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NAVIGATION SYSTEM FOR MULTI FLOOR POSITIONING USING MEMS

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Abstract-This Project is proposed to develop a navigation system based on inertial sensors to track the movement and direction of soldiers or fire fighters accurately within a multi floor building. This system does not require Global Positioning System(GPS). The System consists of 6 DOF(Degree of Freedom) Digital MEMS Geo Magnetic Module which includes 3-axis MEMS accelerometer and magnetometer to provide direction and movement of the soldier. Barometric Pressure Sensor is used to determine the altitude. ARM Processor controls all the units. RF Transceiver is for the communication purpose. By this work the movement (left, right, up and down) and altitude of all the soldiers would be known to the military troop outside the building. Applications include a militant seeking operation or even in a fire fighting operation. This system would help to rescue the injured person in much lesser time.

Keywords- Positioning, ARM Processor, RF Transceiver, MEMS Geo Magnetic Module, Pressure Sensor.

I. INTRODUCTION

Indoor positioning is defined as the system that provides a information about position of the person inside the closed structure. An example for indoor positioning is illustrated in the figure 1.The INS(Inertial Navigation System) is an appropriate method for personal navigation systems. It provides a navigation solution using inertial sensors. The inertial sensors are accelerometers, gyros and magnetometers which provides the positioning informations [10].A navigation system that tracks the location of a person is useful for finding and rescuing firefighters or other emergency first responders or for location-aware computing, personal navigation assistance, mobile 3D audio, and mixed or augmented reality applications [6].

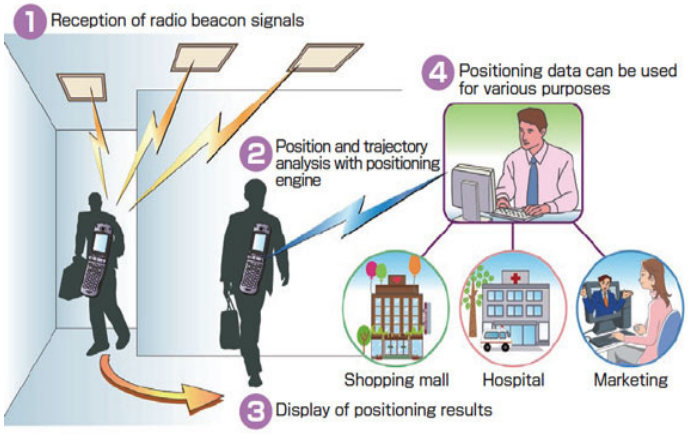

Figure 1. Example for indoor positioning

GPS or cell signals are commonly used for navigation in an outdoor environment, the blockage of the GPS signal occurs frequently in urban and forest areas [5] but indoor positioning remains as an unsolved problem. A small size and low-cost INS is required in indoor navigation.To achieve these requirements the system is proposed.

II. PROPOSED SYSTEM USING MEMS

MEMS are devices that integrate mechanical elements, sensors, actuators, and electronics on a common silicon substrate. Many typically have dimensions in the 1 micron to 100 micron range. They have proven to be a key enabling technology of developments in areas such as transportation, telecommunications and health care, but the range of MEMS applications covers nearly every field. The most significant advantage of MEMS is their ability to communicate easily with electrical elements in semiconductor chips. Other advantages include small size, lower power consumption, lower cost, increased reliability and highly precise. The components of the MEMS is shown in the figure 1.

The individual sensors used in inertial/magnetic sensor modules are low cost Micro-Electro-Mechanical Systems (MEMS) sensors. Low cost MEMS accelerometers are susceptible to drift errors. Reduced Manufacturing Cost & Time. Micro components make the system faster, more reliable, more portable, cheaper, low power consumption, easily & massively employed, easily maintained & replaced. Easy to integrate into systems or modify. Miniaturization with no loss. Little harm to environment and capable of incorporating.

