allen.jones@ieee.org

From: Daniel Eisenbraun <deisenbraun@mail.valenciacollege.edu>
Sent: Thursday, November 03, 2022 3:08 PM
To: Masood Ejaz; allen.jones@ieee.org; varadraj.gurupur@ucf.edu
Cc: Ian Matheson
Subject: Re: Valencia Team Request for IEEE Region 3 Project Funding
Attachments: IEEE_Application_For_Funding.pdf

Good Afternoon Dr. Jones,

Our revised copy of the application for the IEEE Region 3 Project Funding has been completed and is attached to this email.
Upon review, we hope to have addressed some of your main concerns regarding the project.

- Starting with the concern regarding the proposed charging setup, we have decided to move the Solar Panel to the roof in order to gain the most power from it as possible, with this change we have easier access to the vehicles Lead Acid battery which we will use instead of a set of lithium ion batteries and have selected a charge controller that is suitable only for lead acid batteries which is listed in the budget on our project website. This should resolve any issues related to temperature and ensure a much easier integration into the vehicle.
- Regarding the fans shown in the initial report vs those shown on the budget, we have settled for a set of 50mm fans that come in packs of 4 which has helped to reduce the cost of the fans significantly while giving us a set of fans that fit within our proposed cooling module. These fans have been modeled in FreeCAD by Ian and are going to be our best option currently.
- Regarding the driving of the fans, we will be using 3.3V relay boards that are connected to the various output pins of the MCU. This provides a degree of electrical isolation from the load while also allowing us to turn the fans on and off easily using the GPIO pins. The use of P-MOSFETs was proposed, but there were issues related to voltage across the MOSFET and the MCU.
- The use of PWM fans was considered at one point, but as you said the costs are rather prohibitive. Right now, our cost per fan (with the relay boards included) is $3.60. The cheapest PWM Centrifugal Fan would be $7.44 per fan or over double our current cost per fan. In an ideal world, we would have fans that could simply reverse direction, but it seems that currently existing models are too large or too expensive.
- We have added a small contingency to our budget as well as an estimated cost of materials needed for testing.

I hope that our revised application addresses your concerns regarding our initial application.

Thank you for your time, feedback, and consideration.

-Daniel Eisenbraun and Ian Matheson

From: Masood Ejaz <mejaz@valenciacollege.edu>
Sent: Wednesday, October 26, 2022 8:40 AM
To: allen.jones@ieee.org <allen.jones@ieee.org>

Cc: Daniel Eisenbraun <deisenbraun@mail.valenciacollege.edu>; Ian Matheson <imatheson@valenciacollege.edu>
Subject: RE: Valencia Team Request for IEEE Region 3 Project Funding

Dear Dr. Jones,

Thank you for your feedback. The team will review the proposal per your suggestions and resubmit it by the deadline. Dr. Gurupur will also be requested to send you an email to show the section's endorsement to manage funds if project will be sponsored.

Best regards,

-Masood

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From: allen.jones@ieee.org <allen.jones@ieee.org>
Sent: Wednesday, October 26, 2022 7:21 AM
To: 'Daniel Eisenbraun' <deisenbraun@mail.valenciacollege.edu>; Ian Matheson <imatheson@valenciacollege.edu>; Masood Ejaz <mejaz@valenciacollege.edu>
Subject: Valencia Team Request for IEEE Region 3 Project Funding

Daniel, Ian, and Dr. Ejaz,

Thank you for submitting your application for project funding for your Automated Solar Heat Exchange project. The Region 3 Projects Committee reviewed it and we need for you to address a few items before we can pass it up to the IEEE Region 3 Executive Committee (ExCom) and ask them to formally vote to authorize the transfer of funds.

- One of the requirements when submitting the application is that it needs to include "The endorsement of the Section Chair indicating that the Section agrees to be responsible for the financial management of the funds." This is so that everyone is in agreement that Region 3 will transfer the funds to the Orlando Section and then the Orlando Section will take care of handling the reimbursement requests from the Valencia Team. I realize that your team copied Dr. Gurupur, the Orlando Section Chair, on your application, but I need an email from Dr. Gurupur saying that he endorses the project and agreeing that the Orlando Section will be responsible for the financial management of the funds. If you can ask him to provide that, then we can get this requirement checked off.

