Military Soldier's Tracking System

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Abstract- *The basis of this project is to provide a long-range location tracking and monitoring for military applications. The project consists of three sections, a GPS tracker for positioning the soldier, an intermediate vehicle for streaming the video and a data receiving station for observing the position of the soldier.This project mainly addresses the shortcomings of RF frequency communication which has a maximum range of a few kilometers. This also gives way for application in a metropolitan situations such as ethical monitoring of people, especially children for reasons of safety and wellbeing. The main idea of the project is to establish a remote GPS tracker with a wireless interface accessible by an Unmanned Ground Vehicle via a RF transceiver for application in Military and Defense enforcement. This prototype presents a modern approach for surveillance using unmanned vehicles. Manual operation of this intermediate vehicle is done by passing DTMF tones through a GSM module, these tones are used to s manipulate the path of the vehicle as per real time information of the surroundings viewed by a camera interface. This vehicle is designed for reconnaissance and to act as an intermediate station for the reception of the GPS data.*

I. INTRODUCTION

The aim of the project is to track the position of the soldier in the battle field using a GPS tracking system and communicating the data to a base station. GPS or Global Positioning System is a network of orbiting satellites that send precise details of their position in space back to earth. The signals are obtained by GPS receivers, such as navigation devices and are used to calculate the exact, speed and time at the vehicles location. Grinteret. al, showed in [1] that in addition to home automation technology and devices, a modern home relies on three to seven services or companies to provide them with infrastructure support like Internet, telephone, electricity, gas, etc. Another study done by Chettyand Grinter on different homes showed that people choose the "Site" of the home based on factors like the availability of uninterrupted power, high speed Internet, etc., excluding other factors like property prices and neighbours, which are beyond the scope of this work [2]. In this project we are building a home automation system, where one can control the home appliances, using the simple GSM Module, just by sending SMS through his phone. In this project, no Smart phone is needed, just the old GSM phone will work to switch ON and OFF any home electronic appliances, from anywhere. Based on NSIC13 [3]. There exists some systems which makes use of the dual tone multi frequency used in telephone lines. System uses standard public-switched telephone lines. The system includes three components, first is the DTMF receiver and ring detector. Maqbool and Sajaad have proposed a method to make a base for the monitoring of systems [4]. The monitoring of systems could be from monitoring of movements in any particular area to the monitoring of any external electrical, mechanical device. Jose and Malekian[5] presented a comprehensive description about different home automation systems and technologies from a security standpoint. Ahmed et. al., explained how the system allows complete security and is based on microcontroller[6]. The design objective of this project is to make a DTMF based remote monitoring system which can be used to acquire different parameters of any process or machine and send the data obtained to a distant logging system running on a PC so that the data can be represented in a user friendly manner. Radhamani gave an idea on, "Intelligent Home Automation and Security System Mobile devices are ideal in providing a user interface in a home automation system and this paper evaluates development of a low cost surveillance system using different sensors built around the microcontroller [7]. Michael S. Braasch in his paper ,Although originally developed for the military, the Global Positioning System (GPS) has proven invaluable for a multitude of civilian applications[8]. The fundamental receiver measurements are described and the quality of these measurements are related to the aforementioned receiver architectures.

Chinmay Kulkarni, SuhasGrama, Pramod Gubbi Suresh, Chaitanya Krishna, Joseph Antony propose a cost-effective four-wheeled surveillance robot using an Arduino UNO microcontroller and a smartphone running the Android Operating System[9]. The robot can be controlled remotely from a PC using the internet and a microcontroller-smart phone interface residing on the robot.

Ishfaq Ahmad1, Khalil Shah2, Saif Ullah3 explains Military Applications using Wireless Sensor Networks,[10] he said Wireless Sensor Networks (WSNs) received enormous attention in recent years due to its phenomenal ability of implementation in various fields. WSNs consist of a large

number of small sensor nodes. These nodes are very cheap in terms of cost. In military operations, there is always a threat of being attacked by enemies. So, the use of these cheap sensor nodes will help to reduce the loss. In this paper, we analyze the existing literature of using WSNs for military applications. Youjing Cui and Shuzhi Sam Ge told The Global Positioning System (GPS) has been widely used in land vehicle navigation applications. However, the positioning systems based on GPS alone face great problems in the so-called urban canyon environments, [11] where the GPS signals are often blocked by highrise buildings and there are not enough available satellite signals to estimate the positioning information of a fix.

II. EXISTING ISSUES

This section explains about the various problems that may encountered in the process of surveillance.The main motive of this project is to overcome some of the issues that may affect communication or data transferring from the war field to the control station.

