

Arduino based Web Server for Environmental Control

CI301: Individual Project

Ian Smith

# Project Scope

## Aims

I aim to produce a fully working, free of significant errors, efficient and economical solution to temperature climate control within a small to medium sized environment: suitable for use within aquatic, reptilian or hydroponic industries. I should be easily affordable enough to fit into popular use within certain pet enclosures, indoor living accommodation, indoor plant life areas or greenhouses. Logs will be kept of sensor readings over time to assess changes throughout a certain time frame and be visible over the Internet.

## Objectives

230v AC current will be controlled by an arduino based microcontroller.

The entire working product should cost no more than £50 to build.

Energy consuming devices should be powered down when feasible within set limits to reduce environmental impact.

Database records should be made from the sensor readings more than twice per hour and be able to produce a meaningful overview of the environment state throughout the day.

Produce a user-friendly web page as a front end for the code, so that users aged 15 to 75 can understand what is happening on the system.

Each power state controller should be capable of sensing and adjusting environment properties up and down. [eg. settings allow a fan to cool, or a heater to heat by adjusting a setting on the GUI frontend]

Every aspect of the system should be tested and de-bugged entirely. All issues found with hardware interference should be corrected to the best ability possible and solutions found to any repeatable errors.

Different ‘zones’ should be recognized linking to different relay switches and operations [relay1 = heating in zone 1, relay2 = cooling in zone 1]

No longer than 3 months should be spent on the code aspect of the project. Testing and implementation procedures should take no longer than one month after the development has ceased. This includes final packaging and safety aspects of the design.

No 230v lines should be accessible unless the product is disassembled. This means all terminals should be properly shielded and insulated. Silicon glue could be used as an insulator, or for the final product a plastic moulded case that all plugs and timers, screens/terminals screw into, and the front covered from any 3rd party tampering with electrical parts could be used.

## Stakeholders

Key stakeholders are somewhat scarce for this project, due to the fact the development team is very limited in that only I am working on the code and hardware personally. There are however some key members of the team and external groups that will have an interest and input into what is implemented during the project’s entirety.

The stakeholder who will have the most say in how the system is designed and implemented will be myself. As a stakeholder I will be expecting a very high quality of automation as well as manual override functionality, being sure I outline certain goals and attempt to meet them in all specified timeframes.

The second most important stakeholder to consider will be the target audience and consumers that will purchase the final product after the development stages are completed. As they will be investing money into getting ideal living conditions for their desired purpose, I will take their opinions and recommendations for additions and non-required development areas very seriously and will take some time to confirm that my ideas are inline with other possible users needs.

The third most important stakeholder I will be working closely with is the project supervisor, Saeed Malekshahi Gheytassi. I will be working more closely with Saeed than the target audience since it will be of greater ease asking for an individual’s opinion on modules of code than asking users of an incomplete system. I have chosen Saeed to assist with guiding the project towards an ideal outcome as I know he is very familiar and experienced with the art of electronics and the arduino environment, so any problems I may face can be easily overcome, and often simple solutions can be found to what would be very hard to comprehend alone.

## Methods of Communication and Quality checks

I will be attempting to get many opinions through verbal communication with similarly minded people who understand the concepts and aspects of the project. The main communication will be done between my project supervisor and myself. I will attempt to arrange regular updates between the supervisor and me in order to keep the goals I aim to achieve in sight and to accept any recommendations on further development and help with standardizing regular coding principles and protocols.

In respect to the possible users of the system, I will research the desired tolerances between the targeted intended purposes: by reading articles and webpages on desired and ideal fluctuation for optimal conditions in -

* Reptile living,
* Plant life, and
* Home heating/cooling,

- since these will be the main 3 areas the final product could be used to improve.

I will ask a select sample of users, on either end of the intended range of users throughout the development of the system for any possible additions and their views on prioritizing certain key areas. I will also produce a survey to be completed in order to assess the quality of the final system compared to possible user groups’ expected results. Ideally the system will surpass all expectations of the proposed users and feedback will be positive.

