sddec22-10: Low Water Crossing Indicator

Client: Lee Harker
Faculty Advisor: Lee Harker

Team Members: Dylan Blattner, Nithin Sebastian, Brandon Choy, Jacob Ross, Tyler Rebischke

Overview:

In thousands of places in the country including a few hundred in Iowa, there are minimum service roads interrupted by small creeks or rivers. When the flow is low, a regular vehicle can drive through the stream. When the flow is higher, it may only be crossed by a high clearance vehicle or tractor and sometimes it is impassable. If the water is too high, the driver would need to make a u-turn on a minimally maintained road. There is no way for the driver to know the actual condition except by driving within a few yards where they can see the water. The goal of this project would be to create a system so that drivers could see the level of the upcoming low water crossing before driving the length of the road and then possibly needing to turn around.

Design Requirements:

Functional Requirements:

- Read water level and display level appropriately
- Solar Powered
- Minimal maintenance
- Weatherproof
- Dependable/sturdy

Non Functional Requirements:

- Low environmental impact on the stream and surrounding natural features
- Stay within budget

Operating Environment:

- Outdoors in all four seasons

Relevant Standards:

- IP-56/IP-64: Waterproofing Standards
- IEEE /ISO/IEC 17464-2021: Software Lifecycle Standard

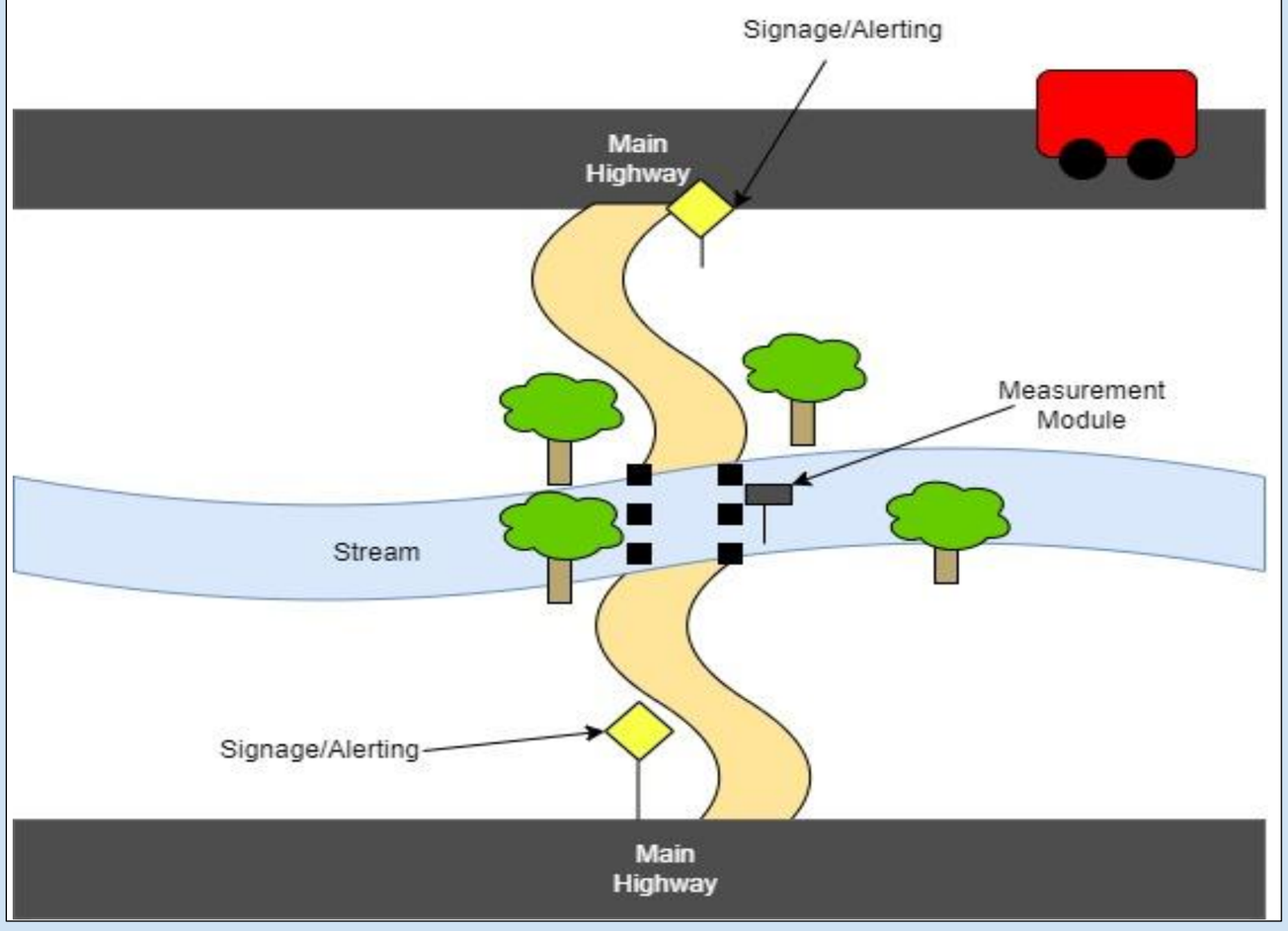
Budget

Original Budget: $500
Actual Expenditures:$741

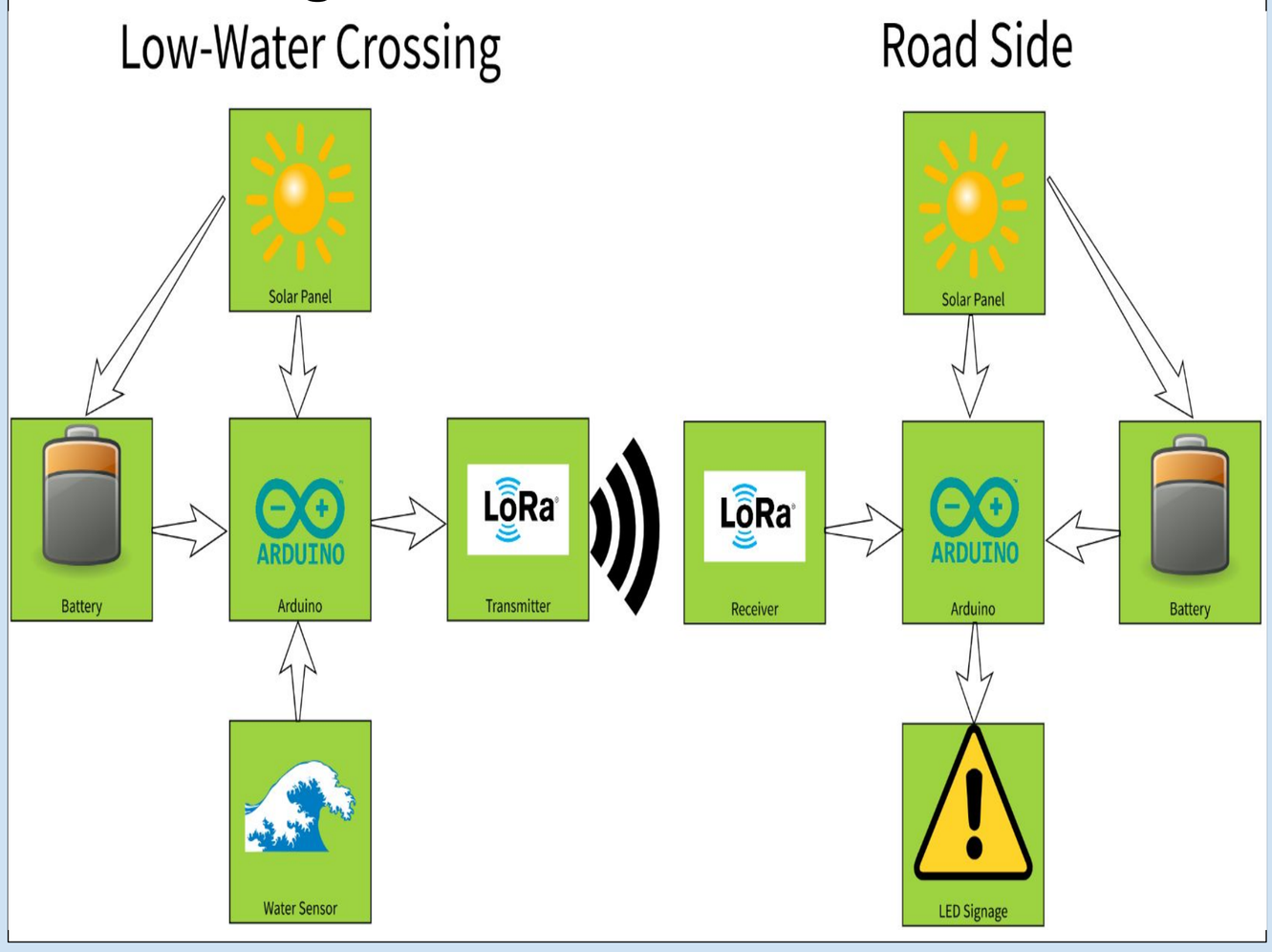
Users and Use Cases

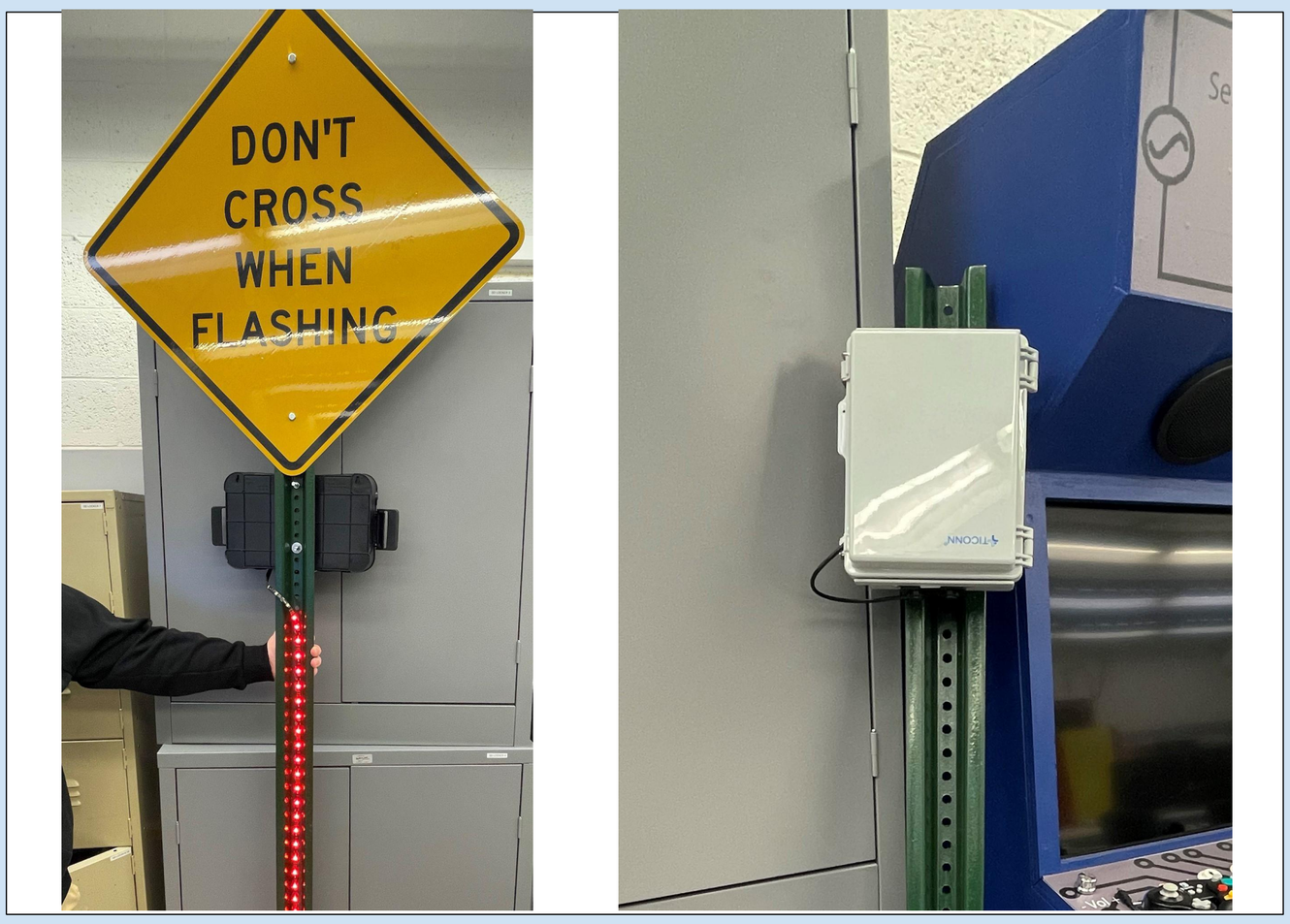
- Rural Driver: Rural citizens driving their vehicles wishing to cross the stream. Could be driving something as large as a tractor or as small as a sedan
- Maintenance Workers: Workers who may have low relevant technical experience that are responsible for the maintenance of the system

Concept Sketch



Block Diagram





Functional Modules

Water Sensor:
- Measures depth of stream

Arduino:
- Main processing unit for the project, controls the waterproof sensor, LoRa Radio, and LED signage

LoRa Radio:
- Wireless communication module, responsible for sending depth readings from the Low Water Crossing to the main highway

Signage:
- LED light strip that makes interpreting the stream depth and danger levels easy for drivers

Solar:
- The solar panels are responsible for charging the batteries and powering the Arduino during peak sun hours

Battery:
- The batteries store power that is used to power the Arduino and ancillary modules

Testing

Testing Environment:
- Tested both in lab and outdoors

Testing Strategy:
- Started with testing each module individually
- Then performed integration testing as units were put together (solar and battery etc)
- Finally performed system testing

Test Results:
- We used an error rate of 10% to determine if a module was acceptable
- All modules performed to within 90% of acceptable levels

Technical Details

- Water Sensor: Ultrasonic sensor, main concern is the sensor being blocked by debris
- LoRa: LoRa Radio, main concern is interference
- Signage: LED and road sign, main concern is visibility at day and night
- Solar: 100W Solar Panels, main concern is cloudy weather reducing charge rate
- Battery: Lead Acid and NiMh batteries, main concern is recharge fatigue and lifespan

Security

- Main security concern is physical security, solution is using locks on the waterproof boxes housing our electronics