

AVR Microcontroller

Group Project: Requirements and Selected Group Project Ideas

ECE 372A

Group Project Requirements

- Must state the problem you are trying to solve.
- Must propose your solution to the problem.
- Must define 4 requirements of the solution that you will use to determine the level of your success (using a rubric).
 - You will determine your criteria to grade your performance (rubric) for each requirement.
 - Requirements must have measurable outcomes.
- Project must include one input sensor minimum.
- Sensor measurement(s) must control an output device.
- Serial communication must be implemented. (sensor device or output device). Use I2C, SPI or RS232 serial communication protocol.
- Initial project proposal must be submitted and approved.
- Well documented source code including all functions that you write.
- Must use original source code for all functions. (Note: Using built-in libraries requires instructor preapproval).
- Your rubric must be evaluated at end of project.
- You will demo and present project as a group at the end of the project.

Project Sequence and Timeline

- Form groups (3 to 4 people) - **Oct 31**
- Submit initial project proposal – **Nov. 8**
 - Initial Proposal submission Requirements are listed in subsequent slides.
- Approval by instructor – **Nov 11**
- Develop tasks and timeline for your project (project plan).
- Execute project plan and track status. (update plan if necessary).
- Demo of project as a group will occur at your last lab date.
- Presentation of project as a group will be during assigned final exam date.
- Code and presentation including any revisions are due in D2L by the last day of final at noon.

Template that you may use

- The initial proposal and the group project final project presentation templates are located under D2L group project (lecture site).

Be sure to include the following in your final presentation

- Power requirements. Estimate how much power is needed. If it is battery operated estimate the battery life. See final presentation slide for details.
- A mechanical diagram – how will your system be packaged and integrated into your system application? A conceptual diagram showing your ideas on what your prototype would look like will suffice. See final presentation slide for details.
- Follow-up recommendations on next steps as part of your conclusion.

Group Project Ideas from past Semesters

Note: See additional ideas in the D2L section for Class Project

Heartbeat sensor

Problem Statement

- Heartbeat sensors are quite popular in today's wearable electronics. But heartbeat is only one of many important factors when determining one's well being.
- Many people enjoy exercising, but in places like Tucson, AZ, it can be all too easy to develop medical conditions like heat stroke, hypothermia, and exhaustion.
- Heartbeat alone can't accurately predict these conditions, or alert the user that there may be a problem unless their heartbeat is extremely high or low.
- There's currently not a great market for testing body temperature that is small and low key, since its accuracy is dependent on skin thickness.

Proposed Solution

- By utilizing both a heartbeat sensor and a temperature sensor however, we may be able to get critical data changes faster.
- Using the heartbeat sensor and a buzzer, the user will know if their heartbeat is continually out of range with a constant beep, or if their sensor pulls an odd reading by a single beep.
- The temperature sensor will show the temperature of the user, and alert them if the value is out of range.

Pressure Detector Glove

Problem Statement

Various health conditions and diseases are capable of causing nerve damage in one's body. Losing feeling in your hands impairs one's judgement when exerting pressure, i.e. gripping an object, pushing forward, etc. The inability to gauge how much pressure your hands are applying can result in further damage to the body or be harmful to the object/person that the pressure is being apply to.

Proposed Solution

A glove will be developed that will assist with regaining the sense of touch and pressure in one's fingers. A sensor will be programmed to detect pressure that is asserted to a fixed object. This technology could be used in various other applications as well, specifically with anything that relates to functions that incorporate force and pressure control.

Rotating Solar Panel

Problem Statement

- Solar panels not angled correctly will not generate as much power due to the sun's movement.
- Most solar panels are installed at an angle that is calculated on an average of the sun's potential throughout the day.

Proposed Solution

- Create a rotating solar panel that would adjust to the sun position and would provide maximum power
- Four photoresistors connected in parallel and we move the solar panel towards the photoresistor with the lowest resistance to maximize solar

Martian Agriculture Revolution System

Problem Statement

- There is a need to regulate soil moisture levels on Mars or on any planet requiring human habitation.

