MOBILE INTEGRATED SOLUTIONS LABORATORY

Fermier Hall, 3367 TAMU, 466 Ross St, College Station, TX 77840

PROPOSAL FOR AN ECETDHA MINI-GRANT

SENSORTAG POWER DRIVER DEVPACK

Dr. Joseph Morgan

Professor

Telephone 979-575-0128

December 5, 2016

Abstract

Of all the technological trends that are taking place right now, perhaps the biggest one is the Internet of Things (IoT). IoT is essentially the concept of making things "smart." It is a network of physical objects, devices, vehicles, etc. embedded with electronics, sensors and network connectivity that allows these objects to connect and exchange data. This allows opportunity for integration of the physical world into computer based systems, resulting in improved efficiency, connectivity, and economic benefit. Experts estimate that by the year 2020, the IoT will consist of almost 50 billion objects.

With that being said, Texas Instruments (TI) recently released an IoT device called the SensorTag that allows for prototyping of IoT devices. The SensorTag, as its name suggests, is a development kit with an array of various onboard sensors including an accelerometer, gyroscope, magnetometer, and temperature sensor. Alone, the SensorTag is unable to display any of its sensor data. However, its ability to integrate seamlessly with mobile applications and communicate through Bluetooth, 6LoWPAN, or ZigBee allow it to utilize the phone's connectivity; making it easy to collect, upload, and share data. It's also simple to reprogram and debug through its JTAG interface. These features allow the SensorTag to integrate into many embedded systems, furthermore allowing consumers to design and create a tremendous number of different IoT systems and devices.

Another feature that makes the SensorTag adaptable to numerous systems is the fact that it is expandable with interchangeable DevPacks that make it easy to add additional sensors, actuators, and capabilities. Some of these include a debugger DevPack, which allows you to program the SensorTag via USB; a Watch DevPack, for smartwatch, refrigerator display, and other remote display applications; and an LED Audio DevPack meant for home automation and smart lighting applications.

However, some systems might require the use of motors, servos, or other higher power actuators to accomplish a task, and as of now, none of the DevPacks support power driver capabilities, nor is there a power driver board made specifically to integrate with the SensorTag. This limits the application space of the SensorTag and although general power driver boards can be integrated to work, a power driver board designed specifically to integrate with the SensorTag would be valuable in allowing the SensorTag to be applied in a wider range of applications.

Proposed Project Details

The Mobile Integrated Solutions Laboratory (MISL) is interested in designing, developing, documenting, and delivering a power driver board capable of interfacing with the SensorTag that can be marketed as a DevPack. We believe this would significantly broaden the SensorTag's application space while also allowing undergraduate students the opportunity to integrate this new technology more fully into their class / lab activities and gain valuable design experience.

Some of the functional requirements planned for the new DevPack are: adding a switch, voltage regulation, an expansion header, and having eight power driver pins; several of which are intended to increase the scope of the SensorTag itself. These can be seen in Figure 1. The inclusion of a switch will allow the system to be powered on and off with ease and eliminate the need to disconnect from the power source/battery to power down the system. The voltage regulation provides the necessary 3.3V to power the SensorTag from the power driver board simply through the DevPack connector, so there's no need for the coin cell battery or additional wiring. The expansion header will essentially provide a breakout of the pins on the DevPack connector so that the pins not being utilized may be used externally – thus removing the need for the Interfacing board DevPack in many applications. Lastly, the most important aspect of the board: the 8 power driver pins. The design will use two dual H-bridge devices, which will allow for 8 independent PWM signals, or 4 different PWM channels. The great thing about this is that it has the ability to support a wide range of applications. The DevPack will allow the user to control up to 4 independently controlled DC motors, 2 stepper motors or other high power devices requiring continuous control. With the intelligence being handled by the SensorTag, the power board can remain relatively small, making it the preferred solution among other boards of its type.