## Project Infrastructure and Installation procedure

I will be planning to use this system myself when completed in a reptile vivarium setup. In the final stage of usability I will switch from a simple light and fan testing setup using a small garden plant to assess and make use of the equipment during the testing and coding phases – I will then change settings and use the same system to have the inverse effect.

In the plant environment development stage I will use an externally powered high intensity discharge lamp, creating more heat than desired, with an arduino controlled fan to cool the environment. In the completed system, I will alter the code to allow zones to be set up. One side as the warm side, and one as a cool side, automatically adjusting the AC potential difference waveform applied to the heat mats with the help of an arduino microcontroller. In this case, the arduino will be heating the environment rather than cooling it.

Currently, I have a 2 ft x 2 ft x 4ft enclosure and a 250w high pressure sodium lamp with ballast I have found second hand – purchased relatively cheap locally for initial testing. I have chosen to use this for development as it will be much easier to resell this equipment once it is no longer required for testing than a vivarium and heat mats would be, and it will be much easier to produce very significant temperature differences using a high power lamp than a low power heat mat. This significant temperature difference will make it very easy to trigger abnormalities to spike sensor readings and will save a significant amount of time during testing and coding stages.

The initial investment is below £40 and I believe I will make this back should the time come, and the lighting could even be used to produce the ‘basking’ and cool areas in the reptile environment. Testing with this equipment, and then moving to the final installation location also verifies that the code and product will be applicable to more than one target audience, and will fulfill the needs I expect it to in all applications.

# Specification

## Stages

I will take a very modular approach to developing the arduino package, as since I am the only coder for the entire software, as well as the person to purchase any equipment for the prototype.

I will break the process down into stages and then expand on how I shall perform each task when the time comes, with only a brief overview on researching possible routes of performing tasks.

Key tasks are as follows;

# Task Allocated Start Time Finish Time Predecessors

1 Obtain hardware 15 days "Mon Oct 6, '14" "Fri Oct 24, '14"

2 (1a) Research AC ‘dimming’/switching options 10 days "Mon Oct 6, '14" "Fri Oct 17, '14"

3 (1b) Research database software options 2 days "Mon Oct 20, '14" "Tue Oct 21, '14" 2

4 (1c) Research graphic data representation options 3 days "Wed Oct 22, '14" "Fri Oct 24, '14" 3

5 Webpage design 5 days "Mon Oct 27, '14" "Fri Oct 31, '14" 1

6 Database design 5 days "Mon Nov 3, '14" "Fri Nov 7, '14" 5

7 Hardware wiring/preparation 2 days "Mon Nov 10, '14" "Tue Nov 11, '14" 6

8 Familiarization with the arduino environment and hardware 3 days "Wed Nov 12, '14" "Fri Nov 14, '14" 7

9 Familiarization with HTML and CSS 3 days "Mon Nov 17, '14" "Wed Nov 19, '14" 8

10 Webserver implementation 2 days "Thu Nov 20, '14" "Fri Nov 21, '14" 9

11 Database to arduino connectivity implementation 3 days "Mon Nov 24, '14" "Wed Nov 26, '14" 10

12 Power handling using code 2 days "Thu Nov 27, '14" "Fri Nov 28, '14" 11

13 Webserver development [HTML/CSS] 15 days "Mon Dec 1, '14" "Fri Dec 19, '14" 12

14 Setting changing development 10 days "Mon Dec 22, '14" "Fri Jan 2, '15" 13

15 Finalizing a sellable hardware form factor 15 days "Mon Jan 5, '15" "Fri Jan 23, '15" 14

16 Quality check and code cleanup 15 days "Mon Jan 26, '15" "Fri Feb 13, '15" 15

17 Testing 20 days "Mon Feb 16, '15" "Fri Mar 13, '15" 16

## Resource allocation

Since there is only one programmer working on the entirety of the project, the steps proceed through one by one, as one task cannot begin before another has finished. If more than one programmer was available, most of the tasks would be able to be produced simultaneously, saving a lot of time for the final finish date.

