AIRBORNE VISIBILITY INDICATOR SYSTEM AND METHOD

I. FIELD OF THE INVENTION

This invention relates to a system and method for objectively determining current visibilities during flight to assist in the determination of whether a minimum required visibility is present to continue with the current flight plan and/or mission.

II. BACKGROUND OF THE INVENTION

There is a fundamental problem in aviation that until recently was not recognized as being the source of pilot error. The problem is that it is extremely difficult to subjectively determine visibility range during flight accurately. As such, pilots are prone to fly into poor visibility situations and not realize it until it is too late. For general aviation such as small planes, there typically is no equipment in the aircraft to allow for instrument flying (because of the cost of the equipment), which results in the pilot gambling he/she will be lucky and is able to fly into better visibility conditions before crashing. This is less of an issue on larger aircraft, because they typically operate under instrument flight rules since these aircraft have equipment that allows instrument flying when visibility decreases and/or becomes difficult to judge such as at night and/or over large bodies of water.

Every year, military and civilian aviation lose lives and aircraft due to the spatial disorientation experienced during periods of minimal visibility or inadvertent entry into instrument meteorological conditions. The flights sometimes end catastrophically when the aircraft flies into an unseen terrain such as a mountain or other unyielding surface.

Spatial disorientation occurs "... when the aviator fails to sense correctly the position, motion, or altitude of his aircraft or of himself within the fixed coordinate system provided by the surface of the earth and gravitational vertical." Benson, *Spatial Disorientation: General Aspects*, Aviation Medicine, 1978. Spatial disorientation remains an important source of attrition in aviation. U.S. Army Field Manual 3-04.301 (Department of the Army, 2000), Aeromedical Training for Flight Personnel, states that, "[s]patial disorientation contributes more to aircraft accidents than any other physiological problem in flight." Regardless of their flight time or experience, all aircrew members are vulnerable to spatial disorientation. According to a Federal Aviation Administration technical report (Kirkham et al., *Spatial Disorientation in General Aviation Accidents*, FAA Civil Aeromedical Institute, Report No. FAA-AM-78-13, 1978), for all fatal accidents in small fixed-wing aircraft from 1970 through 1975, 22.2% involved continued flight into adverse weather while operating under VFR (visual flight rules) and 16.4% were attributed to spatial disorientation. According to the U.S. Army Safety Center (USASC) accident files and a report published by the U.S. Army Aeromedical Research Laboratory (USAARL) (Braithwaite, et al., *Spatial Disorientation in U.S. Army Helicopter Accidents: An Update of the* 1987-92 *Survey to Include* 1993-95, U.S. Army Aeromedical Research Laboratory, USAARL Report No. 97-13, 1997), spatial disorientation was considered to be a significant factor in 291 (30 percent) of Class A, B and C helicopter accidents in the U.S. Army between 1987 and 1995. According to the report, during this time, 110 lives were lost and a cost of nearly $468 million was incurred. The monetary cost of spatial disorientation is high and the fatality rate is between one and one-half to two times that of nondisorientation accidents.

Preliminary results of a review of spatial disorientation accidents for fiscal years (FY) 1996 through 2000 showed similar trends with reviews by Durnford et al., *Spatial Disorientation: A Survey of U.S. Army Helicopter Accidents* 1987-1992, U.S. Army Aeromedical Research Laboratory, USAARL Report No. 95025, 1995 and Braithwaite, et al. (1997). It was further stated that data comparison with fiscal years 1991 through 1995 showed that the spatial disorientation accident rate is not decreasing, and if anything, since 1995, has slowly started increasing. This trend indicates that despite the best efforts of the USASC to educate the aviator through printed accident reviews and the efforts of the developers of improved aircraft orienting technology (cockpit head-up displays, improved night vision devices, global positioning navigation systems, etc.), there has been little change in the spatial disorientation accident rate.

Over the past six years, weather and spatial disorientation has caused 21% of all accidents and 49% of the fatal crashes involving lifesaver flights. Springer, *The IFR Bullet*, Air Medical Journal, Vol. 24, No. 1, January-February 2005. It is estimated that if the weather related accidents were eliminated, then the accident rate (per 100,000 hours) would go from 6 down to 4 while cutting the fatal crash rate in half from 2 to 1.

In the last two years, there was a multiple helicopter NVG long range surveillance corps extraction training insertion conducted by the U.S. Army. The terrain flight was under zero illumination, no visible horizon and unknown weather, which led to a situation involving spatial disorientation and a controlled flight into terrain resulting in four fatalities and a total cost of $8.4 million.

An important action required by pilots in order to maintain situation awareness and avoid visual conditions likely to cause spatial disorientation is to correlate actual enroute visibility with the minimum visibility required for a particular class of airspace or with a mission's minimum visibility as an abort criterion.

Visibility is one of the most complicated of all meteorological elements to determine during flight. The measure of visibility and visual range depends on the characteristics of the atmosphere, the type of viewing instrument, the type of object or light being detected, and the manner by which the object or light is being viewed. The primary factors influencing visibility include: reflecting power and color of the object, reflecting power of the background, amount of scattering and absorbing particles, position of the sun, angular size of the object, nature of the terrain between the object and observer, contrast of the object, and intensity of the light source.

In the case of classes of airspace that allow VFR flight as defined in the Federal Aviation Regulations (U.S. Government, 2003), when flying VFR, it is incumbent on aviators to maintain at least the minimum visibility required for that airspace. The Federal Aviation Regulations issued by the Federal Aviation Administration (FAA) establish rules under which pilots must operate depending on the class of airspace through which they are flying. U.S. pilots must comply with host nation rules when operating in foreign airspace. In the continental United States, there are six classes of airspace that depend upon the class of aircraft, the altitude being flown, and geographical location. In addition to vertical and horizontal dimensions, a regulatory factor of these classes of airspace is the minimum visibility required within each specific class in order to remain legal. As an example, any pilot flying under VFR in Class G airspace below 1200 feet above ground level (AGL) must maintain 0.5 statute mile (sm) visibility during the day (1 statute mile at night) to comply. In a combat/tactical situation, where flight operations are not subject to FAA