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REAL-TIME WIRELESS EMBEDDED ELECTRONICS FOR SOLIDER SECURITY(DOMAINS WNS)

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ABSTRACT

One of the important and vital roles in a country's defense is played by the army soldiers. Every year Soldiers get strayed or injured and it is time consuming to do search and rescue operations. In this project, present a WSN-based environmental and health monitoring approach in which sensor data is processed using robust and stable algorithm implemented in controller. These processed data are then sent to the base station via low-cost, lowpower and secure communication links provided by a IOT network infrastructure instead of cellular networks, since, they are either absent or doesn't allow data transmission in warzone or remote areas. We focus on monitoring environmental factors such as temperature, humidity, air quality; physical factors such as motion, geographic location and health parameters like blood oxygen level, body temperature. Moreover, camera are used to monitor any undesirable situation of soldier. The aim of the system is to reduce the response time for any emergencies with the use of embedded system and WBASN, while being power efficient.

I.INTRODUCTION

The nation's security is monitored and kept by army, navy and air-force. There are many concerns regarding the safety of the soldier. Soldiers in battlefield often lose their lives due to lack of connectivity, it is very vital for the army base station to known the location as well as health status of all soldiers. To avoid life-threatening situations, it is helpful to continuously monitor soldiers suffering from harsh conditions. The Wireless Sensor Network (WSN) plays a crucial role in health monitoring, since it enables us to connect sensors to collect soldiers' health and environmental data and process it to prevent critical events. Major research is being done by some of the world's largest militaries like Russian and U.S. Army to build wearable embedded device which could monitor the physical and environmental factors of soldiers, like in TALOS Exoskeleton (Tactical Assault Light Operator Suit) project which involves 56 corporations, 16 governments agencies, 13 universities, and 10 national laboratory for research and development purpose [1]. In-depth analysis regarding smart wearable clothing has been provided by Scataglini et al. [2], about the application and importance of smart wearable clothing in the Army. A comprehensive survey has been provided by Islam et al. [3] which provides information regarding the impact of IoT on e-health monitoring, monitored parameters and provided services. Existing IoT-based health monitoring systems suffer from three main constraints. First, they often make use of relatively high cost communication links, such as 3G/4G [4, 5]. Second, they typically do not deal with data privacy issues [6, 7]. Third, most of them do not analyze monitored health parameters to prevent critical situations [6, 7]. In this paper, we propose an IoT-based health monitoring approach that addresses above mentioned issues. Ahmed et al. [6] have proposed an architecture for e-health monitoring systems. The authors [8-10], had discussed about various wearable, portable, light weighted and small sized sensors that have been developed in order to monitor physiological parameters of the human. The Body Sensor Network (BSN) consists of many biomedical and physiological sensors which can be placed on human body for health monitoring in real time. GSM is used for communication which may not be useful at places with high altitude or in remote areas where network connectivity would be a big challenge. A message is sent after regular intervals containing the health status of the soldier using GSM. In paper [11], authors implemented monitoring system including data privacy using blockchain which is an important factor, but the use of GSM can be troublesome in the war-field. Another IOT-based system is described in the paper [12] which uses the Wi-Fi module to communicate with control room, which can be costly in terms of power consumption. Gondalia et al. [13] described the system that tracks the location and monitors the health of the soldiers. The data collected from sensors will be transmitted wirelessly using ZigBee module among the fellow soldiers. Furthermore, IOTWAN network has been proposed to be used between the squadron leader and the control unit in high altitude warzones where cellular network coverage is either absent or does not allow data transmission. Mdhaffar et al. [14], has proposed, IoT-based Health Monitoring via IOTWAN in which collected medical sensor data is sent to an analysis module IOTWAN (Long Range Wide Area Network) network infrastructure. Power consumption of their monitoring system is claimed to be ten times lower than other long-range cellular solutions, such as GPRS/3G/4G. Previously, similar work has been done by our group using Arduino [15], but due to limited processing power of Arduino and lacking USB port for camera and microphone connection, we have used Raspberry Pi to overcome the above mentioned controller constraints. In our model, the