1. Communication range

Communicating to an unmanned vehicle may be an easy task. However, communicating with a vehicle from the distant location with no visual aid is a tedious task. The RF transceivers used in Military Tanks and drones act as a communication medium for up to 5 kilometers. To extend the range of the RF transceivers, makes it expensive and inefficient.

2. Lack of Continuous communication

Communication between soldiers in the war- field and the soldier operating from the base station is not a continuous system. This may leads to problems for soldiers such as border crossing ,wrong directions, etc.

III. PRINCIPLE OF GPS

There are three parts to a GPS system: a constellation of between 24 and 32 solar-powered satellites orbiting the earth in orbits at an altitude of approximately 20000 kilometers, a master control station and four control and monitoring stations (on Hawaii, Ascension Islands, Diego Garcia and Kawajale) and GPS receivers.

Each of the satellites is in an orbit that allows a receiver to detect at least four of the operational satellites. The satellites send out microwave signals to a receiver where the built-in computer uses these signals to work out your precise distance from each of the four satellites and then triangulates your exact position on the planet to the nearest few meters based on these distances.

In fact, signals from just three satellites are needed to carry out this trilateration process; the calculation of your position on earth based on your distance from three satellites. The signal from the fourth satellite is redundant and is used to confirm the results of the initial calculation. If the position calculated from distances to satellites “A-B-C” do not match the calculation based on “A-B-D” then other combinations are tested until a consistent result is obtained.

The process of measuring the distance from satellite to GPS receiver is based on timed signals. For example, at 16h45m precisely, the satellite may begin broadcasting its signal. The GPS receiver will also begin running the same random sequence at 16h45m local time, but does not broadcast the sequence. When the receiver picks up the signal from the different satellites, there will be a time lag, because the microwaves take a fraction of a second to travel from the satellite to the receiver. The time lag is easily converted into distance to each satellite. The slight difference between signals from each satellite is then used to calculate the receiver's position.

IV. PROPOSED SYSTEM ARCHITECTURE

In this project, three sections are involved to make communication of data from soldier to base station possible. The first part includes the GPS Receiver which receives NMEA sentences from the trilateration of multiple satellites. These NMEA sentence is decoded in the form of float or double data types by the Arduino UNO. The decoded sentences are converted to a string format so that it can be transmitted by the RF Transceiver in the form of Unicode characters.

The transmitted string is received by the RF Transceiver which is interfaced with the Raspberry Pi 3. The Raspberry Pi receives these strings and extracts the characters in the string. The string is then streamed to a secure web server to be displayed on a tabular column along with the timestamp of the data received.

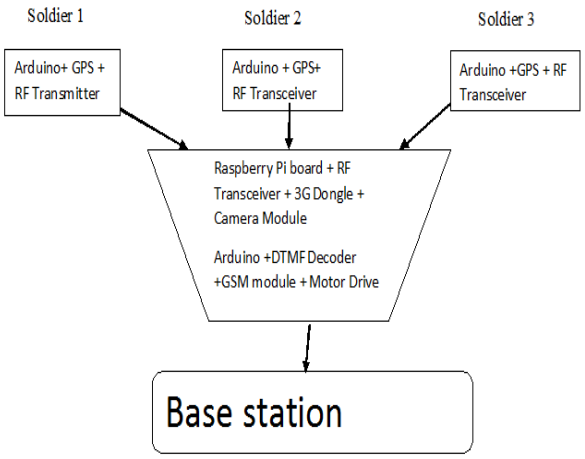

Figure 1. Proposed architectural diagram

This data is observed at the base station to monitor the location of the soldier in Real-time. The range of communication is maintained by the Intermediate Vehicle for an extended distance by controlling the vehicle to move towards the location of the soldier.

V. PROPOSED METHOD

The overall system architecture of the proposed work is presented in figure 1. It consists of 3 sections namely soldier part, intermediator and base station.

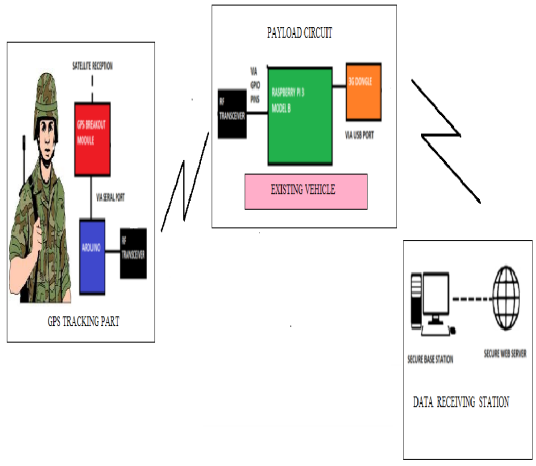

Figure 2. System Architecture

The soldier component will require interfacing between the Arduino, GPS Module and RF Transceiver. The Arduino code is written in such a way that the GPS NMEA sentences which are received by the module is filtered and only the essential data is decoded in a float or double format. The decoded sentence is converted to a string so that it can be transmitted via the RF Transceiver. The string that is transmitted is visualized in the form of Unicode characters.

