Team #50

Kinetic Dispersion Testbench

Team members: Trey Stroupe, Brent Dardeen, Dalton Webber, Griffin Miller

PURDUE UNIVERSITY NORTHWEST

Customer Background

Charles A. Steele, M.S.
Charles Steele teaches forensics, chemistry, and physics while coordinating the forensic science program. He actively mentors students in fingerprint detection, pattern evidence analysis, and drug testing, and collaborates with CIVS and UIC on innovative projects like a virtual reality crime scene. His research focuses on improving forensic methods and understanding how jurors interpret scientific evidence.

Problem Statement

Current methods using ballistic gelatin fail to accurately measure how kinetic energy disperses through soft tissue. This limits understanding of internal damage from bullets, affecting ammunition design and protective gear development. Our project introduces a sensor-integrated gelatin system to capture real-time pressure data during impact, offering a more precise analysis of internal damage and improving military safety and effectiveness.

Requirements

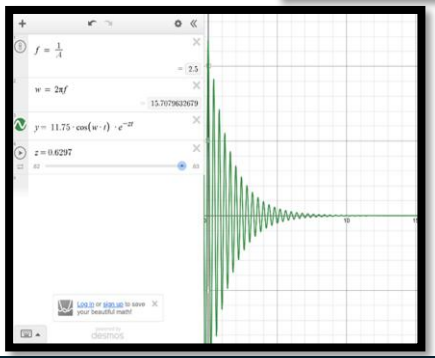
Req. #	DESIGN REQUIREMENTS	DESIGN TARGETS	VALIDATION
	RATIONALE		
1	Ballistic Gel Test Bench	Must be a realistic analog	Procure professional grade ballistics gel
	This is the medium that the bullet would travel through for this experiment.		
2	Device must produce accurate readings	Minimal margin of error	Repeated testing
	The user must be able to trust the data gathered from the device to inform future analysis.		
3	Device must withstand repeated testing	Sensors must not become damaged during normal testing procedure	Inspection of sensors after testing
	This device should have a long service life		
4	Device can be used with a variety of ammunition types	Sensors able to read at least pistol calibers such as 22lr and 9mm	Testing with multiple calibers of rounds
	Using a large range of firearms and ammo types will allow for direct comparisons between rounds.		

Experimentation & Concepts

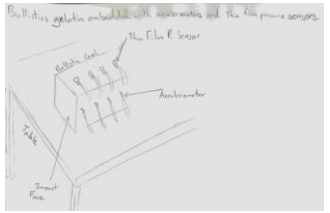
Mathematical Model

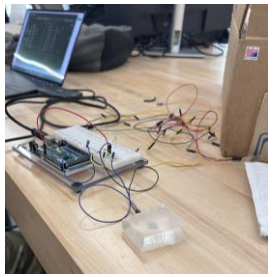
$$v(x) = v_0 * e^{-\frac{Cd*\rho*A*x}{2*m}}$$

$$v^2 = u^2 + 2as$$
$$a = \frac{(v^2 - u^2)}{2s}$$
$$F = ma$$



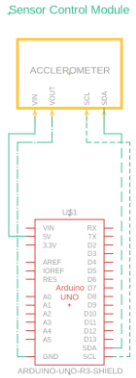
Initial Models

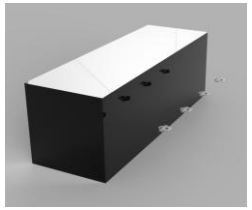




Final Design

External/Internal CAD



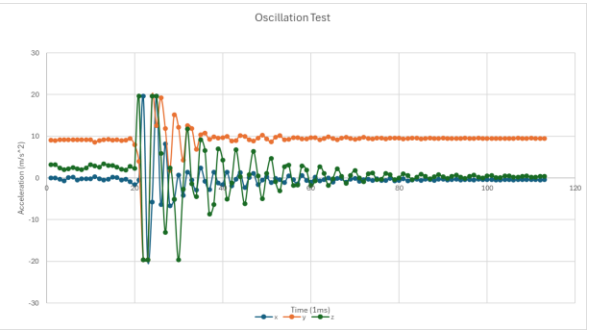


Code

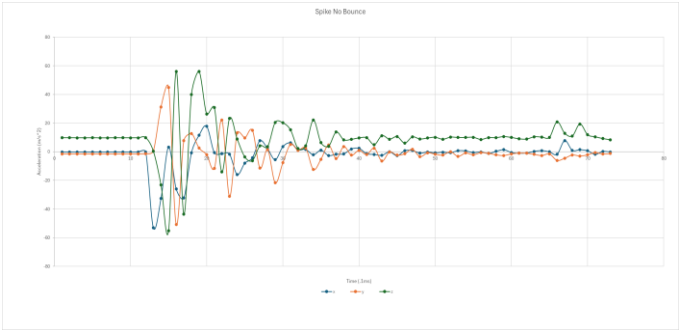
```
/*****************************************************************/
/*
  Capstone Group 50 Sensor Code
  Written by Dalton Webber
  Based on Adafruit.h test files
*/
/*****************************************************************/

#include <Wire.h>
#include <Adafruit_MMA8451.h>
#include <Adafruit_Sensor.h>

Adafruit_MMA8451 mma = Adafruit_MMA8451();

void setup(void) {
  Serial.begin(9600);
  Serial.println("Adafruit MMA8451 test!");
  if (! mma.begin()) {
    Serial.println("Couldnt start");
    while (1);
  }
  Serial.println("MMA8451 found!");
  mma.setRange(MMA8451_RANGE_8_G);
  Serial.print("Range = "); Serial.print(2 << mma.getRange());
  Serial.println("G");
}

void loop() {
  /* Get a new sensor event */
  sensors_event_t event;
  mma.getEvent(&event);
  /* Display the results (acceleration is measured in m/s^2) */
  Serial.print(millis()); Serial.print(",");
  Serial.print(event.acceleration.x); Serial.print(",");
  Serial.print(event.acceleration.y); Serial.print(",");
  Serial.print(event.acceleration.z); Serial.println("\t");
}
```

Testing

Initial Oscillation Test



Rebar Drop Test



Future Recommendations

Future iterations should focus on integrating rugged, high-speed pressure sensors. Molding gel blocks with sensor channels would allow for easier, more consistent placement. Implementing an instantaneous trigger mechanism for data recording will ensure that no critical information is lost. Validating results with alternative tissue analogs can further broaden the system's applicability.