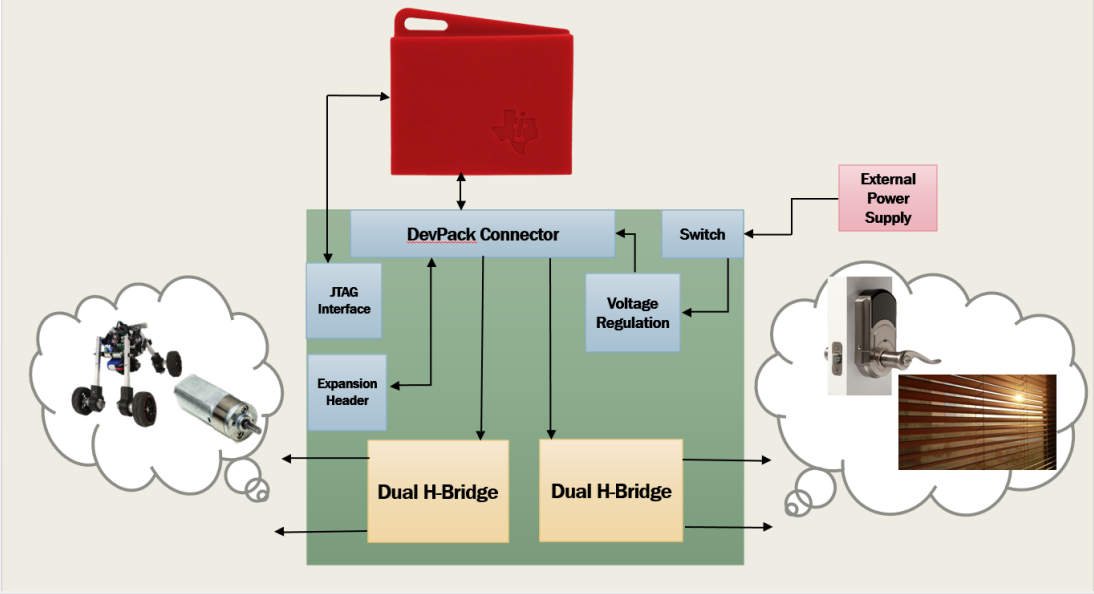

Figure 1 - Conceptual Block Diagram

There are a number-of examples of how MISL would use the SensorTag paired with the new power driver DevPack. One of the most visible would be upgrading the newly developed STEM outreach robot. As part of a current/ongoing project, the SensorTag is being used as the embedded intelligence to wirelessly control the Dynamic Systems Technology Robot (DSTR), pictured in Figure 2, over Bluetooth Low Energy (BLE). The SensorTag connects to an android powered device which, with the use of an app designed in MISL, is used to power and control the robot's four DC motors. Currently, the DSTR robot is being driven by a generic L298N H-bridge that connects with the SensorTag's interface board, and the wiring, shown in Figure 3, is somewhat daunting and detracts from the high-tech appearance. In this system, having a power driver DevPack would eliminate the need for the interface board and generic dual H-bridge and replace it with one board that can plug directly into the SensorTag and essentially remove a majority of the messy and fault inducing wiring. The DSTR robot is gaining popularity as a resource for outreach and STEM education in grade schools. It has been featured in two workshops this past summer, with plans future workshops already underway. It is also being integrated into two sections of Freshman Engineering at Texas A&M, where students will have the opportunity to build the robot from the ground up, allowing the students to study the mechatronics platform from a systems engineering approach. Student teams will analyze the power, mechanical, electrical, control, and communications subsystems as they build and then race the robots at the end. With the power driver DevPack, TI would be able to offer a compact solution for the "brain and power" components for the DSTR robot, thus enriching TI's recognized support in STEM education and outreach.

Figure 2 - DSTR

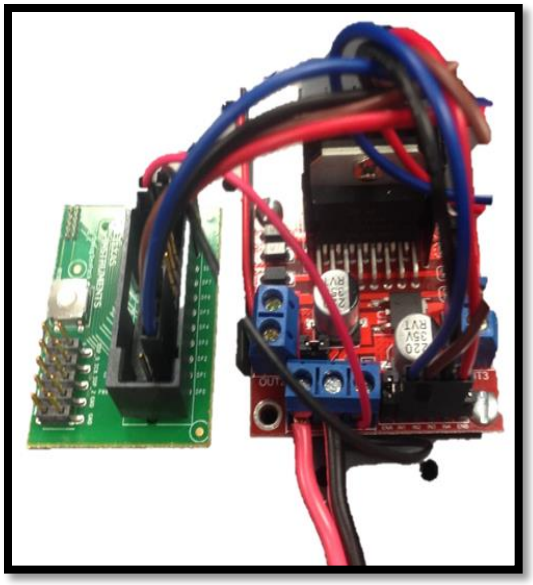

Figure 3- Current Wiring to implement DSTR

With the recent boom of IoT devices, smart house applications are also gaining considerable popularity. With this power driver DevPack, the SensorTag can easily be a go-to device for those wanting to design and control their own smart house systems. Some of these systems may include but are not limited to automated door locks and enhanced temperature control using automated blinds.

Timeline

This project will be completed by one ESET undergraduate student working in MISL. The design process is already underway, with the anticipated completion scheduled for May 2017. The student will have an ESET faculty member participate as a technical advisor and will be expected to meet defined prototyping standards, including a number of formal design reviews with the project stakeholders. These standards include a conceptual block diagram, functional block diagram, presenting a preliminary design review, then developing a schematic, board layout and Bill of Materials so the board can be manufactured, populated and tested to verify it meets all the functional requirements and performance specifications expectations of the customer agreed to at the start of the project.

The Mobile Integrated Solutions Laboratory is seeking funding support for this project. The power driver DevPack will be supported by MISL, and all technical design information will be disseminated on its wiki pages. The intent is to commercialize the DevPack so that other students and universities can increase the value proposition of TI's new SensorTag. For more information or inquiries into supporting the project, please email Ms. Alexis Crandall at crandall1029@tamu.edu.

Budget

As seen on the budget attached, the mini-grant will help the research lab and faculty member to fund the labor costs, manufacturing costs, the acquisition of parts, and board population associated with the successful completion of this project.

Student Labor:	$500
PCB Manufacturing:	$300
Parts:	$100
Population:	$100

($ Requested $1,000.00 from ECETDHA)