The entire architectural design has been explained structurally in Fig.2

The project involves three stages:

- The Soldier Component
- The Intermediate Component for GPS
- The Intermediate Component for Video Streaming

The RF transceiver which is interfaced with the Raspberry Pi and placed on the intermediate vehicle receives the GPS string and prints out the data by extracting the characters in the string. The received data is transmitted to a secure web server known as Plotly along with the time stamp of the data when it was received.

The Raspberry Pi placed on the intermediate vehicle also contains a camera module which streams live video to a webpage. This webpage is capable of recording and saving the video and even creating a time-lapse. However, the main purpose of the video is to control the intermediate vehicle carefully by avoid obstacles and monitoring the surroundings.

The intermediate vehicle also consists of another component which is used to control the direction of the vehicle. This is accomplished by an Arduino UNO which is interfaced with a DTMF decoder, GSM module and a Motor Driver. The DTMF tones which are received by the GSM module is decoded by the DTMF decoder. The decoded tones are received by the Arduino and the appropriate motor response is initiated.

The base station constitutes of a computer that has access to the feed from the camera module as well as the python script which streams the GPS data to the Plotly server. The 3G Dongle consists of a Subscriber Identity Module(SIM card) that contains a data plans. This 3G Dongle is interfaced with the Raspberry Pi via the USB port. There are two possible ways to connect the GPS breakout module with the development board. The first way is by using the UART pins available on the Raspberry Pi to be interfaced with the GPS. The other possible way is by converting the I/O pins of the GPS module which is in the TTL (Transistor-Transistor

Logic) format to the USB format using a suitable adapter. Using the USB ports of the development board is preferred as it increases the capability of interaction between the devices.

VI. SOLDIER'S GPS TRACKER

1. Arduino UNO:

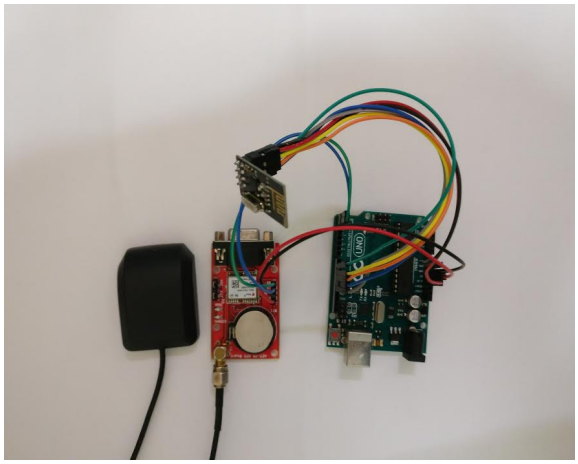

Figure 3. Implemented soldier component

Arduino is a computer hardware and software company, project, and user community that designs and manufactures microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL) permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself kits.

2. GPS Breakout Module

This module manufactured by U-Blox is one of the latest GPS chips which is capable of both GNSS and GLONASS. GLONASS is a Russian based satellite service which orbits the earth at a lower altitude when compared to GNSS. The GLONASS also is inclined with the earth's axis at 64.8 degrees. This improves the accuracy of the positioning device at obstacle dense locations such as metropolitan cities with tall skyscrapers. The NEO 7 can shift between GLONASS and GNSS effectively. The version of NEO 7 known as NEO 7M is a low powered, high accuracy version. This version also consists of an internal clock for data logging.

3. RF Transceiver

The nRF24L01 is a single chip 2.4GHz transceiver with an embedded baseband protocol engine (Enhanced ShockBurst™), designed for ultra low power wireless applications. The nRF24L01 is designed for operation in the world wide ISM frequency band at 2.400 - 2.4835GHz. An MCU (microcontroller) and very few external passive components are needed to design a radio system with the nRF24L01.

