Department of Electronic & Electrical Engineering

MEng/BEng in EEE/CES
CX/EE318 Engineering Project

This project planning is organised in five parts:

PART 1: PROJECT DESCRIPTION – including background, aims and objectives
PART 2: PROJECT WORK PLAN – including Gantt chart
PART 3: RESOURCE REQUIREMENT
PART 4: TECHICAL RISK ASSESSMENT
PART 5: CONDUCT & SAFETY DECLARATION & SIGNATURES

- All parts of the document must be completed jointly by the group members.
- An e-copy of the document must be submitted on CX/EE318 MyPlace page by 9.30 on 21st January 2022.
- The document should be completed by adding text and input where required.
- The completed document should be no longer than 8 pages of A4 – sections 1 and 2 are limited to 2 pages of A4 while sections 3, 4 and 5 are single pages.
- In addition to the submission of the planning document, each group is required to give a 10 minute presentation (followed by questions) to their project mentors and other student groups. The project presentation should be no longer than 4 Powerpoint slides and should describe the idea proposed, the technical design (hardware and software) and summarise the salient points of the project planning to date.
- The document must be signed by all group members and all group members must attend and participate in the presentation and Q&A session.
- The project plan and presentation will be assessed by the group's mentor and a mark (worth 20% of the final group project mark) will be assigned.
- Each member of the group is advised to retain a copy of the completed form for reference and revision. This planning document should be included in the project logbook.

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Name (Group Member): Ross Inglis	Name (Group Member):Ruiqi Wang
Name (Group Member): Jorge Fernández Mortera	Name (Group Member):Xintong zhou
Project Team: 19	**Group Mentor:**

Project Title: Tracking Solar Panel System

PART 1: PROJECT DESCRIPTION

A. Project Description:

The tracking solar panel project will be a demonstration of tracking solar panel systems and how they are more efficient than fixed panels due to them maintaining a perpendicular incident angle of light hitting it throughout the day. The tracking solar panel project will consist of an MSP430 microcontroller, a light sensor and a PCB containing a manual control panel, power measurement and indicator. It would be aimed to achieve a 90º incidence angle between the Photovoltaic (PV) cell and the light source for max efficiency. This will be accomplished by using the MSP430 and a servo motor to control the position of the panel based on the amount of light detected by the Light Dependent resistor (LDR) sensors. However, we would also add the possibility for the user to switch configurations between manual control, a fixed one and the tracking setup for them to experience first-hand the effect of these configurations on the energy production of a solar panel. The MSP430 would use the data from the LDR sensor to determine the relative position of the light source, and then adjust the angle of the panel to face it directly. The overall goal of the project is to show how the efficiency of the solar panel varies depending on its incidence angle to the light source which is as well determined by its position and by ensuring that it is always facing the sun. The project will also allow users to move the light source on a single axis, allowing them to compare the difference in energy production of a PV cell when it tracks the light source and when it doesn't. The user will be able to see exactly how the incident angle of the light hitting the panel affects power production. A high-level block diagram showing the main elements of the design and how they connect together is seen in Figure 1.

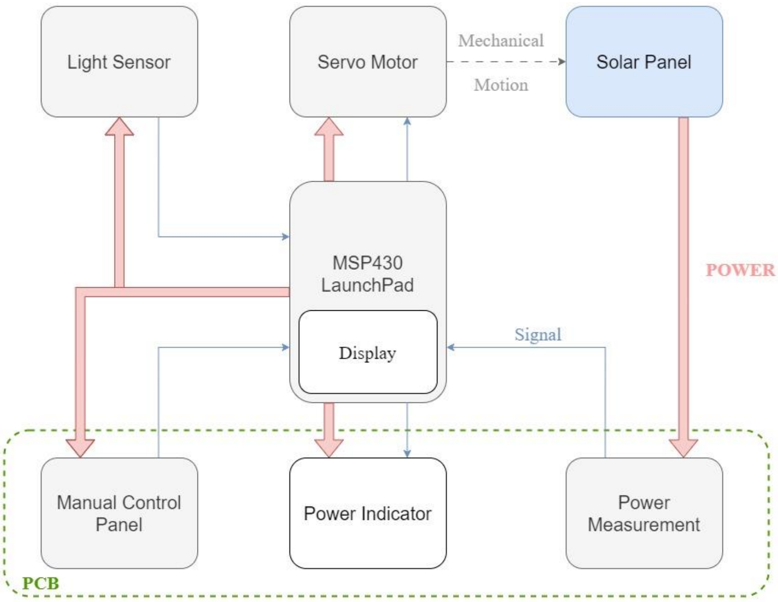

Figure 1 – High-level block diagram.

