

Michigan State University
College of Engineering Dept. of Electrical and Computer Eng.
ECE 480 Capstone Design Course Project Charter

Techmark, Inc.
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Background Information:

Techmark was founded in 1987 to provide advanced technology solutions to progressive agriculture producers and companies around the world. Today Techmark continues this mission by designing, distributing and servicing computerized ventilation systems, and value added products for a variety of food and agricultural applications. Techmark is headquartered in Lansing, Michigan and has a dealer network across the world.

The Techmark Impact Recording Device (IRD) is the world's leading tri-axial impact recorder. It is a self-contained microprocessor device designed for data collection, and applied specifically to recording impacts during agriculture commodity handling.

Business Case:

Bruised produce is the most common type of mechanical damage, and the easiest to correct. A 2013 Study by Stellenbosch University suggest that up to 40% of produce may be affected by bruising. Bruised produce leads to shorter shelf life, higher chance of disease in storage, lower quality and ultimately lower profits for the grower.

To help reduce bruising Techmark currently manufactures and sells the Impact Recording Device (IRD). The IRD offers fruit and vegetable handlers the opportunity to access where potential damaging impacts are causing bruises to their produce.

The current design of the IRD allows for IRD sizes down to 2.25" in diameter. While this allows for a wide range of fruits and vegetables that the IRD can match in size, it is simply too large for others. Blueberries, cranberries, strawberries, tree nuts and mushrooms are some of the crops that could benefit from a smaller IRD.

Project Intellectual Property Considerations:

The Techmark IRD is licensed and sold under US patent 4745564.

Techmark request that all embedded software and software programs source code developed or shared through this project remain private and protected from public record.

Opportunity Statement

Techmark would like to modernize the components of their existing IRD to use today's technology, and reduce the overall size of the IRD. By doing so, Techmark will be position to enter new markets to help reduce bruising in the smaller berry and fruit markets.

Past Work

During the Fall 2016 semester 2 design teams started on the initial design of the miniature IRD design. This previous work provided the basic schematic and software. This semester will continue their work and produce a completed product.

Primary Deliverables

- A sub-one-inch diameter working prototype of the miniaturized IRD.
- A charging mechanism for the power source.
- A communication mechanism to transfer data from the miniaturized IRD to Techmark's existing Windows based program, PCIRD
- All Schematics.
- All Source Code and Project Files for the build environment.
- Complete Project Files for all Circuit Boards.
- Bill of Materials (BOM).
- Specialized Instructions for being able to completely build and program new IRD's.

Secondary Deliverables

- Mechanism for casting IRD (3D printed, silicon mold, rubber mold, wax, etc....)
- Calibration procedure for IRD.

Scope

- Find updated components to modernize the IRD: microprocessor/memory/accelerometer/communication/power(batteries)/charge circuit/power supply
- Build a functional working prototype of the newly designed circuit.
- All new components should be able to be laid out on a ¾" round circuit board or smaller.
- Build/provide charging circuit for maintaining power.
- Charging circuit should have protection for high/low voltage

Constraints

- Accelerometer needs to be centered on the circuit board
- IRD will need to record impacts up to 200g, impacts of up to 500g would be preferred.
- IRD will need to withstand accidental drops of up to 5,000g.
- IRD will need to record the time duration of each impact. (determined by when the impact level rose above a defined threshold level till it drops below it).
- The total cost to build the IRD should be less than \$500 (Hardware component)
- IRD will need to be able to store high frequency data. Current sampling rate is 3906 Hz.
- IRD should have proper protection for preventing deep discharging of the power source.
- The power source needs to provide at least a 4-hour operation window.
- IRD should be able to turn off components to save on power, i.e., "low power mode"
- IRD unit needs to be able to be calibrated to give consistent readings.
- Be able to withstand environment: dust, moisture, water, dirt, oil.

- Work on Conveyor equipment that will be working in close proximity to Electric Motors, Hydraulic motors, and high temperatures.
- Work in temperatures of 32 degrees F to 120 degrees F.
- Needs to communicate with Techmark's existing PCIRD Software.
- Needs to be powered by a single battery or similar device. (no placing batteries in parallel or series)
- Microcontroller (Currently using MSP430) should communicate directly to a windows pc using the onboard UART.
- Eliminate noise/interference between components by using a multi layered pcb layout with Ground Plane in between for reducing interference. (will add time delay to having a pcb made)
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Possible improvements

- Wireless Charging
- Wireless connectivity i.e. Bluetooth, Bluetooth low energy, Wi-Fi, ZigBee, etc....
- Use a Waterproof connector to interface with the IRD.