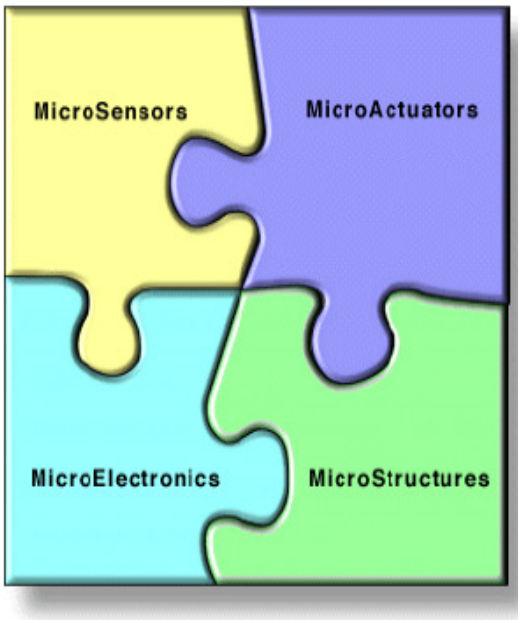

Figure 2. Components of MEMS

Although there are many technologies available to miniaturize devices, the acronym MEMS is used almost universally to refer to all devices that are produced by micro fabrication or micromachining except Integrated Circuit (IC) or other conventional semiconductor devices, micromachining is any process that deposits, etches or defines materials with minimum features measured in micrometers or less. The general field of miniaturization is known as Micro Systems Technology(MST).Most of the PDR systems use inertial sensors (accelerometer, gyroscope, and digital compass) to measure step length and heading direction [7]. Generally, the PDR system that uses the inertial sensors can be classified into two categories, depending on the place where the sensors are placed. For the first type,

the sensors are mounted on foot. The foot mounted method uses double integral to estimate distance and use gyroscope or compass to measure the heading direction [9].

2.1 System Design

The hardware design consists of two sections ,one is the soldier's section which is wearable by the soldiers and another section is monitoring section with the military troops outside the building.

2.1.1 Soldier's section

The soldier's section has 3-axis MEMS magnetometer and 3-axis MEMS accelerometer. MEMS magnetometer to determine direction and tilting information about soldiers. An accelerometer measures acceleration, either due to motion or due to gravity and it measures acceleration using an inertial frame of reference. This can also be used to measure its orientation.

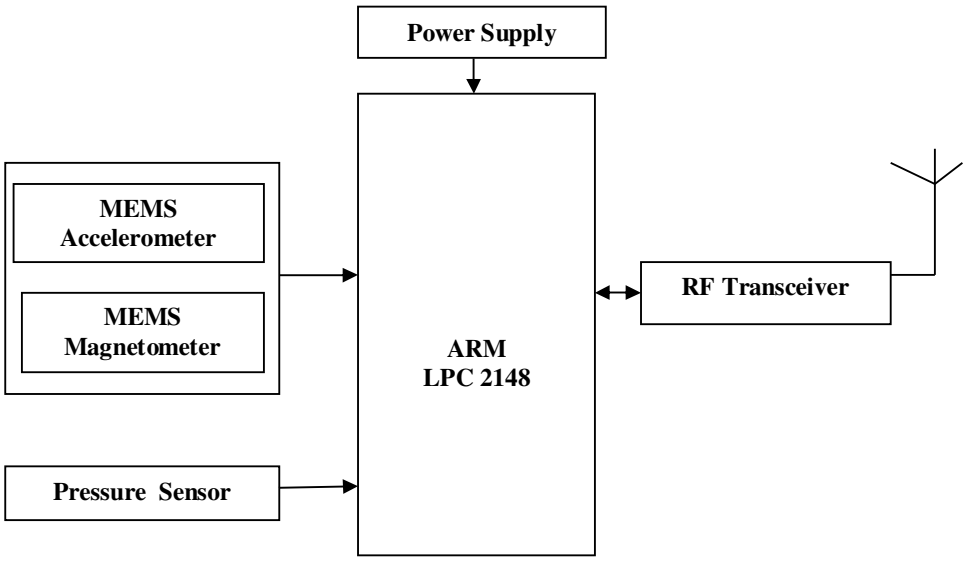

Figure 3. Block diagram of Soldier's Section

The orientation can be calculated from the three axis roll, pitch and yaw. The data processing is carried by the LPC 2148 ARM processor. It is also used to control all the units of the system. Pressure sensor to estimate the altitude. The section consists of RF transceiver for communication between soldiers and military troops outside the building. ARM Processor receives the information from the sensors and transmits information to RF transceiver. The Block diagram of soldier's section is shown in the figure 3.