Proposed Solution

- Our system will implement a soil moisture sensor which provides the controller with soil data. This data is used to control a water pump. When the sensor reports a moisture level below a certain threshold, the controller activates a water pump until the moisture level is above the threshold. The system will be designed for added inputs if the need arises.

Automatic Dog Feeder

Problem Statement

We are working to mitigate the time it takes to manually feed family pets, such as dogs or cats. This will also solve the problem of trying to find someone to care for your animals when you are gone on vacation.

Proposed Solution

We are going to create an automatic dog feeder that will feed the dog based upon the weight of the dog and how much food they need to eat.

This feeder will have timers that will dispense food in cycles according to the owner to ensure a proper feeding cycle.

Cooled Backpack

Problem Statement

- During long walks between classes, backpacks can cause perspiration on your back. So this project will help relieve the issue by keeping your back cooler.

Proposed Solution

- Our solution will consist of a Thermoelectric Cooler that will be monitored by a temperature probe. This probe will help us control the temperature through a motor controller. We will set the target temperature through a bluetooth connection.

Posture Tracker

Problem Statement

- People with poor posture report headache and pain in the cervical and lumbar spine more frequently.¹
- The **number one reason for absenteeism** among employees is due to musculoskeletal disorders (MSD). MSDs are a result of prolonged postural distortion patterns.²
- According to the Bureau of Labor Statistics (BLS) in 2013, MSD1 cases accounted for 33% of all worker injury and illness cases.
- Work-related MSDs can be prevented. Ergonomics --- fitting a job to a person --- helps lessen muscle fatigue, increases productivity and reduces the number and severity of work-related MSDs.⁴ Neutral body positioning is a comfortable working posture in which your joints are naturally aligned. Working with the body in a neutral position reduces stress and strain on the muscles, tendons, and skeletal system and reduces your risk of developing a MSD.³

Proposed Solution

- Our solution: a **posture tracking sleeve** that can be used on a variety of different chairs. The sleeve, made of a stretchy fabric, goes over the back of the chair with an additional part going over the back of the seat. It can **alert the user of poor posture** in real time and **track posture data** over time in order to encourage neutral posture. The sleeve uses pressure sensors and a microcontroller.
- It integrates with three OSHA-recommended sitting postures: upright, declined and reclined sitting and can be for personal use as well as use in schools or, particularly, the workplace.³

Breathalyzer

Problem Statement

- Many people are unaware of their Blood-Alcohol content when drinking alcoholic beverages, especially in larger amounts. Due to this, some may believe they are more sober than they might actually be, leading them to make bad choices, such as driving under the influence.
- Although there are many breathalyzers on the market today, they can be costly or inaccurate.
- Even The most expensive breathalyzers only last a few years before the sensor loses accuracy.

Proposed solution

- The prototype has the following components:
 - A Replaceable battery
 - A button to take the measurement
 - A replaceable MQ-3 Alcohol Sensor
 - A 7-segment display for showing the BAC
 - A piezo buzzer that beeps once when the measurement has been taken and twice when the BAC is above the legal limit.
 - A mouthpiece to breath into.
 - Arduino AT-Mega 2560 for controlling the breathalyzer.
- The prototype is a hand-held device that could easily be tucked in your pocket and carried around. To take a measurement, the user presses the measurement button once, breathes into the mouthpiece, hears a beep, and reads the display. If the BAC reads above 0.08, 2 more beeps are made telling the user they shouldn't operate a vehicle.

Automated Object Detection and Avoidance System

Problem Statement

- As our world grows fond of automation, there are many devices to be improved upon. Some such technologies are automated vehicles like rovers, submarines, and drones. These vehicles all move, and require a system which prevents crashing into obstacles or self-inflicted harm on its own machinery.

Proposed solution

- With an Accelerometer and multiple Ultrasonic Sensors, we can create an object/collision detection system that will promote the safe use of these self driving and self sustaining automated vehicles.
- More specifically, the Ultrasonic sensors will detect three different ranges of obstacles (in practice even more will be required for maximum safety) and will relay information of oncoming obstacles quickly to the vehicle. Detection of objects will allow the vehicle to avoid them, or brake in response.
- The Accelerometer will be used to notify handlers of sudden stops, whether manual or unannounced.