## 

## Risk Assessment.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Risk name | Rate | Severity | Details | Damage applicable | Prevention strategy |
| Power cut | Very low | Low | Power company has issues and an outage occurs. The system stops working until power returns. | No long-term damage to equipment will take place, however animal’s discomfort may be considerable. This would be the case without the product, such as with hardwired, timed or thermostatic devices. | Ensure the entire system contains a sufficiently rated fuse, promote the use of surge protectors alongside the plug to prevent further damage. |
| Heater/cooler does not support AC dimming | Medium | Low | Some AC appliances such as digital humidifiers or heaters do not support lowering the AC current below 230v. | Device would not start or could power up and not respond. Very rare that any major damage would occur because of this. Most of the time the appliance would simply flicker on and off until the upper tolerated limit is reached and then full 230v power will be applied. | Provide an option in software to disable ‘dimming’ in order to only use relay switching instead. |
| Electromagnetic interference | Medium to High | Low | A high voltage power line can interfere with the signals flowing between 5v pins on the microcontroller. | Possible misreadings from the sensors. Ethernet data corruption. Arduino restarting/crashing etc. | Remove outlying data [recorded by sensors] from being submitted to the database logs. Use octocoupler enabled devices when 230v power is required to remove any possible connection to the arduino. |
| Touching high power terminals | Low | Very high | An animal, infant or elderly person may be unaware of the high current flow of the relay terminals and touch them. | Risk of death. Very strong shock and extreme discomfort. May also short fuse. | Locate relay and wire terminals away from the reach of external bodies. This will be done during the packaging and final hardware design. |
| Relay/sensor failure. | Very Low | Medium | Relay/sensor failure due to extended use or age of components. | Incorrect relay switching/sensor readings. | Use high quality sensors and relays. Also warn users to check readings against independent sensors such as a thermometer, as well as checking that appliances to cool and heat are turning on as desired. The webpage can be visited in order to check for inconsistencies with readings over time to spot issues. |

**SCHOOL OF COMPUTING, ENGINEERING & MATHEMATICS ETHICS FORM**

This ethics form is designed to help you quickly and easily identify how you should approach any ethical issues raised by your project or dissertation. It should be completed for ALL research projects and dissertations prior to the commencement of the project. Please do not approach any participants involved in the research until this have been completed and discussed with your supervisor or member of the CEM ethics committee (if appropriate).

This form must be completed by the project student or researcher responsible for the project. Once completed, you should discuss it with your supervisor to ensure that you take the right follow-up actions.

**If you answer ‘No’ to all questions** **in this form and this is confirmed with your supervisor (if appropriate) then no further action is required.** Please note that in signing this form you accept that it is still your responsibility for your project or dissertation module to follow the **University’s Guidance on Good Practice in Research Ethics and Governance**, available on StudentCentral. Any significant change in the question, design or conduct of your project or dissertation that would alter your answers on this form must be notified to your supervisor who will advise you on whether you need further action.

**If you have answered ‘yes’ to *any* of the questions in Section B of the Student Checklist your supervisor will need to make a judgment as to whether or not the research includes more than a minimum level of risk. If this is the case then your supervisor will need to email this form to the CEM ethics committee (**[**CEMethics@brighton.ac.uk**](CEMethics@brighton.ac.uk)**) for discussion prior to the commencement of research**.This does not mean that you will not be able to do the research, but it will need to be considered by the School Research Ethics and Governance Committee.

Ethics forms, example consent forms/participant information sheets and supporting guidance are available on the ***Research Ethics for Projects – CEM*** area of StudentCentral.

**Signed copies of this completed ethics form must be submitted with your project or dissertation. Note: the project or dissertation will not be marked if the completed checklist is not included.**