2.1.2. Monitoring Section

The monitoring section has LCD display, ARM Processor and RF transceiver. LCD display to display the position information. RF transceiver is used for wireless transmission and reception of data. The ARM Processor receives information from the RF transceiver and sends it to the LCD display. The monitoring section receives the information via RF transceiver. The block diagram of monitoring section is shown in figure 4.

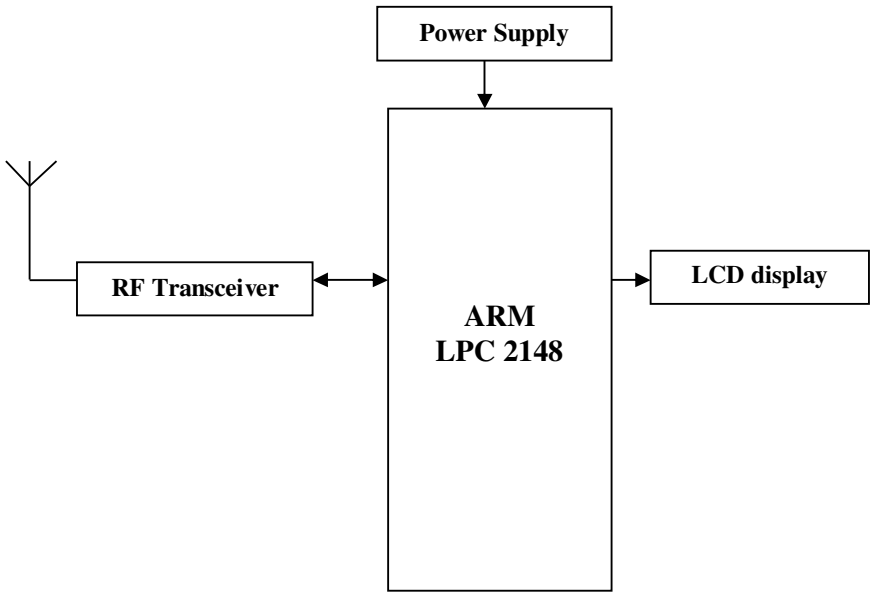

Figure 4. Block diagram of monitoring section

III. SIMULATION

The simulation process is carried out by Proteus 8 software. It is easy to install, free of viruses and perfect for laptops. The language C is very portable language that enjoys wide popular support and is easily obtained for most systems. Existing program investments can be quickly adapted to other processors has needed.

The Keil C compiler provides more features and allows you to write ARM applications in C and have the efficiency and speed of assembly language. Language extensions in the compiler gives the full access to all resources of the ARM. The compiler translates C source files into reloadable object modules which contain full symbolic information for debugging with micro vision debugger. The various steps through which entire simulation is carried out. Initially the process is started. The pressure value, magnetometer value and accelerometer values are obtained. The pressure value is checked whether it is at ground floor pressure level or another floor pressure level. Similarly magnetometer and accelerometer values are checked. Then collected datas are displayed using virtual terminal

3.1 Design of proposed system using proteus software

The design of proposed system with ARM Processor and Sensors is shown in the figure 5.Three sensors such as accelerometer sensor, magnetometer sensor and pressure sensor are connected to the ARM Processor. When the value of pressure sensor gets changed, the virtual terminal window shows the floor details. Eight directions are shown by varying the magnetometer sensor. When the accelerometer value changes, window shows the information about tilting.