After connections made in Fig.3, connect the USB cable to the computer, open your Arduino IDE software in computer, select com port and open serial monitor to listen the serial port and Power up the Arduino and GPS module. Now , will see GPS data on Arduino Serial Monitor Window . In serial Window, we can see some sentences that start from $ sign. These are NMEA sentences. GPS module sends the Real time tracking position data in NMEA format.

Arduino is a very powerful and versatile micro controller board and it gives us the ease to perform multitasking. NRF24l01 has total 8 pins.

3. Nodal Technique

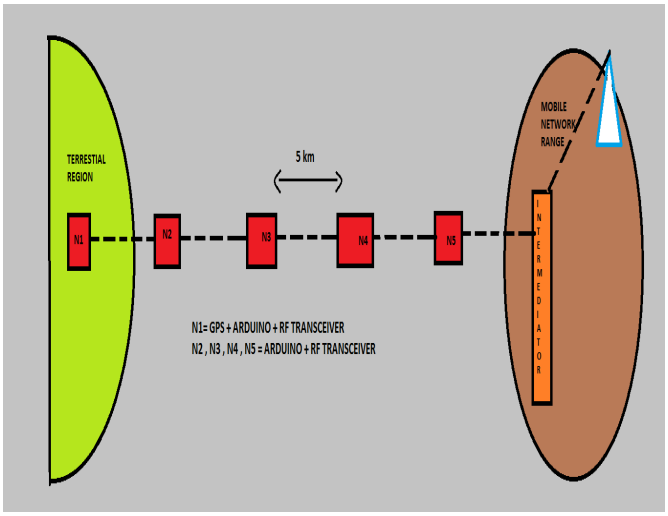

Figure 4. Implemented soldier component

In this project we included this nodal technology to increase the range of communication by RF transceiver. The fig.4 shows five nodes N1,N2,N3,N4 and N5. These nodes are wirelessly connected by RF waves. The 1st node N1 transmits the data to its maximum range of 400meters. (This is RF Transceiver's maximum range used in this project). After the 400 meters there is another node N2 will be available to receive the GPS data, like wise the data can be transmitted to the target location by using required number of nodes in a desired sequence. The number of nodes implementation is basically depends on the distance of the base station.

VII. INTERMEDIATE COMPONENT FOR VIDEO STREAMING

1. Raspberry Pi

The Raspberry Pi Compute Module (CM1), Compute Module 3 (CM3) and Compute Module 3 Lite (CM3L) are DDR2-SODIMM-mechanically-compatible System on Modules (SoMs) containing processor, memory, eMMC Flash (for CM1 and CM3) and supporting power circuitry. These modules allow a designer to leverage the Raspberry Pi hardware and software stack in their own custom systems and form factors.

2. Dongle:

A dongle is a small piece of hardware that connects to another device to provide it with additional functionality. In relation to computing, the term is primarily associated with hardware providing a copy protection mechanism for commercial software in which the dongle must be attached to the system that the software is installed on in order for it to function.

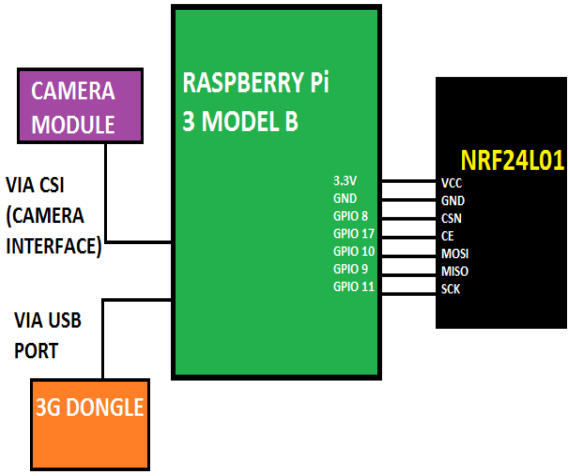

Figure 5. Interfacing Raspberry pi with transceiver, camera module and 3G Dongle

The payload circuit has been explained by illustrating the pin connections in Fig.5

3. Camera module rev 1.3

The Raspberry Pi camera module can be used to take high-definition video, as well as stills photographs. It's easy to use for beginners, but has plenty to offer advanced users if you're looking to expand your knowledge. There are lots of examples online of people using it for time-lapse, slow-motion and other video cleverness. You can also use the libraries we bundle with the camera to create effects.

