

**BALLISTIC IMPACT DETECTION SYSTEM****CROSS-REFERENCE TO RELATED APPLICATION**

The present application represents a National Stage application claiming priority of PCT/US2005/021195 filed Jun. 16, 2005 entitled "Ballistic Impact Detection System", which claims the benefit of U.S. Provisional Patent Application Ser. No. 60/581,975 filed on Jun. 16, 2004 and entitled "Ballistic Impact Detection System (BIDS)"

**STATEMENT OF GOVERNMENT INTEREST**

The United States Government retains a royalty fee, fully paid up, non-exclusive license to make, use, have made, or have the invention used for governmental purposes.

**BACKGROUND OF THE INVENTION****1. Field of the Invention**

The present invention is generally directed to ballistic impact detection systems. More particularly, the invention is directed to a wearable ballistic impact detection system for detecting impacts to a body and especially impacts which might cause injury.

**2. Discussion of the Art**

The future battlefield is projected to be asymmetric, non-contiguous and nonlinear. To meet the challenge of future conflicts, the U.S. Army is changing its paradigm from linear and sequential operations to simultaneous and distributed operations. Sophisticated and adaptive adversaries are making unconventional tactics, such as guerrilla warfare and terrorist attacks, commonplace. In the future, as today, ground forces will continue to be counted on to win, hold the ground and rebuild the peace. The centerpiece enabler of the Army's transformation is the Future Force Warrior (FFW). FFW is a revolutionary redesign of the individual warfighter platform from the skin out. FFW is a system wherein data from sensors on the individual soldier are fused with similar information from other soldiers in the unit of action. As the data is integrated and sent back, the warfighter becomes a sensor node in a bigger network mesh which ultimately allows battlefield commanders to quickly react to critical information. Elements of the individual warfighters health status will be incorporated into the data stream from physiological monitoring devices worn by each soldier. The Warfighter Physiological Status Monitor (WPSM) is the medical system that will deliver pertinent information that will keep the soldier in the fight and, in the event of becoming a combat casualty, aid medics in rescue and recovery operations.

The central tenet to the Army's transformation to FFW is the ability to "see first, understand first, act first and finish decisively." The underlying foundation for achieving this detect-decide-deliver goal of battlefield tactics will be information technology. Acquiring critical information and delivering it rapidly and correctly will have a profound effect on the tactical, operational and strategic success of future combat missions. In the future, the Army unit of action will conduct operations over larger spaces. This translates into small, disparate fighting groups covering far more territory with a single medic in support. It is quite likely that FFW warfighters will be out of sight and hailing distance of medics and will rely on a medical information sub-network to achieve adequate levels of medical support. Early notification of a soldier's need for medical attention can reduce the time to initial treatment and thus may reduce the morbidity and mortality of wounded soldiers.

Data from a study of causes of death from the Vietnam War shows that while 66% of combat casualties die within the first 5 minutes of being wounded, there is an opportunity to save lives if a medic can get to a soldier quickly. FIG. 1 shows the percentage of all combat deaths as a function of the time from the wounding event. A therapeutic window of opportunity exists for those soldiers killed in action (KIA) in the time-frames encompassing 5 minutes to 6 hours. Given findings during Operation Desert Storm that the predominant cause of deaths in Corps hospitals was exsanguinations from extremity wounds, it is likely that with advances in body armor, extremity wounds will become a large percentage of potentially salvageable casualties on the battlefield. Knowing when a wounding event occurs and the ability to engage other physiological apparatus on the soldier to determine the extent of the casualty will play an important role in the required remote triage capability needed to change battlefield casualty statistics.

One known way to detect penetrating impacts is to use a mesh fabric incorporating fiber optics. When a fiber is broken, it is assumed to be caused by a penetrating impact. However, such a system is fragile and cannot accurately determine a ballistic impact from a rip or tear in the fabric caused by other sources.

Regardless of potential solutions, there exists a need in the art for a wearable ballistic impact detection system for detecting impacts to a body and especially impacts which might cause injury. The over-arching goal of the Ballistic Impact Detection System (BIDS) and WPSM program is to increase survivability of the soldier on the battlefield and facilitate more rapid triage for the combat medic. The BIDS has the following advantages: it is less expensive to manufacture; it detects impacts in extremities; is not prone to false positives from rips and tears; and is able to detect non-penetrating, but injurious blast overpressure.

**SUMMARY OF THE INVENTION**

The Ballistic Impact Detection System (BIDS) comprises a means to detect when a human body is impacted by a potentially injurious impact, such as a bullet, shrapnel or a significant blast wave. Piezo-film sensor elements detect the acoustic vibration patterns caused by an impact and convert them to a voltage. The voltage is passed through a circuit which determines if the impact has the frequency and amplitude characteristics of impacts that cause injuries. BIDS will be integrated into the Warfighter Physiological Status Monitor (WPSM) being developed for the Future Force Warrior (FFW) program. The WPSM represents the first attempt to place physiological monitoring equipment on individual soldiers. While the overall purpose of the WPSM is to provide information as to the health of the soldier, it has two distinct modes: operational and combat casualty. The BIDS will be used as the trigger mechanism to automatically detect a potentially injurious impact. This will enable the WPSM to begin monitoring physiological signals at faster rates in order to provide the medic with information enabling remote triage. This information is also of value to command and control elements.

Two sound sensors are positioned on a combatant's body to register high-energy acoustic signatures produced by ballistic impacts. The voltage output from these sensors feeds a small battery-powered analog and/or digital circuit also carried by the combatant. The circuitry isolates these signatures according to their voltage amplitudes and frequencies and discerns the approximate impact locations on the body within right, center and left general regions. The circuitry outputs "off" or