Aims

The primary aims of a tracking solar panel project would include:

1. Tracking the movement of a light source with the MSP430 and the LDR sensor working together in order to detect the position of the light source and adjust the angle of the solar panel, so that the incidence angle of the solar panel and the light source is as close as possible to perpendicular (90º), ensuring like this maximum exposure to sunlight and accordingly maximum power output generation.
2. Allowing the user to switch between a fixed tilt solar panel configuration, a manual configuration and the tracking solar panel configuration with the purpose of teaching the operator how much of a difference each arrangement makes on the power output of the PV cell.
3. Showing this power output on a power display so that the users see the real value of the solar panel output so they can quantify the difference between fixed and tracking systems and

learn in real-time the importance of the incidence angle in a solar panel and how it directly affects the power generation of the solar panel.
4. Making a more visual approach to the power output, using a row of LEDs which will show how efficient the solar panel is with the configuration that is running, being the red LED, the least efficient and the green LED, the most efficient when the incidence angle between the panel and the light source is 90º.
5. Making the system cost-effective and cost under the £20 budget using a simple microcontroller, sensor and a small low-power solar panel.

Background

Solar panel tracking systems are devices that follow the movement of the sun across the sky in order to optimize the amount of sunlight that hits the solar panels. This can increase the efficiency of the panels by as much as 20-30% compared to fixed systems [1]. There are two main types of solar panel tracking systems: single-axis and dual-axis. Single-axis systems rotate the panels around a single axis, while dual-axis systems rotate the panels around both the azimuth and elevation axis [2]. The decision to use a tracking system is usually based on the location and the specific needs of the installation.

Solar panel tracking systems work by constantly adjusting the angle of the solar panels in order to optimize the amount of sunlight that hits them. This is accomplished by using motors, sensors, and a control system to move the panels in response to the position of the sun in the sky.

Single-axis tracking systems rotate the solar panels around a single axis, typically the horizontal or azimuth axis, which runs east to west. These systems follow the movement of the sun from east to west, keeping the panels perpendicular to the sun's rays for the greatest amount of time possible. The control system of a solar panel tracking system uses sensors such as a sun-tracking sensor which consists of a light sensor that locates the position of the sun or a GPS sensor that directly determines the position of the sun in the sky. This information is then used to adjust the angle of the solar panels accordingly so that they are always pointing directly at the sun with a perpendicular incidence angle, achieving like this maximum efficiency. However, efficiency does also rely on the clearness index, air mass and other location, time of year and meteorological factors.

As photovoltaic electricity extends its branch worldwide, the discussion for which configuration is best in terms of efficiency, maintenance and costs increases. According to research, PV systems with manually controllable fixed support that is modified throughout the year in order to achieve a more optimal angle for every time of the year (two seasonal angle configurations), are cheaper than tracking solar systems but only increase the energy production between 2.8% and 4.8%. [3]

The cost of the tracking system must be weighed against the potential increase in efficiency and the specific needs of the installation. However, solar panel tracking systems are usually more expensive than fixed systems, and they also require more maintenance.

References:

[1] https://skymarksolarpower.com/maximizing-solar-panel-installation-10-tips/ - accessed 17 Jan. 2023
[2] https://www.ionsolarpros.com/post/solar-trackers-what-are-they-and-how-do-they-work - accessed 17 Jan. 2023
[3] https://sinovoltaics.com/learning-center/csp/solar-tracker/ - accessed 16 Jan. 2023

B. Project Objectives:

Project Objectives	Importance
Be able to locate light source constrained to a single axis.	High
Have the capability to tilt the solar panel roughly 120° on a single axis.	High
Display/Indicate to the user the PV cell power output.	High
Allow the user to have manual control over the angle of the solar panel.	Medium
Prove the difference between fixed and tracking solar panels in that the tracking systems will result in higher daily efficiencies due to it maintaining a perpendicular incidence angle from sunrise to sunset.	High

B. Project Deliverables:

Project Deliverables	Index
A system consisting of a structure and motor that will support a solar panel and be able to tilt the panel on a single axis depending on the MSP430 control signal.	1
Light sensor module capable of determining the relative position of a light source and sense when it is directly over the sensor with a perpendicular incidence angle.	2
A system able to measure both the voltage and current at the solar panel which can then be used by the MSP430 to calculate the power output of the panel.	3
A manual control panel with a potentiometer for control of the angle of the solar panel, a switch for enabling/disabling tracking functions and a button to reset the panel to a horizontal position.	4
A power efficiency indicator module made up of a row of equal numbers of red, orange and green LEDs that will show the real-time efficiency of the solar panel. The number of LEDs that would light up depends on the incidence angle of the light hitting the solar panel. When all the lights (up to the green LEDs) are lit, this indicates max efficiency with light hitting at a perpendicular incidence angle.	5
Displaying current power output of solar cell on the MSP430 LaunchPad’s LCD display.	6

PART 2: PROJECT RESPONSIBILITIES & WORK PLAN

A. Project Plan: Gantt Chart & Description

The project plan Gantt chart showing the schedule of tasks to be achieved in certain time frames for the overall project to be completed can be seen in Figure 2.