collected data is processed by Raspberry Pi and then sent to the base module by a low-cost, low-power, long range and secure communication links provided by a IOT communication. The transmitted data is analyzed to detect, predict and prevent crisis situations by generating and executing adequate treatment plans. Base module receives images and audio recording clip whenever emergency situation is detected by robust and stable algorithm on the bases of data acquired from the sensors. All this will help the base station to get a better understanding of the situation and will help to create more informed and efficient strategy to overcome the situation.

II. LITERATURESURVEY

An embedded system is a special-purpose computer system designed to perform one or a few dedicated functions, sometimes with realtime computing constraints. It is usually embedded as part of a complete device including hardware and mechanical parts. In contrast, a general purpose computer, such as a personal computer, can do many different tasks depending on programming. Embedded systems have become very important today as they control many of the common devices we use. Since the embedded system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product, or increasing the reliability and performance. Some embedded systems are mass produced, benefiting from economies of scale. Physically embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants. Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure. In general, "embedded system" is not an exactly defined term, as many systems have some element of programmability. For example, Handheld computers share some elements with embedded systems — such as the operating systems and microprocessors which power them — but are not truly embedded systems, because they allow different applications to be load and peripherals to be connected. An embedded system is some combination of computer hardware and software, either fixed in capability or programmable, that is specifically designed for a particular kind of application device. Industrial machines, automobiles, medical equipment, cameras, household appliances, airplanes, vending machines, and toys (as well as the more obvious cellular phone and PDA) are among the myriad possible hosts of an embedded system. Embedded systems that are programmable are provided with a programming interface, and embedded systems programming is a specialized occupation. Certain operating systems or language platforms are tailored for the embedded market, such as Embedded Java and Windows XP Embedded.

In today's word, the science and technology is growing rapidly with new inventions, innovations and with advance level of their implementations. These immerging advance technologies are firmly adopted by defense services to provide some safety systems to our soldiers. There are many parameters by which defence services can provide safety to the soldiers. In our project, we are trying to provide an embedded wireless system by which the Army base stations can monitor the heart beat count and body temperature of soldiers using wireless body area sensor networks (WBASNs) such as temperature sensor, heart beat sensor, etc. [1]. Base stations can also know the location of soldiers by tracking them through Global positioning system (GPS) and can guide them to any safe area. Also, the soldier can ask for his location from army control unit in case if he feels that he is lost or to plan any new strategies against enemies. In this project, all the processes are in real time because of the use of ARM 7 microprocessor. The sensed data and the tracked location of soldiers will be transmitted wirelessly using ZigBee module [2]. In military operations, one of the fundamental challenges is that is the soldiers are not able to communicate with control room and sometimes not even with the other fellow soldiers. Once a troop or a soldier become lost during fight in battle field due to some unfavourable environment or adverse fight conditions, then it becomes more difficult to search them and bring back to the army base station. In addition, every defence organization needs to design and develop some advance, small, portable and robust system to provide safety measures to their soldiers.

III. DESIGNOFHARDWARE

3.1ESP32

ESP32 is a series of low-cost, low-power system on a chip microcontrollers with integrated Wi- Fi and dual-mode Bluetooth. The ESP32 series employs either a Tensilica Xtensa LX6 microprocessor in both dual-core and single-core variations, Xtensa LX7 dual-core microprocessor or a single-core RISC- V microprocessor and includes built-in antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power-management modules. ESP32 is created and developed by Espressif Systems, a Shanghai-based Chinese company, and is manufactured by TSMC using their 40nm process.[2] It is a successor to the ESP8266 microcontroller.