**PROJECT DETAILS**

1. Name of researcher: Ian Smith

2. Name of supervisor: Saeed Malekshahi Gheytassi

3. Title of project: Arduino based Web Server for Environmental Control

4. Outline of the research (up to 100 words): No public hands-on involvement with the project.

5. Location of research: Aldrich Library, Cockcroft building, University of Brighton

6. Email address: contact@simstop112.co.uk

7. Contact address: 3 Selba Drive, East Moulsecoomb, Brighton, East Sussex. BN2 4RG

8. Telephone number: 07706 129 330

| **Please tick the appropriate box and answer the questions where appropriate.** | Yes | No |
| --- | --- | --- |
| 1. Does the study involve **participants who might be considered vulnerable** due to age or to a social, psychological or medical condition? (*e.g. children, people with learning disabilities or mental health problems, but participants who may be considered vulnerable are not confined to these groups).*   If yes then provide details of any such participants. See the University’s ‘Guidance on Good Practice in Research Ethics and Governance’ for more details.  ……………………..……………………..……………………..……………………..………..……………………..………..  ……………………..……………………..……………………..……………………..………..……………………..………..  Note: proposals involving vulnerable participants are often likely to require ethical approval from the Faculty of Science & Engineering Research Ethics and Governance Committee (FREGC). |  | ✔ |
| 1. Will **photographic or video recordings** of research participants be collected as part of the research?   If yes then please outline consent and data protection procedures *(e.g. interviews cannot be overheard, details will not be accessible to others),* for the use of participants’ images. Example consent and information forms can be found on StudentCentral and see guidance on data collection at the end of this document.  ……………………..……………………..……………………..……………………..………..……………………..………..  ……………………..……………………..……………………..……………………..………..……………………..………..  If your data will not be confidential and anonymous then outline the justification for this decision here and procedures for mitigating against potential harm.  ……………………..……………………..……………………..……………………..………..……………………..………..  ……………………..……………………..……………………..……………………..………..……………………..……….. |  | ✔ |
| 1. Does the study require the **co-operation of an individual to gain access** to the participants? (*e.g. a teacher at a school or a manager of sheltered housing)*   If yes then describe the procedures that will be put in place to ensure safe and ethical direct involvement of human participants. Where necessary and as appropriate, include comments on obtaining informed consent, reducing harm, providing feedback, and accessing participants through an individual providing information such as a teacher/lecturer, manager, employer etc. Example consent and information forms can be found on StudentCentral.  ……………………..……………………..……………………..……………………..………..……………………..………..  ……………………..……………………..……………………..……………………..………..……………………..……….. |  | ✔ |
| 1. Will the participants be asked to discuss what might be perceived as **sensitive topics** (*e.g. sexual behaviour, drug use, religious belief, detailed financial matters) or* could participants experience psychological stress, anxiety or other negative consequences (beyond what would be expected to be encountered in normal life)?   If yes then describe the procedures that will be put in place to ensure safe and ethical direct involvement of human participants. Where necessary and as appropriate, include comments on obtaining informed consent, reducing harm, providing feedback. Example consent and information forms can be found on StudentCentral.  ……………………..……………………..……………………..……………………..………..……………………..………..  ……………………..……………………..……………………..……………………..………..……………………..……….. |  | ✔ |
| 1. Will individual participants be involved in **repetitive/prolonged testing or vigorous physical activity, experience pain of any kind, or be exposed to dangerous situations, environments or materials** as part of the research?   If yes then describe the procedures that will be put in place to ensure safe and ethical direct involvement of human participants. Where necessary and as appropriate, include comments on obtaining informed consent, reducing harm, providing feedback. Example consent and information forms can be found on StudentCentral.  ……………………..……………………..……………………..……………………..………..……………………..………..  ……………………..……………………..……………………..……………………..………..……………………..……….. |  | ✔ |
| 1. Will members of the public be **indirectly involved** in the research without their knowledge at the time? (*e.g. covert observation of people in non-public places, the use of methods that will affect privacy)*.   If yes then provide brief details here *(e.g. how they will be involved and, where known, the age, gender, ethnicity and location of those who will be indirectly involved).*  ……………………..……………………..……………………..……………………..………..……………………..………..  ……………………..……………………..……………………..……………………..………..……………………..………..  Provide details of any negative impacts members of the public will be likely to face and that would not be considered minimal impacts (e.g. invasion of privacy, harm to property, being subject to what an individual perceives to be inappropriate behaviour). Describe the risks and if appropriate explain why you believe they are only minimal.  ……………………..……………………..……………………..……………………..………..……………………..………..  ……………………..……………………..……………………..……………………..………..……………………..………..  Describe any procedures that will be put in place to ensure safe and ethical indirect involvement of members of the public (*e.g. providing information and feedback if requested by the public*). Examples of participation information forms can be found on StudentCentral.  ……………………..……………………..……………………..……………………..………..……………………..………..  ……………………..……………………..……………………..……………………..………..……………………..………..  Describe how you will ensure data collection is confidential and anonymous (*e.g. people will not be able to be identified by photographs or notes taken by observers*), how data will be stored and who will have access to the data. If the data will not be confidential or anonymous, outline the justification for this decision here and procedures for mitigating against potential harm.  ……………………..……………………..……………………..……………………..………..……………………..………..  ……………………..……………………..……………………..……………………..………..……………………..……….. |  | ✔ |
| 1. Does this research include **secondary data** that may carry personal or sensitive organisational information? *(Secondary data refers to any data you plan to use that you did not collect yourself, e.g. datasets held by organisations, patient records, confidential minutes of meetings, personal diary entrie).*   If yes then provide details regarding any secondary data to be used that may carry sensitive personal or organisational information.  ……………………..……………………..……………………..……………………..………..……………………..………..  ……………………..……………………..……………………..……………………..………..……………………..………..  If secondary data CEMs containing sensitive personal or organisational information are to be used, outline how such use will be ethically managed *(e.g. details such as anonymising data CEMs, ensuring protection of source agency, gaining consent of data owners, and how the data will be stored)*. See guidance on data collection at the end of this document.  ……………………..……………………..……………………..……………………..………..……………………..………..  ……………………..……………………..……………………..……………………..………..……………………..……….. |  | ✔ |
| 1. Is this research likely to have significant **negative impacts on the environment**? (*For example, the release of dangerous substances or damaging intrusions into protected habitats.)*   If yes then provide details of these impacts here (for example the release of dangerous substances or damaging intrusions into protected habitats) and  ……………………..……………………..……………………..……………………..  ……………………..……………………..……………………..……………………..  Describe how you will mitigate against significant environmental harm and manage risks.  ……………………..……………………..……………………..……………………..  ……………………..……………………..……………………..…………………….. |  | ✔ |
| 1. Will any participants receive **financial reimbursement** for their time? (*excluding reasonable expenses to cover travel and other costs*).   If yes then provide details and a short justification (e.g. amounts and form of reimbursement).  ……………………..……………………..……………………..……………………..………..……………………..………..  ……………………..……………………..……………………..……………………..………..……………………..……….. |  | ✔ |
| 1. Are there any **other ethical concerns** associated with the research that are not covered in the questions above?   If yes then give details here.  ……………………..……………………..……………………..……………………..………..……………………..………..  ……………………..……………………..……………………..……………………..………..……………………..……….. |  | ✔ |