VIII. CONSTRUCTION OF INTERMEDIATE VEHICLE

The construction of the robot is of three steps. They are IC circuit assembly, rover body and camera mounting on the designed vehicle. In IC circuit assembly, it is nothing but the PCB board which controls the movement of the vehicle according to the instruction given by the user. Here we are using three main IC's. They are,

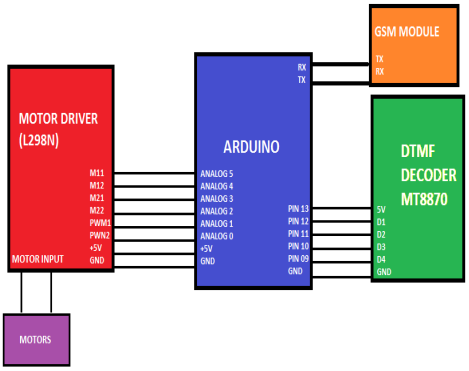

Figure 6. Intermediate vehicle circuit for motor controls

A. DTMF Decoder

The IC MT8870 is known as the DTMF Decoder which gets the input frequency generated from the user mobile phone as DTMF tone, converts them into the binary digits and sends it to the microcontroller as inputs. The MT8870 is a complete DTMF receiver integrating both the band split filter and digital decoder functions. The filter section uses switched capacitor techniques for high and low group filters; the decoder uses digital counting techniques to detect and decode all 16 DTMF tone-pairs into a 4-bit code.

B. Microcontroller

The Microcontroller is the heart of the vehicle which controls the motion of the vehicle according to the user instructions. Here we are using Arduino uno microcontroller and the program coding was written in Arduino IDE program and fed into the microcontroller IC using IDE compiler.

C. Motor Driver

The output supply from the microcontroller is not sufficient to run the motors hence a motor driver IC is used as shown in Fig. 6. The IC L293D is known as the motor driver IC which inherits H-Bridge concept and can run the two motors simultaneously at different directions.The voltage need to change its rection for being able to rotate the motor in clockwise or anticlockwise direction, Hence H-bridge IC are ideal for driving a DC motor.

D. Rover Body

The rover body is the mechanical design of the vehicle which consists of motors, robotic wheels, steel and fibre glass sheets ,etc as shown in fig.7., The design of the vehicle is made as robust to withstand disturbances and vibrations carrying power supply, camera, IC circuit board, etc., on the vehicle.

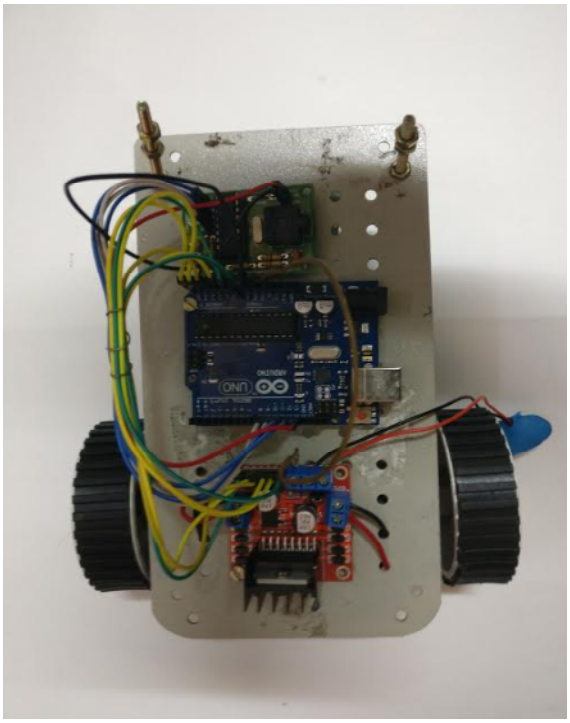

Figure 7. Intermediate vehicle

E. GSM Module

GSM/GPRS module is used to establish communication between a computer and a GSM-GPRS system. Global System for Mobile communication (GSM) is an architecture used for mobile communication in most of the countries. Global Packet Radio Service (GPRS) is an extension of GSM that enables higher data transmission rate. GSM/GPRS module consists of a GSM/GPRS modem assembled together with power supply circuit and communication interfaces (like RS-232, USB, etc.) for computer. The MODEM is the soul of such modules. The MODEM needs AT commands, for interacting with processor or controller, which are communicated through serial communication. These commands are sent by the controller/processor. The MODEM sends back a result after it receives a command. Different AT commands supported by the MODEM can be sent by the processor/controller/computer to interact with the GSM and GPRS cellular network.

IX. CONCLUSION

In conclusion, the communication of data over a larger range has been achieved using an intermediate station. The project has accomplished the task of transmitting wireless data through several wireless technologies. The concept of this project has been constructed and a working model of the project has been demonstrated. This project has also displayed the capabilities and reliability of wireless technology is formal applications.

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