Smart Parking Garage

Problem Statement

- In accordance to the National Safety Council, “On average, more than 50,000 crashes occur in parking lots and parking garages annually”
- Many of those accidents that occur are due to distracted drivers that are searching for a parking lot instead of paying attention to obstacles
- A system should be implemented that aims to reduce accidents that are a result of distracted drivers searching for a parking spot

Proposed solution

- With an Accelerometer and multiple Ultrasonic Sensors, we can create an object/collision detection system that will promote the safe use of these self driving and self sustaining automated vehicles.
- More specifically, the Ultrasonic sensors will detect three different ranges of obstacles (in practice even more will be required for maximum safety) and will relay information of oncoming obstacles quickly to the vehicle. Detection of objects will allow the vehicle to avoid them, or brake in response.
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SOS Alert System

Problem Statement

- Falling can be dangerous and require immediate attention. Where elderly people are at a higher risk of falling and not being able to get up. Our project directly solves this issue with the implementation of an SOS alert system.

Proposed Solution

- Our device uses sensors to trigger an alert system when someone has fallen. The simple design registers when someone goes from standing up straight to laying on the ground i.e. falling. The alert system consists of 4 LEDs and buzzer to alarm people around for help. There is also a on and off button to turn off the device when it is unneeded.

Bike Theft Begone Bike Alarm (BTBBA)

Problem Statement

- Bicycles are frequently stolen even when conventional locks are used. In addition, even if a lock prevents a thief from stealing the entire bike, they might make off with a wheel or a seat. For example my friend Noah, his bike wheel was stolen at 3 am when its parked outside of the main library. Needless to say, the campus would benefit from some added bike security.

Proposed Solution

- Our proposed solution is an armable and disarmable alarm that is triggered by vibration of the alarm itself. This alarm will be small enough to attach to a bike. This way, should a thief attempt to move the bike, the alarm will go off and alert others that trouble is afoot.

Fish Nanny

Problem Statement

- Taking care of fish is really hard. Poor fish die everyday because their living conditions are subpar. There are a lot of variables to keep track of in order to make sure the fish can have the best life possible. Things like temperature, pH level and moss growth can be the difference between life and death... for fishes.

Proposed Solution

- Our proposed prototype is a device that can track some of the most important metrics of a fish tank. It will track temperature, pH, water clarity, and whether or not the tank is upright through the employment of various sensors and a creative tank setup. If any of these sensors see less than ideal conditions, the fish owner will be notified by either a light (LED) or a message on an LCD screen

Automatic Desktop Air Conditioner

Problem Statement

- Arizona is a dry desert state where temperature can reach over 100 degrees F. To keep cool, Arizonans will crank up their AC's all day. By blasting the AC at full force all day, some Arizonans' electric bill will be over \$300 per month this summer. This is a huge problem for families wishing to lower their energy bill.

Proposed Solution

- Our solution is air condition that only turns on at the programmed temperature while someone is nearby. By controlling how much it's turned on and how fast the fan spins, the reduction of energy will decrease the waste of energy and will lower customers' electric bill.

Hep, They Takin Meh Bike

Problem Statement

- Bicycle theft is a very relevant problem in settings where bicycles are a prominent form of transportation and are left out for extended period of times in public places like the UofA. Bike theft reported to UAPD averaged to 276 bicycles for 2015 and 2016 and the number of thefts is even higher because not all thefts are reported. Just fewer than 6 percent of stolen bikes in 2016 and 2017, as of May 3, were recovered and returned to the owner.

Proposed Solution

- The goal of our project was to create a device that could be used to decrease bikes stolen on campus by bringing attention to thieves in the act. Our project was implemented using an accelerometer to detect the movement of the bike caused by a potential thief. This activates the buzzer giving continuous noise to hopefully dissuade the potential burglar. In the event that the burglar is not dissuaded, similar to a car alarm, a bike alarm can prevent theft by alerting bystanders that a crime is being committed and to call the police.