Figure 2 - Gantt chart illustrating project schedule.

The duration of each task does not include weekends. Every colour of the column represents who has the responsibility to complete each task. Pink tasks are where all group members will contribute to its completion.

B. Project Responsibilities:

Table 1 - Project Responsibilities.

	Group Member	Tasks	Criticality (H, M, L)
1	Ross Inglis	Research LDRs	L
		Design PCB	H
		Soldering	M
		Develop light sensor software.	H
2	Jorge Fernandez Mortera	Research on power measuring modules	L
		Design the light sensor module	H
		Design the structure & case	H
		Develop software for the motor system	H
		Design the demonstration	H
3	Ruiqi Wang	Research on servomotors	L
		Design the control panel	M
		Design the motor system	M
		Develop software for the light sensor module	H
		Design the user guide	M
4	Xintong Zhou	Research on materials and other components	L
		Design the control panel	M
		Develop software for the motor system	H
5	All members	Design the schematic	M
		Ordering the components	M
		Manufacture the structure & case	M
		Manufacture the PCB & control panel	H
		Test & configure the motor module	M
		Test & configure the PV module	L
		Final Assemble	H
		Test & Configure the entire device	H

PART 3: RESOURCE REQUIREMENTS

A. Equipment:

1x MSP430 LaunchPad - free
1x torch (with variable light intensity) - ~£5? -
1x 0.5 W solar panel - https://uk.rs-online.com/web/p/solar-panels/1793740 - £3.46
1x PCB – free – from workshop
1x servo motor - https://www.rapidonline.com/feetech-fs90-mini-servo-120-9g-37-1339 - £4.07
1x Plastic project box - free
1x power bank

B. Components:

2x LDRs for light sensor (each may require a resistor of unknown value)
1x potentiometer, 1x switch & 2x push buttons (for manual control panel)
~9x LEDs (3 red, 3 orange & 3 green) for power indicator (each with a current limiting resistor of unknown value)
An indeterminate number of passive components of varying values such as resistors and capacitors.
1x low value resistor used for current measuring.

C. Technical Workshop Input:

Component Ordering
PCB fabrication - ~5 days
Use of 3D printers for structure

PART 4: TECHNICAL RISK

Management of project work requires that technical risk be assessed in advance, during initial planning and as an on-going process. As the first stage to this process, identify any aspects of risk associated with your project proposal. Risk in this context is taken to mean any event or action (or inaction) that would jeopardise any project outcomes or significantly impede project progress. Furthermore, having identified such potential risks, indicate what actions you would take to mitigate the effects of this risk. (Examples of such risks include non-delivery of a key component, illness or absence from University, non-completion by student or other of key deliverable, equipment malfunction, extended learning curves- new techniques or software, etc). Please recognise potential impacts that arise from change in COVID-19 restrictions and issue relating to remote and distributed working.

	Possible Risk:	**Mitigating Action:**
1	Light sensor struggling to track light source in bright room.	Develop enclosure to shade device.
2	Problems measuring power output accurately.	Use dedicated IC that will have higher accuracy.
3	Motor not being strong enough to move the solar panel and structure.	Research motor max torque and calculate the torque required to move the panel.
4	Light sensor not able to locate relative position of light source.	Research and test multiple designs to find one that works the best. Different sensors could also be tested.
5	MSP430 cannot provide enough current for all components.	Use external battery power source.

Students will be asked to reflect upon parts 1, 2 and 4 in the final report.

PART 5: SAFETY DECLARATION

All project students must be aware of the need for safe working during the conduct of their project. The Area Safety Regulations for the Department of Electronic and Electrical Engineering, which appear in the MyPlace pages, provide general guidance. By signing at the end of this form, the project student is declaring that:

1. he/she has read and understood the Area Safety Regulations and will abide by these regulations during the conduct of the project, and
2. he/she will act responsibly, professionally and ethically during the period of the project, and
3. he/she recognises that this is a group project and that all group members share equal responsibility for meeting the deliverables associated with the project and for the return, in working condition, all hardware and equipment provided to support their group's project.
4. On return to campus, further safety-related support will be mandated and he/she agrees to participate in said training and briefings.

Signature of Student Ross Inglis Date……18/01/23……

Signature of Student Jorge Fernandez Mortera Date……18/01/23……

Signature of Student Ruiqi Wang Date……18/01/23……

Signature of Student Xintong Zhou Date……18/01/23……