UNIVERSITY OF CAPE TOWN

EEE3088F

CONCEPT PROPOSAL

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GROUP 18

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1. Environment Sensing HAT Concept

The HAT will be designed to operate a rotating frame which is intended to sense the direction in which the sunlight is brightest. The HAT will be programmed to rotate the frame, using 2 motors, to point its face in the direction of maximum brightness. This design is intended to be used to charge solar panels efficiently. A small solar panel would ideally be connected to the face of the frame thereby allowing for optimal sunlight to be provided to the panel at all times.

The HAT will be powered by the discovery board (STM32 series) and it will drive the operation of the rotating frame; it will thus be connected to both the discovery board and the frame.

This design could be implemented for energy projects. Those who desire efficient off-the-grid power generation could broadly replicate this design and adjust it depending on their requirements. It could also be the basis for complex light tracking systems and numerous home-automation designs.

2. Requirements

User Role/Scenario 1

The HAT could be scaled and used in an agricultural context. Often different plants require different amounts of sunlight and too much or too little sunlight can damage the plant. Further, temperature can also have an effect on the wellness of plants (while the system does not necessarily track temperature, the amount of sunlight can correlate to temperature and can be used in conjunction with other information to extrapolate whether any action should be taken). Thus, tracking the amount of sunlight the plant is receiving can be useful. This would allow someone to move plants if they feel the environment is not suitable or could cover plants/windows to provide shade or reduce temperature where necessary.

- **R1.1:** Suitable interfacing so that the HAT either triggers shading mechanisms and/or alerts the person responsible when a change needs to be made for plant health.
- **R1.2:** A suitable space for the system to be set up so that it is not shaded by the plant but is also receiving the same amount of sunlight as the plant.
- **R1.3:** The system needs to be weather-proof and sturdy for outside use.

User Role/Scenario 2

The HAT could be used to generate power for a home. Those in rural areas that lack either the infrastructure or finances to be connected to the power grid could use this HAT system to generate power efficiently. Homes in urban areas could likewise use the system for power generation purposes. Modifications would clearly need to be made to the system depending on the exact usage conditions.

- **R2.1:** A suitable place to install the solar panels and the (modified) HAT system.
- **R2.2:** Enough liquidity to be able to afford the initial system investment.
- **R2.3:** The infrastructure for the solar panels. This includes setting up the electrical side of things to ensure that the user benefits from the system.

User Role/Scenario 3

The HAT design could be scaled for powering shopping centres or other commercial spaces. Specifically in South Africa, where the sun is available all year round, we should be making use of alternative power generation methods like solar panels wherever possible to alleviate some of the pressure on the energy crisis.These spaces could utilise mechanisms like the HAT to directionally track the sunlight and use solar panels for energy generation. This could also increase the effectiveness of energy generation for businesses (like a Makro who uses carport solar systems at some locations) with existing renewable energy systems.

- **R3.1:** A suitable environment for the solar panels and (modified) HAT system
- **R3.2:** The system must be weather-proof and sturdy for outside use.
- **R3.3:** The system must be set up alongside a connection to the national power grid or an alternative energy source. While solar panels are a reliable source of energy, there may be periods of time in which there is insufficient sunlight to generate the power required for operations.

Alternative User Roles

While we understand that this project is largely centred around the functional uses of the proposed HAT, we also recognize that it could be used to make products for hobbyists and for commercial sale. These uses include:

User Role/Scenario 4

The HAT could be used to estimate the time based on the position of the sun. This would require interfacing with another device to display the time (this could be a screen or a physical clock) as well as additional coding to determine the time based on the position of the sun.

- **R4.1:** Interfacing with an additional device to tell the time.
- **R4.2:** Additional capabilities to run code to extrapolate the time from the position of the sun.
- **R4.3:** Given that this would be used more as decoration and enjoyment, the HAT and the discovery board should be concealed to make the “clock” visually appealing.