Features

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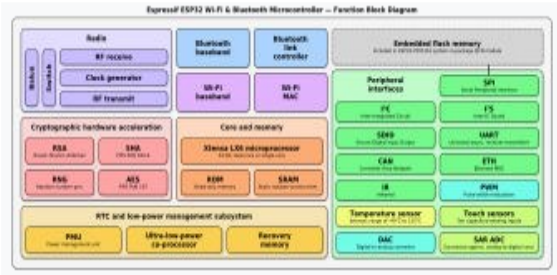


ESP32functionblockdiagram.

ESP32-C3

3.2.POWERSUPPLY:

Thepowersuppliesaredesignedtoconverthigh voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can by broken down into a series of blocks, each of whichperformsaparticularfunction. A
d.c power supply which maintains the output voltage constant irrespective of a.c mains fluctuations or load variationsisknownas“RegulatedD.CPowerSupply”.

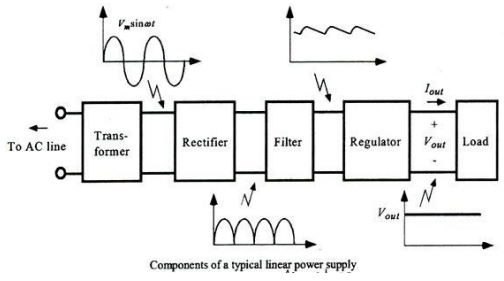


Fig:4.4. BlockDiagramofPowerSupply

3.3.LCD:

A model described here is for its low price and great possibilities most frequently used in practice. It is based on the HD44780 microcontroller (Hitachi) and can display messages in two lines with 16 characters each. It displays all the alphabets, Greek letters, punctuation marks, mathematical symbols etc. In addition, it is possible to display symbols that user makesuponitsown.Automatic shifting message on display (shift left and right), appearance of the pointer, backlight etc. areconsideredasusefulcharacteristics.

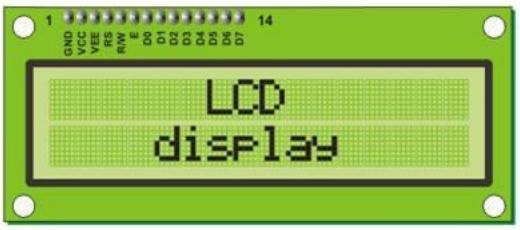
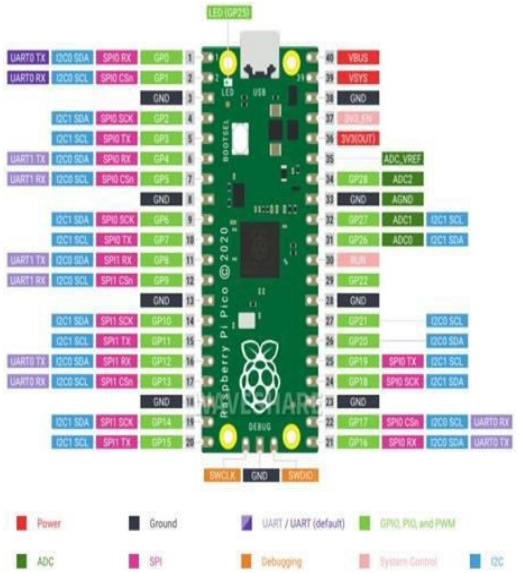


Fig:LCD

3.4RaspberryPiPico

RaspberryPiPicoisalow-cost,high-performance microcontroller board with flexible digital interfaces. It incorporates Raspberry Pi's own RP2040 microcontroller chip, with a dual-core Arm Cortex M0+ processor running up to 133 MHz, embedded 264KB of SRAM, and 2MB of onboard Flash memory, as well as 26 x multi-function GPIO pins.
For software development, either Raspberry Pi's C/C++SDKortheMicroPythonisavailable.Thereare also complete development resources and tutorials to help you get started easily, and integrate it into end productsquickly.

Pinout



The RP2040 chip has two ARM Cortex M0+ CPU cores running at up to 133 MHz (before overclocking). Each core also has an integer division unit and interpolator.