- The second thing that needs to be addressed is the proposed charging setup. There are a few safety issues with what is being proposed that will need to be addressed before we can recommend your project for funding.
    - Although I realize that the seller's listing for the PowMr 10A Waterproof Solar Charge Controller says that it is for Li(NiCoMn)O2 batteries, the product installation web page of PowMr's site (https://powmr.com/solar-charge-controller/current/10amps-mppt/powmr-solar-charge-controller-waterproof-10a-charge-controller-12v-24v-auto-load-on-24hours-ip68-waterproof-solar-controller-for-lead-acid-battery/) specifically says that this product is suitable for lead-acid batteries and not for nickel-metal hydride or lithium-ion batteries. On their Solar Charge Controller web page, if you check the lithium battery option for battery type, they only list one product – a 60A 12V 24V 36V 48V MPPT Solar Charge Controller for $94.90. Charging lithium-ion batteries with a charger that is not specifically designed for that creates a very serious fire hazard. If you connect several lithium-ion batteries in series to get the 12 volts that you need for your fans and then connect them to a 12 volt charger, the individual batteries will often charge at different rates due to things like normal production variations. Since a charger that is not designed to charge multi-cell lithium batteries can only see the voltage of the combined string of cells and not the voltage of each cell, it can easily overcharge one cell in the string of cells while leaving another cell undercharged. The overcharging can lead to a battery fire.
    - A second safety issue involves the temperature rating of the proposed batteries. I couldn't find a manufacturer's datasheet for the batteries, but the seller's listing on Amazon says that the upper *charging temperature* limit is 45°C which is 113°F. It is easy to imagine a scenario where the user leaves their car parked without putting the windshield sunshade/solar panel in place. The batteries run low and the interior temperature in the car rises to more than 45°C. So far that's not a problem because they are not charging the battery and the battery's maximum *storage temperature* rating is 60°C (140°F). But now the vehicle's driver realizes that they forgot to set up the sunshade/solar panel. They deploy the sunshade/solar panel and start charging the battery when it's temperature is more than 45°C. Now you have the fire risk problem again.

  Lithium batteries can be very tricky things to charge safely. In order for us to recommend your project for approval, you will either need to find a way to charge the lithium-ion batteries safely, or you will need to shift to some other battery type that is more forgiving than lithium-ion.

Unlike the two issues listed above, the following things aren't "show stoppers," but you may want to consider addressing them while you are working on your application.

- In Figure 1, you call for 40mm x 40mm fans while the parts list calls for 60mm x 60mm fans. You just need to make the two references consistent.
- I don't see parts for any kind of a driver circuit between the Raspberry Pi Pico H and the fans included in the parts list. The output pins of a Raspberry Pi are not capable of directly switching the voltages or currents that a 12 volt, two wire fan uses. The Raspberry Pi, and most other processors, also can't handle the inductive kick that directly turning a fan on and off produces. It might work at first, but after a while the Raspberry Pi will start mysteriously dying. Even before the inductive kick kills the chip, it could inject electrical noise spikes into the power connections for your Raspberry Pi, causing your program to occasionally crash for no apparent reason. The driver circuitry is made to sit between the processor and the load and adapt the voltages and currents that the processor can provide to the voltages and currents that the fan needs.
- As you noted in your application, the large number of fans make up a major part of the budget. That is not necessarily a problem when it comes to getting this approved, but if you ever did want to turn this into an actual product, it might become problematic due to the cost. As part of your senior design project, you might want to have the Raspberry Pi experiment with utilizing varying numbers of the fans to see what the optimum tradeoff between resulting product cost and performance is. You may also want to consider using PWM controlled (4-wire) fans instead of the 2-wire fans that are being called for. When dealing with fans (and pumps), something called the "affinity laws" come into play. Basically, the affinity laws say that the rate of flow of a fan varies directly with the fan speed, the air pressure varies with the square of the fan speed, and the power consumption varies with the cube of the fan speed. So if all other factors are equal, cutting the fan speed in half cuts the airflow in half but cuts the power consumption by a factor of eight. That can make a big difference in terms of the size of the battery that you need, the size of the solar charge controller, and the size of the solar panel. If

you use PWM controlled fans, you can vary the speed of the fans by simply varying the duty cycle of the pulse width modulation signal that goes from the Raspberry Pi to the fans. The 4-wire fans are more expensive, but you might greatly simplify or eliminate the driver circuitry between the Raspberry Pi and the fan and eventually cut the cost of the solar panel/charge controller/battery.

- On virtually any project, something unexpected comes up. You may want to include a "contingency" line item in your proposed budget to allow for that. Something around 10% of the total budget might be reasonable. That way if you end out needing the extra funds to take care of things like a part that dies, the Orlando Section will still have funds set aside that they can use to handle your reimbursement request. If it turns out that you don't need all of the contingency funds, then the extra money would remain with the Orlando Section.

Please make your changes to your application and send it back to me no later than Friday, November 4th at 5:00 pm. That will give the Region 3 Projects Committee time to review the revised application and have it ready to present to the Region 3 Executive Committee during their meeting in November. If we get it later than November 4th at 5:00 pm, then we may or may not be able to have everything ready for the ExCom to approve in their November meeting. Since they are considering canceling their December meeting, that could cause the funding approval to get delayed until January.

Thanks,

Allen

Allen Jones
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