1. Title: "*Scholarship of Teaching and Learning: Smart Heating and Ventilation System development for urban Houses*"

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3. Budget: The total requested amount is $1,988, including the faculty stipend and consumables.

4. Enrolment: STEM courses ETEC 4378 HVAC systems and ETME 4376 Applied Thermodynamics is targeted in this proposal. The expected enrolments are in the range of 8 to 15 students for ETME 4376, since it is a new course offered for the first time. The expected enrolment of ETEC 4378 is in the range of 15 to 30 for spring 2021.

5. Project narrative:

Executive Summary:

Conventional Heating, Ventilation and Air Conditioning (HVAC) systems are based on direct digital control which automates the control of a condition or process by a digital device (computer). With the innovations happening in the HVAC industry, the modern houses tend to build cost efficient, compact and smart HVAC systems. This includes replacing the bulky HVAC ducts with direct cooling tubes, replacing expensive control systems with cheaper microcontrollers and relays, and customizable air conditioning system using smart phone or web-based interfaces. These types of novel systems are already catching the market, for example Google Nest, ecobee3 etc. The objective of this project is to develop an active learning experience for undergraduate students to become creative in developing such modern HVAC systems. The students will be able to program the Arduino microcontroller, make reduced scale models of homes using plywood, utilize electronic actuators to control the heating and cooling systems in the model.

Project Narrative

The project consists of a set of electronic, electrical devices integrated together like as shown in the Fig. 1. The central control system for the HVAC will be Arduino or Raspberry pi 4 depending on the student interest. Raspberry pi 4 can perform like a computer and is more advanced than a regular Arduino microcontroller.

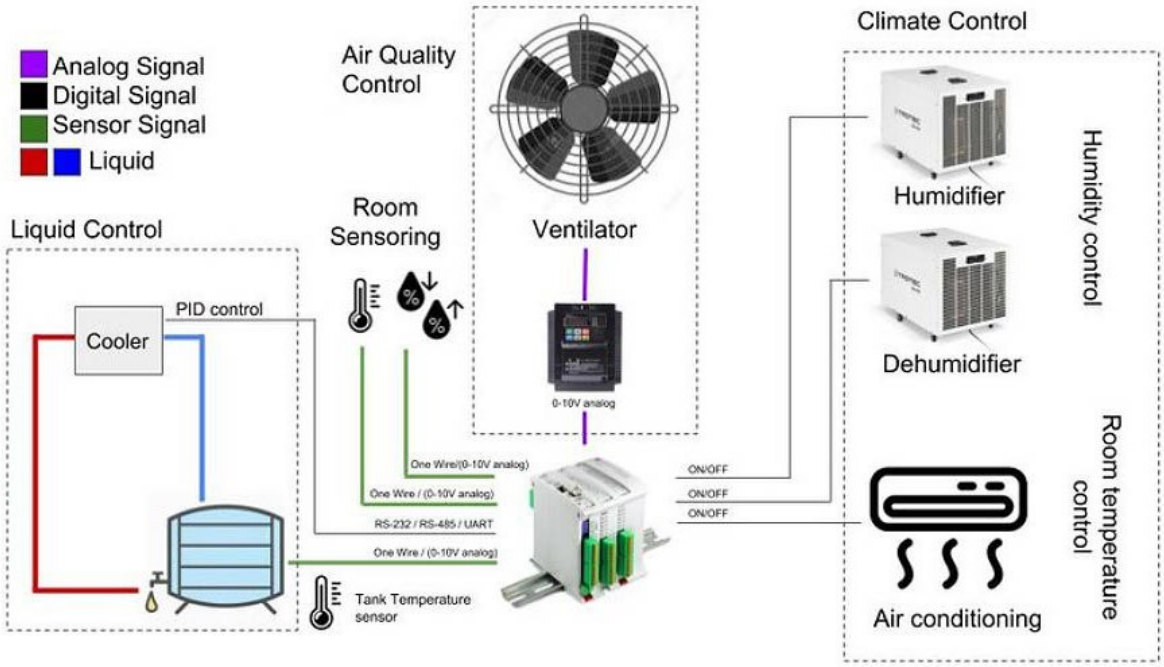

Figure 1: Arduino based HVAC control system (Image from industrialshields.com)

The *first phase* of the project consists of brain storming session with student groups to come up with a control logic diagram for the entire system. Meanwhile students will get trained on using microcontrollers by the PI. The *second phase* of the project focuses on making the scale down version of the home using plywood and basic building materials. Then students will utilize the microcontrollers supplied by the PI to program the system to turn on and off the cooling fan, heater, duct openings etc. The *third phase* of the project is aimed at controlling the system remotely using an android app or web-based server. This will help students to commercialize the product.

Rationale:

The project focuses on active learning experience for the students, where they will experience the "break and fix" methodology of a concept. Also, the students will get exposed to a real-world type engineering project where they gain the confidence in building an actual application for customers, which can lead to business startups. From PI's experience on similar projects, students are very excited to do such hands-on activities than conventional lecture-based learning. Also, the students will be able to work in groups, make decisions through discussions etc. It is also noticeable that students who tend to perform average on written exams, performs very well on these creative projects.

Materials and Methods

Most of the materials needed for this project is listed out in the budget section. The microcontroller, tools and supplies, dc power supply etc. are not listed in here and will be supplied by the PI's research budget. The experiments and development of the project will be conducted in the Engineering Technology Annex C building in the Room 105 and associated lab spaces.

Expected Results and Dissemination Plan

The main output of the project is a physical prototype of the miniature home with control system and HVAC accessories to simulate the real-life HVAC systems. The developed prototype will be functional through a smartphone app and the temperature and humidity of the home can be controlled remotely.

The experiments will be conducted to predict the optimum power usage of the HVAC system on a cold day and a hot day. The microcontroller logic is optimizable, and students can experiment on getting the best outcome with least power consumption. This study results will be published in peer reviewed journals and ASME conferences and in undergraduate research symposiums of SHSU.

Budget and Brief Budget Justification

Description	Cost	Units	Price
Faculty Stipend	$1,500	1	$1,500
Compact 9.2 in. 1500-Watt Electric Ceramic Space Heater with Automatic Overheat Protection	$27.9	5	$139.5
USB Mini 4 in. Desktop Cooling Fan with Adjustable Direction	$11.04	5	$55.25
18 in. x 24 in. x 0.093 in. Clear Acrylic Sheet Glass Replacement	$13.48	5	$67.4
Medium Density Fiberboard -Common: 1/2 in. x 2 ft. x 4 ft.	$10.78	10	$107.8
Iot Relay - Enclosed High-power Power Relay for Arduino, Raspberry Pi, PIC or Wifi, Relay Shield	$23.5	5	$117.5
Total			$**1,987.45**

The faculty stipend is aimed towards the effort the PI will be spending in developing the microcontroller logic, trouble shooting the student logics etc, assisting students with soldering, assembly, fabrication of the systems beyond the regular teaching and office hours.

The heater is required to supply heat to the small home if the temperature drops below the set condition. The cooling fan is used to circulate the air throughout the small ducts in the model house. The acrylic sheet is used to visualize the interior details of the HVAC system while demonstrating the project. Fiberboard is used to cut and make the model house. Relay is used to turn on and off the high voltage electrical devices using low voltage microcontrollers.