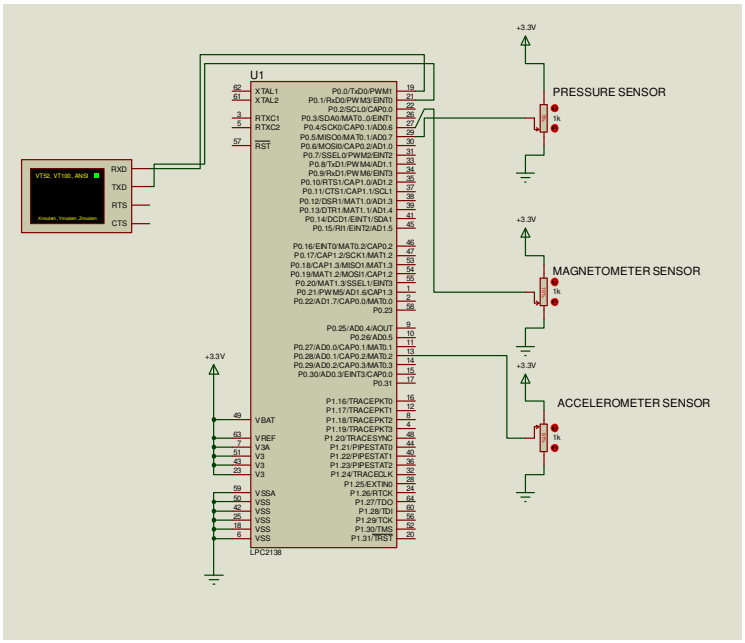

Figure 5. Design of Proposed System using Proteus

IV. RESULTS

The three sensors senses and gives a positioning informations. when pressure sensor value lies between 1% to 29% . It gives an output as ground floor. The Magnetometer gives an output as north east direction when it lies between 10% to 19%. The accelerometer gives an output as left when it lies between 45% to 100%. Here the values of magnetometer is 10%, pressure sensor is 5% and accelerometer is 91% which is shown in the Figure 6. The output is displayed as ground floor, north east direction and left side is shown in the Figure 7.

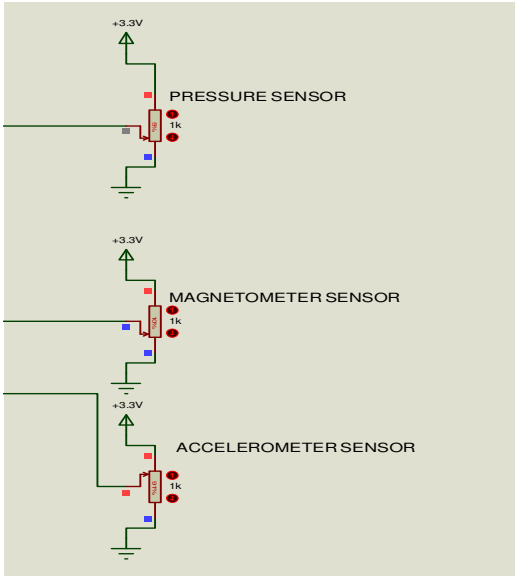

Figure 6 .Values of Sensors for North East Direction and Ground Floor

Figure 7. Simulation Output for North East Direction and Ground Floor.

The values of sensors for south direction and first floor is shown in the figure 8.The Magnetometer gives an output as south direction when it lies between 54% to 63%.The simulation output for south direction and first floor is shown in the figure 9. Here the value of magnetometer is 54%.The pressure sensor and accelerometer values are unchanged. The values for north west direction and second floor is illustrated in the figure 10. So the output is displayed as first floor, south direction and left side.