There are two programmable I/O modules (PIO), capable of communicating with addressable LEDs, among many other things. The board is however not 5V-capable.

Program code (firmware) is loaded from a 2MB Flash chip on the board. There is a 16KB SRAM cache which allows*eXecution In Place*(XIP) as if

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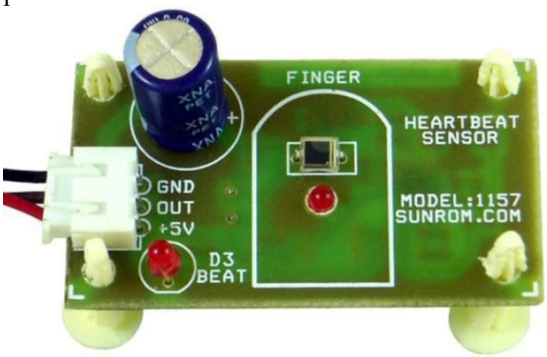
all the program memory was in RAM—albeit with a performance hit on cache misses. Code can also be loaded into internal SRAM and run from there. If all code is run from SRAM, the cache could be reused as additional SRAM instead.

3.5 HeartBeatSensor:

Heart beat sensor is designed to give digital output of heart beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heart beat. This digital output can be connected to microcontroller directly to measure the Beats Per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse.



UsingtheSensor:

· Connect regulated DC power supply of 5 Volts. Black wire is Ground, Next middle wire is Brown which is output and Red wire is positive supply. These wires are also marked on PCB.

· To test sensor you only need power the sensor by connect two wires +5V and GND. You can leave the output wire as it is. When Beat LED is off the output is at 0V.

· Put finger on the marked position, and you can view the beat LED blinking on each heart beat.

· The output is active high for each beat and can be given directly to microcontroller for interfacing applications.

3.6 GPS

The Global Positioning System (GPS) is a space-based satellite navigation system that provides location and time information in all weather, anywhere on or near the Earth, where there is an unobstructed line of sight to four or more GPS satellites. It is maintained by the United States government and is freely accessible to anyone with a GPS receiver.

The GPS program provides critical capabilities to military, civil and commercial users around the world. In addition, GPS is the backbone for modernizing the global air traffic system.

The GPS project was developed in 1973 to overcome the limitations of previous navigation systems,[1] integrating ideas from several predecessors, including a number of classified engineering design studies from the 1960s. GPS was created and realized by the U.S. Department of Defense (DoD) and was originally run with 24 satellites. It became fully operational in 1994.

Advances in technology and new demands on the existing system have now led to efforts to modernize the GPS system and implement the next generation of GPS III satellites and Next Generation Operational Control System (OCX).[2] Announcements from the Vice President and the White House in 1998 initiated these changes. In 2000, U.S. Congress authorized the modernization effort, referred to as GPS III.

In addition to GPS, other systems are in use or under development. The Russian Global Navigation Satellite System (GLONASS) was in use by only the Russian military, until it was made fully available to civilians in 2007. There are also the planned European Union Galileo positioning system, Chinese Compass navigation system, and Indian Regional Navigational Satellite System.

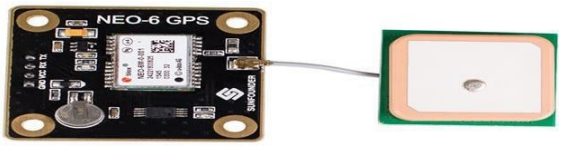


Fig:GPSMODEM

3.7 TEMPERATURESENSOR(LM35):

In order to monitor the temperature continuously and compare this with the set temperature preprogrammed in the microcontroller, initially this temperature value has to be read and fed to the microcontroller. This temperature value has to be sensed. Thus a sensor has to be used and the sensor used in this project is LM35. It converts temperature value into electrical signals.

LM35 series sensors are precision integrated-circuit temperature sensors whose output voltage is linearly proportional to the Celsius temperature. The LM35 requires no external calibration since it is internally calibrated. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range.

The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air.

