electric assisted bikes.

Acknowledgement

Such an organisation has been possible thanks to the Universities, the Institutes of Technology and their technological platforms, the enterprises partners and sponsors, the local scientific associations and public administrations.

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