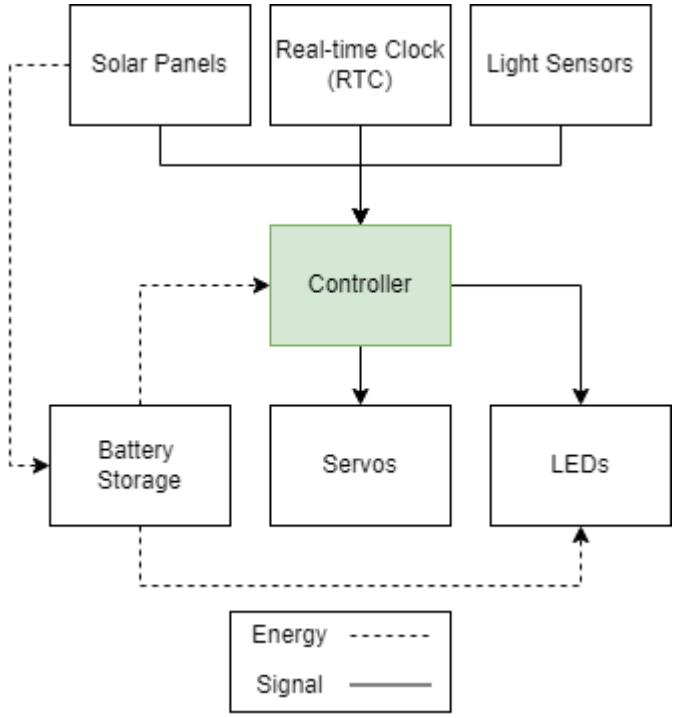
Project Title	*Adaptive Solar Tree*
Project Sponsor/ Data Source	*NIL*
Project Members	*Ahmed Syalabi Seet*
Overview	- *over 100,000 streetlights in Singapore and over 300 million world-wide* - *cumulative amount of power consumed per night is high* - *current streetlights are equipped with small solar panels to extract some solar power but not enough to power for the whole night* - *an avenue to reduce power consumption by implementing solar panels* - *solar panels technology still not implemented in Singapore due to space-constraint and is unsightly* - *existing solar panel systems can effectively track the sun to allow higher power extraction levels but does not consider shadow loss from shadows being casted on its solar panels from external objects and maybe itself.*
General Architecture	*To design an adaptive solar panel system that is more efficient in terms of power extraction, space, cost, and aesthetically pleasing, as a power source for streetlights as a green solution*
Scope of Work	*<u>3D Environment</u>* *The environment will be built using Unity game design engine. The 3D model of the solar tree will be built using Solid works CAD and imported as an asset.* *A gym environment wrapper will have to be designed using the 3D environment. The environment will consist of the solar tree and a geographically accurate sun position system to simulate real-life conditions.* *Observation States:* 1. *Shadow states of each solar panel* 2. *Incidence angles of each solar panel* 3. *Rotation angles of each servo motor* *Action space will be the incremental angles of the servo motors.* *Reward will be presented when all solar panels are in light and that their incidence angles are approximately perpendicular to the sun for maximum output. Penalties will be incurred for every movement of the servo motors, to promote minimal power usage behaviour.* *<u>Reinforcement Agent</u>* *A model-less agent policy will be trained from scratch using the 3D environment. The agent will learn to modulate the servos autonomously without any fixed time steps, to ultimately maximize the reward for any given day.* *<u>Branch Module</u>* *Each branch will have a 3-axis servo design that is able to orient the solar panel array towards the sun and away from shadows, mimicking etiolation in plants. The solar panel array will consist of a 3 x 3 arrangement of solar panels stringed in series. The branches' solar panel arrays will then be densely arranged like a tree canopy to reduce the footprint.* *<u>Controller</u>* *The branch modules will then be connected and orchestrated by a single board computer like the Raspberry Pi acting as a single robot entity. The energy outputs and light sensor states from each solar panel will be communicated to the controller as the environment observation state. The controller will give inputs to the branches' servo motors to manoeuvre the solar panels by learned policy. The controller will be self-powered using the energy outputted by the solar panels. At night, the LEDs will be turned on using the power from the battery storage.*

Hardware
Mini PV modules
Mini servo motors
Carbon fibre rods
LEDs
Light sensors
Battery storage pack
RTC module
Single board computer (Raspberry Pi Zero 2 W)
Miscellaneous (building materials)



Schematic

Inspiration from of Ross Lovegrove solar tree design