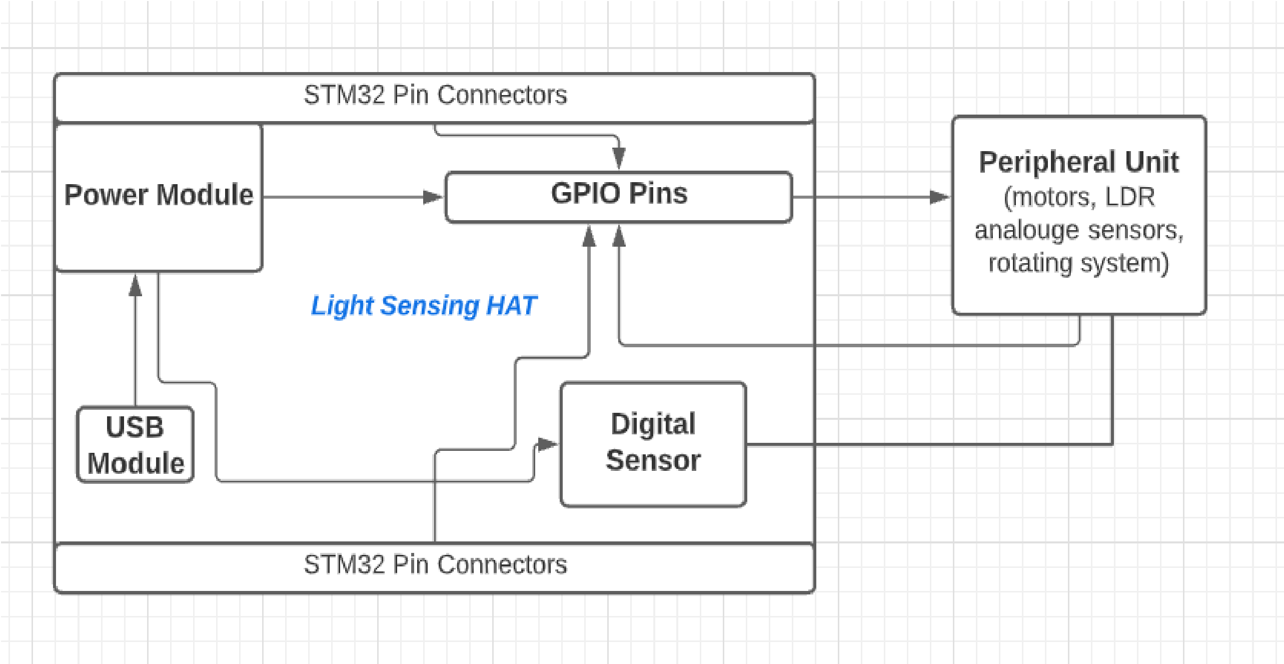
User Role/Scenario 5

Sensor-controlled cars and robots are popular among hobbyists. The HAT could be used as a control mechanism for such projects. For example, it could be placed on top of a pre-built car or system on wheels that is programmed to move in the direction of a light. The HAT would essentially be used as part of a larger project. This would require additional interfacing and code depending on what the project it is being used for.

- **R5.1:** Ability and instructions to interface with other systems.
- **R5.2:** An additional power source would need to be used as it would not be practical to have to be connected to a power source via a wire for moving components.

- **R5.3:** The HAT and its power source would need to be encased to avoid damage and to allow for compatibility with the broader system. The bottom of this casing should have clips or an adhesive for easy attachment.

3. Project Subsystems Block Diagram



1. Power Module

Contains the following components:

- 18650 connector (DNP)
- Li-Ion battery charger
- Input voltage polarity protection
- Battery polarity protection
- Battery Under-voltage cutout protection

2. USB Module

Contains a USB micro connector port, an onboard FTDI, and has detect and input capabilities. Powers the power module and thus charges the batteries.

3. **GPIO Pins**

   Contains pins that redirect GPIO capabilities from the STM32F051 to the HAT. These are connected to the development board via the STM32 pin connectors.

4. **Digital Sensor**

   Temperature sensor included here. This monitors the temperature of the peripheral unit.

5. **Peripheral Unit**

   Contains 2 DC motors which drive the rotation of the system. 4 LDR sensors will be included to monitor the direction of brightest sunlight. The system will likely be held together with a plastic/metal frame.

4. Link to Our Team's Git Repository

GitHub link: https://github.com/ShameeraC4/EEE3088F-Group18

GitLab link: https://gitlab.com/g5168