**All Undergraduate and Masters level projects or dissertations in the School of CEM must adhere to the following procedures on data storage and confidentiality.**

All data should be encrypted and stored securely. Documentation should be kept in a locked cabinet or desk, and electronic data should preferably be kept on a removable disk or data stick which can be locked away, or if this is not possible on a password protected computer. Confidential and sensitive data should not be emailed unless it is encrypted or password protected since emails are centrally archived.

For Undergraduate/Masters projects, normally only the student and supervisor will have access to the data (see the University’s ‘Guidance on Good Practice in Research Ethics and Governance for further details).Once a mark for the project or dissertation has been published, all data must be removed from personal computers, and original questionnaires and consent forms should be destroyed unless the research is likely to be published or data re-used. If this is the case a justification for this should be included where appropriate in this form and in the relevant consent and participant information forms.

**Student:** Please sign below to confirm that you have completed the Ethics form and will adhere to these procedures on data storage and confidentiality.

Signed (**Student**): ………………..………..……………………..………..

Date: ………………..………..……………………..………..

**Supervisor**: I confirm that the research ***does/does not*** (delete as applicable) include more than a **minimum level of risk**.

Signed (**Supervisor**): ………………..………..……………………..………..

Date: ………………..………..……………………..………..

Note: If the **supervisor judges** that there is more than the **minimum level of risk** then your supervisor will need to email this form to the CEM ethics committee (<CEMethics@brighton.ac.uk>) for discussion prior to the commencement of research.