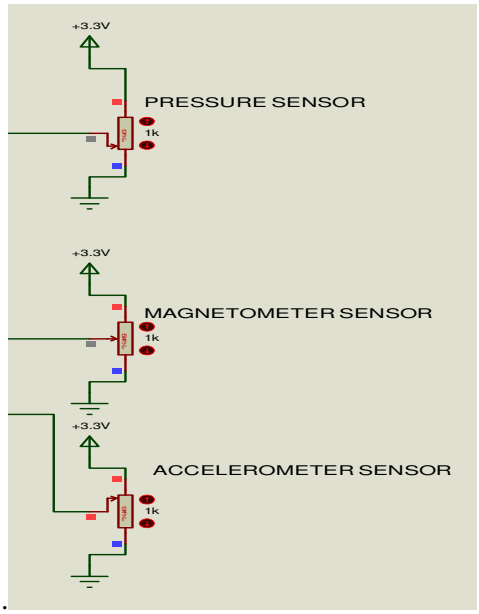

Figure 8. Values of Sensors for South Direction and First Floor

Figure 9. Simulation Output for South Direction and First Floor

Figure 11 shows the simulation output for north west direction and second floor. The Magnetometer gives an output as north west direction when it lies between 84% to 100%. Here the value of magnetometer is 89% and the value of pressure sensor and accelerometer remains unchanged. The output is displayed as north west direction ,second floor and right side. The pressure sensor gives an output as third floor when it lies between 88% to 100%. The Magnetometer gives an output as north direction when it lies between 1% to 9%. Figure 12 shows the values of sensors for north direction and third floor

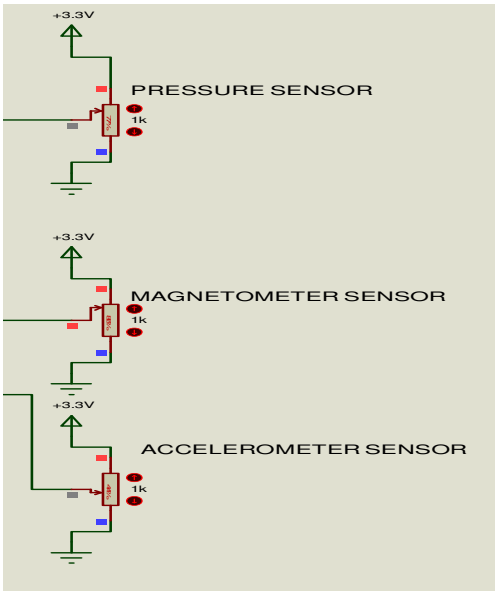

Figure 10. Values of Sensors for North West Direction and Second Floor

Figure 11. Simulation Output for North West Direction and Second Floor

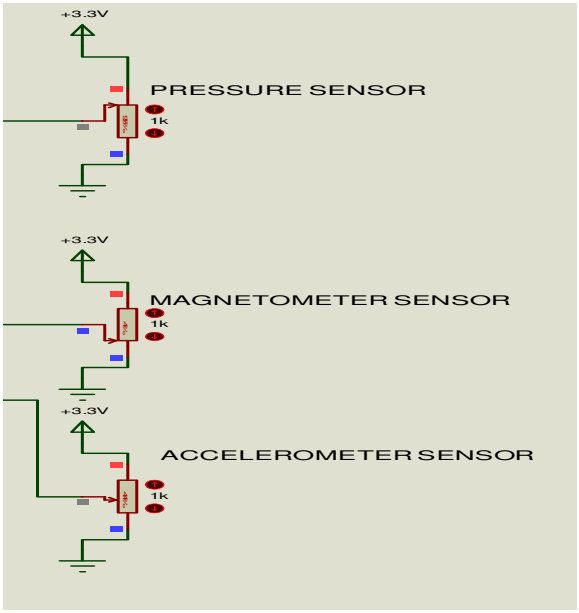

Figure 12 . Values of Sensors for North Direction and Third Floor

Figure 13 shows the simulation output for north direction and third floor. Here the values of magnetometer is 4%, pressure sensor is 96% The output is displayed as third floor, north direction and right side.

Figure 13. Simulation Output for North Direction and Third Floor

V. CONCLUSION

This system is used to detect the positioning information of the soldiers within multi floor building during urban combat operations. At the same time, it sends the information to the troops outside the building. These information are obtained by the inertial sensors. Many difficulties may arise during indoor localization. The positioning should be more accurate for the military purpose. In this system inertial sensors are employed to achieve better accuracy at low cost. Other advantages include small size, lower power consumption ,faster response, reliability and portability etc., It can also used in the open indoor spaces like big hotel lobby. In addition to that altitude estimation is also performed within a multi-floor building using this system and it is more convenient compared to the GPS based navigation system. This system eliminates the problem arising in the Positioning system based on the RFID reader.

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