Prototyping Voice Command Recognition and Automatic Response through Arduinos using Headphones

Problem Statement

- Listening to music while doing an activity is a common thing to do nowadays. Most people do it to drown out other sounds, but to realize that one is being talked to, one has to make a conscious consideration of the sounds around them. Further, to acknowledge that one is being talked to, and to engage in conversation, one usually has to manually pause the music or lower the volume. Rather than having to do this manually, why not make this an automatic action? That is the problem this group aims to solve.

Proposed Solution

A device that constantly tracks the audio environment around the User. Once the device picks up a certain sound (for example, the user's name), the device automatically deafens the volume of the headphone sounds, allowing the user to now hear the environment around them. After either a set time delay, or by command, the device manipulates the volume of the headphones once again to revert back to the original volume settings.

Voice Modulation

Problem Statement

- Voice modulation is extremely common - especially in the entertainment and music industry. Benefits of this technique include everything from quick audio fixes to turning an off-tune singer to a pop virtuoso.
- AKA “autotune”
- One of the biggest issues with voice modulation and amplification is minimizing as much feedback as possible while providing a clear output.

Proposed Solution

- Voice Modulation.
- The manipulation of pitch through wavelength modulation
- Numpad for controlling voice effects for corresponding sound
- LCD Output for displaying voice control settings from numpad

Sun Chaser

Problem Statement

- Electricity is a necessity when planning out any modern venture. However, due to the short range of electrical infrastructure available outside of cities, some areas are not able to access it easily.
- An irrigation system has been set up to reduce and control the consumption of water for a small agricultural project in a remote location outside the reach of current electrical infrastructure.
- Our task is to provide an Electro-Mechanical System that optimizes the collection of solar radiation for use in an off grid irrigation system.

Proposed Solution

- Create a tracking solar panel array that can track the sun over the course of a day
- A solar tracker is a generic term for a device that orients a payload towards the sun. The problem we are facing is providing energy to an off-grid irrigation system. The solution we have chosen is to create a Sun Chaser (Solar Tracker) that will provide energy to the irrigation system.
- To do this, our Sun Chaser (Solar Tracker) system will consist of a solar panel and photo-resistors that will automatically follow the direction of the sun by a computer aided program created in lab. The reason of this system (Sun Chaser) is to optimize the power generated from the sun.
- In hardware design we will need solar panels, servo motors and circuit (or device) that will convert the DC electricity from solar panels into appliance-friendly AC.
- The advantages of Solar energy is that amongst all the benefits it is a renewable energy source, reduces electricity bills, has diverse applications, and has a low maintenance cost.

Everything Should Be All Fun and Games

Problem Statement

- In 2015, the Entertainment Software Association (ESA) conducted a study on video game use 155 million Americans regularly play video games
- 42 percent of Americans play for at least 3 hrs/week
- Many disabilities prevent or hinder some people from using hand-held video game controllers
- Competitive gaming becomes exclusive to these players
- Some of these people, however, possess some control of their hands, digits, or limbs for a small or significant amount of time

Proposed Solution

- Two-dimensional games can be played with one directional-input and one button
- Analog input: joystick
- Digital input: D-pad (we will be working with this one)
- Use various proximity-sensors to simulate a controller's physical inputs
 - Obstacle sensors for a hands-free directional input
 - Sonar ranging detector for the buttons
- Binary encoding will be used for the buttons

Climate Optimization System

Problem Statement

Certain labs and industrial environments require specific temperature & humidity conditions to properly function. The inability to monitor and control these conditions could lead to damage to equipment, non uniform production, and failed experiments.

Examples:

- 🔗 Silicon wafer fabrication
- 🔗 Bio Labs
- 🔗 Data centers

Proposed Solution

We proposed the creation of a system that will simultaneously measure both the temperature and the humidity level of a given work space.

This system will monitor for conditions outside the designated optimal range and take action to bring the environment of the work space back into the designated optimal range.