SPECIALIZED INNOVATIVE ROBOT: CAPABLE OF FUNCTIONING IN EXTREMELY CHALLENGING TERRAINS

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ABSTRACT

To develop a fully autonomous vehicle that can operate in any terrain without any hindrance and perform various tasks in different environment such as in mines or post natural disaster, detection of hazardous elements with the help of different sensors is the basic aim of this paper. The main objective for this vehicle is to reach and perform multifarious operations where humans cannot reach and are out of reach of skilled personals. This system is built using ATMEGA 128 microcontroller and varied devices are interfaced with the same to obtain the final result. These devices work simultaneously providing accurate and exact data to the robot and are fixed in a layered manner. It also includes onboard communication if the commander wants the robot to perform particular task then through wireless communication device the task can be assigned to the robot while it's on a mission.

Keywords- GPS, GSM, IMU, Jumping Mechanism, Temperature Sensor, Ultrasonic Sensor, Water Sensor, Webcam, Wireless Module

I. INTRODUCTION

The word Robot was discovered by Karl Capek and his brother Joseph Capek in 1920. Robots changed the life of human from their first invention in 4th century B.C by Greek mathematician to MH-2 -wearable communication robots build by Japanese researchers in 2013. Robots give a variety of freedom and variation in their jobs, one work in place of a farmer while other defuses a bomb and save the day. This gives them a way to shape in different structures to do jobs they are assigned to do. Autonomous Robots in today's world are gaining traction though they have been around for several years now. These are basically automated machines that are taking place of humans in every field from laborious task such as in rescue operations, military uses, mining operations, detection of hazardous conditions to effortless task such as transportation etc. For example when fire breaks down in a building and even fireman cannot reach certain places where people are held, then at these extreme temperature position a robot can reach and inform through GSM [1] –SMS system about the precise location of the people via GPS [1] and IMU [2] device so that the fireman can think and act accordingly rather than acting in a hypersonic manner. Sensor mechanism of the robot here works in full mode by

activating the temperature sensor [3] which detects the surrounding temperature and the ultrasonic sensor [4] tells the distance from the obstacles and to avoid them. It also includes a webcam which gives the real time picture of the situation to the user by automatically detecting and segmenting the object [5]. We have also added a very unique and special feature to this application is its jumping mechanism [6] which avoids obstacles by jumping the length for example the sand flea robot build by Boston dynamics but not to such a precision. The fireman can directly connect to the robot as well by wireless connectivity through wireless communication module and ask for certain real time data. Another example where the application can be used is if there is a flood then the robot can detect the water level in any area and people affected through that water with the help of water sensor build which alerts the user. Not only it can be used in disaster management but it can be used to avoid situations that are harmful to people in physical or any other manner, the prolonged working hours it can offer can be beneficial for positioning the robot for 24x7 task and it can also be featured as an autonomous or driverless car which can navigate through different waypoints from dessert to mountains without human intervention. The robot can do multifarious task and can also act as spy robot so this application of the robot can be termed under special purpose robot category. Detailed description of the functioning of the robot is explained in the following points.

II. TECHNICAL OVERVIEW

This special purpose robot consists of various technological methods which can be explained through following-

2.1 GPS: Global positioning system (GPS) is system used around the world by military or civilians for determining the exact position and time of desired location. It receives varied data from satellites which is helpful in navigation and keeps on updating the same which gives an accurate output in various conditions like receiver -moving, standing or accelerating. We used GPS (developed by NMEA -US based National Marine Electronics Association Fig 1)protocol which receives latitude, longitude ,altitude and current time which is further used by controller to determine the location .Due to its limitations in connectivity we used GPS with IMU(Inertial Measurement Unit) to obtain precise data shown in fig 1.

2.2 GSM: the Global System for Mobile Communication has been a great source in providing connectivity in our communication network. A system can use a GSM modem with a SIM card to get connected to a network and can operate according to the instructions given by the user. Robot can also use SMS sending and receiving feature to notify or communicate to the other modem on the end of the communication network. A GSM modem as shown in Fig 2 is a device which supports one or more evolutionary technology in GSM evolutionary family. It works on "AT commands "which are the basic building blocks of a GSM modem command sequence shown in fig 2.