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3.8 HUMIDITY

Humidity is a term for the amount of water vapor in the air, and can refer to any one of several measurements of humidity. Formally, humid air is not "moist air" but a mixture of water vapor and other constituents of air, and humidity is defined in terms of the water content of this mixture, called the Absolute humidity. In everyday usage, it commonly refers to relative humidity, expressed as a percent in weather forecasts and on household humidistats; it is so called because it measures the current absolute humidity **relative** to the maximum. Specific humidity is a ratio of the water vapor content of the mixture to the total air content (on a mass basis). The water vapor content of the mixture can be measured either as mass per volume or as a partial pressure, depending on the usage.

In meteorology, humidity indicates the likelihood of precipitation, dew, or fog. High relative humidity reduces the effectiveness of sweating in cooling the body by reducing the rate of evaporation of moisture from the skin. This effect is calculated in a heat index table, used during summer weather.

3.9 Webcam

Higher cost webcam

Typical low-cost webcam used with many personal computers (2007)

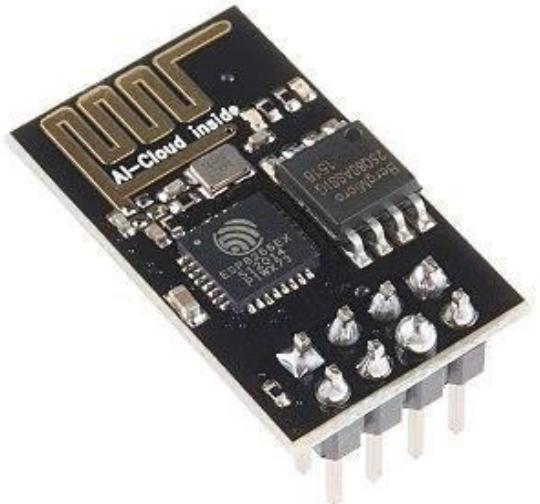
A **webcam** is a video camera that feeds or streams an image or video in real time to or through a computer to a computer network, such as the Internet. Webcams are typically small cameras that sit on a desk, attach to a user's monitor, or are built into the hardware. Webcams can be used during a video chat session involving two or more people, with conversations that include live audio and video. For example, Apple's iSight camera, which is built into Apple laptops, iMacs and a l of iPhones, can be used for video chat sessions, using the Messages instant messaging program. Webcam software enables users to record a video or stream the video on the Internet. As video streaming over the Internet requires much bandwidth, such streams usually use compressed formats. The maximum resolution of a webcam is also lower than most handheld video cameras, as higher resolutions would be reduced during transmission. The lower resolution enables webcams to be relatively inexpensive compared to most video cameras, but the effect is adequate for video chat sessions.[1]

The term "webcam" (a clipped compound) may also be used in its original sense of a video camera connected to the Web continuously for an indefinite time, rather than for a particular session, generally supplying a view for anyone who visits its web page over the Internet. Some of them, for example, those used as online traffic cameras, are expensive, rugged professional video cameras.

3.10 ESP8266WIFI

The **ESP8266** is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability produced by Shanghai-based Chinese manufacturer, Espressif Systems.[1]

The chip first came to the attention of western makers in August 2014 with the **ESP-01** module, made by a third-party manufacturer, Ai-Thinker. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands. However, at the time there was almost no English-language documentation on the chip and the commands it accepted.[2] The very low price and the fact that there were very few external components on the module which suggested that it could eventually be very inexpensive in volume, attracted many hackers to explore the module, chip, and the software on it, as well as to translate the Chinese documentation.[3]



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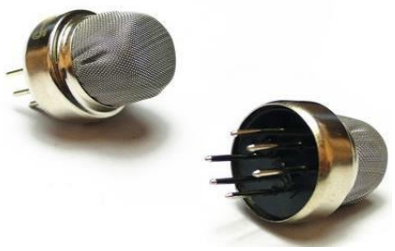
3.11 MQ2-SENSOR