2.3 IMU: Inertial Measurement Unit – is a device consists of more than one accelerometer, gyroscope and magnetometer. The combination of these technical modules gives a precision in the movement of an object on which they are mounted. Their output consists of movement in three axes. This again increase the precise evaluation of object`s state in the coordinate system.

Fig1 : GPS Modem

Fig 2: GSM Modem Used In the Robot

2.4 Ultrasonic Sensor: Ultrasonic sensors are widely used in today's world and are the basic building block for detecting obstacles, measuring the distance. These are also helpful in detecting various transparent objects which are difficult to detect by other sensors such as plastic bottle, glass bottles and glass films and make them ideal for detection of uneven surfaces and liquids. Ultrasonic sensors are basically known as transducer because they receive and send at the same time and it uses sound waves instead of light waves. The project uses two types of ultrasonic sensor-a) short range ultrasonic sensor shown in Fig 3 and b) long range ultrasonic sensor.

2.5 Jumping Mechanism: a robot that can jump the obstacles is a very important feature for upcoming robots so we introduced a mechanism for the same by using a simple technique [6]. Use of dc motors ,legs, cam and adjusting materials all made up the robot to jump- a dc motor is connected to the cam as the cam rotates it activates the motor connected to the legs and giving motion to the legs the adjusting weight placed near the legs helps the robot to jump. An acceleration sensor is also used to detect the height of the obstacle so that the robot can jump the same height to avoid the obstacle.

2.6 Temperature Sensor: Temperature sensor is used to detect the temperature of any medium. We used LM 35 temperature sensor Fig 4 which is analog in nature and provides with output voltage which we later convert and use in centigrade. It does not require any calibration from outside to provide accuracy. It has linear output, low output impedance and draws only 60 micro A of current hence very less self heating. It can operate to a large range of temperature. Other sensors can be used in this so that it can withstand in the higher temperatures shown in fig 4.

Fig 3: Short Range Ultrasonic Sensor

Fig 4.LM 35 Temperature Sensor

2.7 Water Sensor: The water sensor is used to detect the water level in any terrain. The sensor consists of copper strips which are arranged in a systematic manner as in Fig 5 such that as soon as water reaches in between the order of the strips the resistance changes and alerts the user through implicating the resistance

value by using microcontroller and detecting the water level. Here we used water sensor made according to our specifications shown in fig 5.

2.8 Webcam: We are using I-ball Face to face C8.0 web camera with interpolated 8.0MP still image resolution as shown in Fig 6. The code for webcam is written in Matlab which helps us in performing various tasks such as scanning, video photograph and many other physical actions. The code also provides information about a person by face detection and identification methods which are very useful during disaster management shown in fig 6.

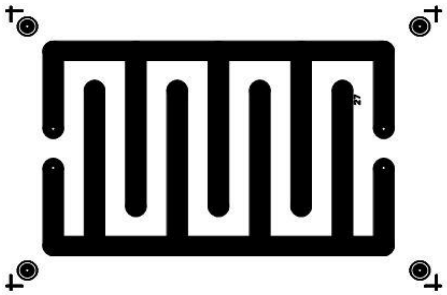

Fig 5. Water Sensor Systematic Strip Arrangement

Fig 6: I-ball C8.0 Webcam

2.9 Wireless module: CC2500 is a wireless module with a 6 to 7 meters range hence it is very productive in sending and receiving data with this radius .This transfer of data is based on radio frequency (RF) and the high transfer rate makes it more usable which is required during emergency. It can also be used in the burst mode data transmission.

III. WORKING PRINCIPLE

This robot is covered with a carbon shield plate which protects it from the heated environment. As its primary use is in disaster management it can tolerate high temperatures i.e. above 100 degree centigrade. Temperature sensor build in the robot gives the analog signal which in turn is given to the inbuilt ADC in the microcontroller that is Atmega 128. These values given by ADC are then used to convert to the actual temperature value. Knowledge of temperature can give an upper hand to a fire-man so that he can concentrate on the parts where the fire is at its extreme and can reduce the fire in the minimum time. Apart from indulging in high temperatures , its stream line body can also support it to move in water filled areas its water sensor which detect the presence of water near the tires triggers a system that convert it to a boat with two propellers at the hind side of that boat . ATMEGA 128 microcontroller of this robot is an advanced controller with many features inbuilt in it. Analog module of temperature sensor is connected to the inbuilt ADC of microcontroller, two USART of this controller make our work very easy as one USART is connected to the GSM module and other is to the CC2500 module for radio transmission and receiving. Six ports give us a wide variety of pins to fix many modules like water sensor, ultrasonic sensor, motor driver IC. In addition to these it also have inbuilt two wire protocol (I2C) which help us to communicate to the robot to and fro shown in fig 7.