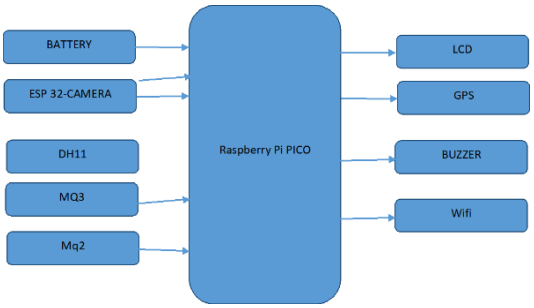


MQ2 flammable gas and smoke sensor detects the concentrations of combustible gas in the air and outputs its reading as an analog voltage. The sensor can measure concentrations of flammable gas of 300 to 10,000 ppm. The sensor can operate at temperatures from -20 to 50°C and consumes less than 150 mA at 5 V.

Connecting five volts across the heating (H) pins keeps the sensor hot enough to function correctly. Connecting five volts at either the A or B pins causes the sensor to emit an analog voltage on the other pins. A resistive load between the output pins and ground sets the sensitivity of the detector. Please note that the picture in the datasheet for the top configuration is wrong. Both configurations have the same pin out consistent with the bottom configuration. The resistive load should be calibrated for your particular application using the equations in the datasheet, but a good starting value for the resistor is 20 kΩ.

IV. PROJECT DESCRIPTION

This chapter deals with working and circuits of "Real Time Wireless Embedded Electronics for Soldier Security". It can be simply understood by its block diagram & circuit diagram. **BLOCK DIAGRAM:**



Previously, similar work has been done by using Arduino [15], but due to limited processing power of Arduino and lacking USB port for camera and microphone connection, we have used Raspberry Pi to overcome the above mentioned controller constraints. In our model, the collected data is processed by Raspberry Pi and then sent to the base module by a low-cost, low-power, long range and secure communication links provided by a Wifi communication. The transmitted data is analyzed to detect, predict and prevent crisis situations by generating and executing adequate treatment plans. Base module receives images and audio recording clip whenever emergency situation is detected by on the bases of data acquired from the sensors. All this will help the base station to get a better understanding of the situation and will help to create more informed and efficient strategy to overcome the situation.

Soldier's Unit: In this unit, Raspberry pi 3 is used as a controller module at the node(soldier), which collects data from the different sensors, processes the data and sends information to the base station via Wifi module. Neo 6M GPS sensor is used to gather geographical location of soldiers, which helps to track location of soldiers continuously. This sensor provides NMEA (National Marine Electronics Association) raw data, which is used to extract the coordinates of the soldier. Both the above modules (GPS and Wifi module) use UART (Universal Asynchronous Receiver-Transmitter) communication, while Raspberry pi 3 has only one UART port, i.e. it can communicate with only one device at a time. To overcome this, we have used MUX and time division polling has been done to communicate with both the sensors. DHT11 is used to get information about humidity in the warzone. Gas sensors like MQ-2 and MQ-136 are used to detect combustible gas, smoke and harmful gases like H2S (Hydrogen Sulfide), which are usually present during chemical warfare. DHT11 and both gas sensors use one-wire protocol for communication.

V. CONCLUSION:

This project presents a successfully implemented smart soldier health monitoring system, which has the potential to improve the military operations substantially. It helps to acquire the information from the warzone about each soldier's health condition. This helps to take swift decisions and can prevent causalities by providing backup or further assistance. Besides that, energy consumption of the system is only 3.2 Wh which is much less, due to the use of IOT module for data transmission instead of high-power consuming GPRS modules. Therefore, it can be concluded that the use of the smart soldier health monitoring system improves upon the traditional methods of executing military operations considerably.

FUTUREWORK:

More sensors like EDA (electrodermal activity), EEG (Electroencephalography) and biochemical sensors can be integrated with the system. The soldier's unit can be integrated to the wearable clothing using flexible electronics to make it more convenient for the soldiers.

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