Jumping mechanism is a basic need of this robot as if there is an obstacle which can`t be moved or touched then only way to cross that obstacle is to jump over it hence it can increase the reach ability of that place.

Another important and unique feature of the robot to shrink to its minimum size makes it to crawl under many obstacles which cannot be jumped. Ultrasonic sensor is a distance calculating device which is situated at the front end of the robot. These sensors sense an accurate distance through ultrasonic sound wave giving us an accurate measure of distance of an obstacle in its path so that the controller can decide to jump or go underneath the obstacle. Combined with the camera and human commands through cc2500 module they work at their best. Camera installed in this robot sends us real time pictures of that place where we can get these pictures through cc2500 module and hence we can guide it through the correct path. By these picture one can also find, if there is a person inside, people inside can be saved before some fatal tragedy happen to them. These modules in this robot can reduce the risk of life for humans and can also save it from being lost. Effective measures can be taken by the information given by the robot in total.

GPS is the most useful device which is used to find the location of a place and hence giving us an accurate position of the place with the height of that place from the sea level so that we can calculate height and location of our robot from the ground level of that place. This system is very useful in a multi-story high-rise building in which many stories are on fire and we have to be precise where and which floor to hit first and save more and more people as possible.IMU and GPS is a combination which in turn gives us a precise location of a place, since IMU also work on the three dimensional space hence giving us an accurate reading of its movement for even an inch in any of the three axis. These movements can be very useful in reducing the error by the reading given by the GPS module. It would be more beneficial in the areas where GPS has no or very less network.

Fig 7: Internal structure of the robot

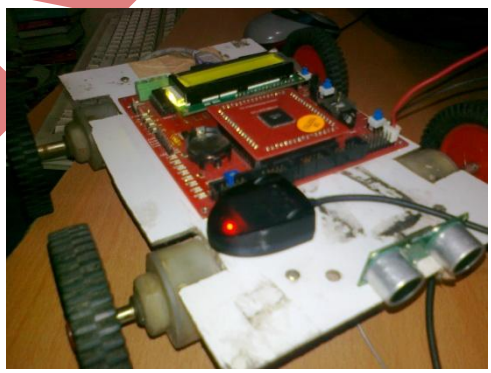

Fig 8: GPS and Ultrasonic sensor mounted on chasy

GSM is a technology with large network all over the world. GSM in our project sends a SMS from the robot in which it sends each and every detail of modules connected to microcontroller. If we are out of range from cc2500 module then basic movement instructions can be sent to the GSM modem as an SMS , which in turn decoded by the microcontroller to perform instructions such as moving in particular direction, jumping or any other task which we want the robot to do.

IV. CONCLUSION

The paper presented the use of autonomous and semi autonomous robot in the field of disaster management such as in natural calamities-earthquake, flood, landslides, cloud burst affected areas which are out of reach of human. The robot can also be used in all terrain and provides with an optimum solution to situations which are

difficult to solve for humans. Robot uses multifarious modules to perform particular task such as the temperature sensor is used to detect the temperature and act according to the environment, the water sensor is used for water level detection so that the robot can turn on its boat mode to move in water. The IMU and GPS modems are used to locate the actual location and provide data with the help of wireless module cc2500. GSM modem is used to provide information in another form to the user which can be used to interact with the robot which sends the data to the user turning the autonomous vehicle to semi autonomous robot, performing actions according to the user which generally is not provided with fully autonomous robots. The camera also adds on the feature to the robot by providing various functions of onboard streaming of the pictures, another very different and important characteristics of the robot is its jumping mechanism which helps avoid obstacles. So the robot build for this paper is innovative, different, performs multi task, non obvious, autonomous and semi autonomous according to the situation and most important aspect of the paper is its user friendly nature and cost effectiveness.

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[7] www.google.com for images of the modules used in technical overview such as temperature sensor, webcam and GSM.