WATCH REGULATED MEDICAL HELI-CARRIAGE USING DCS AUTOMATION

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Abstract: In 21st century, the medical industry is tending to reach its pinnacle, unattended and ignored medical emergencies still remain a loophole in the system. Hence this paper proposes the idea of medical heli-carrige. The proposed system promises to reach the patient irrespective of local traffic conditions, variable terrains and climatic conditions. It employs solar power as the primary energy source and also has sufficient battery backup in case of inadequate solar energy. Under any unlikely event of technical fault in the system, it will acknowledge the nearest medical heli-carrige available and the task will be rescheduled to the latter. It will be capable of carrying first aid medical instruments along with two hospital staffs and the patient. Under any critical situation, the patient will tap on the smart watch, which will send a signal to the nearest hospital. The GPS location of the received signal will be tracked by the hospital and fed into the heli-carrige so that it can reach the very location to the earliest. Hence, the system can prove out to be a revolutionary step in the modern medical industry.

INDEX TERMS Lillypad arduino, REES52 ultrasonic range finder module sensor, VDM (Vehicle Dynamic Model), GNSS (Global Navigation Satellite System), UAV (Unmanned Aerial Vehicle), GPS (Global Positioning System), DCS (Distributed Control System), photovoltaic solar panel, raspberry pi, skid steering method.

1. Introduction

Autonomous driving has gone from "maybe possible" to "definitely possible" to "commercially available". As robotics and artificial intelligence is reaching its zenith, so is the medical industry. Inspite of this fact, one of the slit still prevailing in the concrete wall is unavailability of medical aid felicitously.

Hereby, the paper proposes a watch regulated medical heli-carrige that combines the fields of robotics, artificial intelligence, GNSS, VDM-Based Navigation. The system is a perfect blend of the above given fields being capable of reaching the patient irrespective of traffic conditions, climatic conditions, topography and other ethnological differences. The medical heli-carrige is on call as soon as the patient initializes the signal by tapping on his/her smart watch. No sooner the signal is initialized by the patient, than the hospital receives an alert message along with the current location of the sender. The request for aid will be allocated to the available heli-carrige. The heli-carrige is capable of gaining a certain height(6-7m) to avoid small obstacles like trucks etc and takes a flight in case of bigger obstacles eg buildings. It will reach the patient along with two hospital staffs and first aid instruments. The staffs will assist the patient till the hospital is reached. But in case, none of the heli-carriages are free to attend the patient or any other technical fault, a signal will be auto generated to any other heli-carrige available in the nearest proximity.

The above system will be perfect filler for the slit if implemented to the fullest.
2. MATERIALS AND METHODS

A. LILYPAD ARDUINO

![Figure 1. Lilypad arduino](image1.png)

The LilyPad Arduino is an advanced microcontroller board specially designed for wearable and e-textiles. It has a great feature to be sewn onto fabrics and similarly mounted power supplies, sensors and actuators with conductive threads. The board employs the ATmega168 or the ATmega328. Special care should be taken while providing power supply to it as more than 5.5V or backward plugging will damage it. The perfect power supply should vary between 2.7-5.5V. The following are its specifications - 6 analog input pins, 40 mA of Dc current per I/O pin, 16 KB of flash memory, 1 KB of SRAM, 512 bytes of EEPROM, 18 MHz of clock speed. The LilyPad arduino is programmed with software versions 0010 or higher. A boot loader is pre-burned on the ATmega168 or ATmega328 which allows uploading fresh code to it with the arduino software. It is powered by the USB connection or with an external power supply. It is circular in shape which has physical characteristics of approximately 50mm diameter, 0.8 mm thickness.[1]

B. REESS52 ULTRASONIC SENSOR

![Figure 2. REESS52 Ultrasonic sensors](image2.png)

Ultrasonic sensors or transceivers evaluate dimensions of a target by comprehending the echoes from the radio or sound waves. They generate high frequency sound waves and the echo that is received back is evaluated by the sensor. The distance of the object is calculated
by the time interval created between the sent and received signal. The speed and direction of the object can be detected by employing multiple detectors. The velocity of the object is calculated in relativistic terms. The ultrasonic sound waves generated by the sensor are above 18,000 Hz. The process starts by converting electrical energy into sound energy while sending. Upon receiving, the sound energy is again converted into electrical energy that is measured and displayed.[2]

C. ATmega168/ATmega328

The microcontroller ATmega168 is a low power ABR RISC based microchip. It’s an 8-bit microcontroller that combines 16 KB ISP flash memory and also provides with read-while-write mode. It has 1KB SRAM, 512 B EEPROM, 23 general purpose input/output lines, 3 flexible timers, 32 general purpose registers, SPI serial port, 6 channel/10-bit A/B convertor. The device executes complex instructions in a single clock cycle, thereby approaching 1 MIPS per MHz. It has a balance between processing speed and power consumption. Its operating temperature ranges between -40°C to 85°C and supports an operating voltage range of 1.8-5.5 V. It has a pin count of 32. [3]

ATmega328 is 8 bit ABR RISC based single chip microcontroller. It combines 32 KB ISP flash memory and also supports the read-while-write mode. It has 2 KB SRAM, 32 general purpose registers, 23 general purpose input/output lines, 3 flexible timers, serial program, USART, etc. It too has a pin count of 32. [4]
D. SOLAR PANEL

![Solar Panel Image](image)

Figure 5. Solar Panel

The photovoltaic solar panels use sunlight as a source of energy to generate electricity. A module is an assembly of 6x10 photovoltaic solar cells. They are being extensively used for commercial and residential purposes. The modules generally constitute of an array of photovoltaic cells, a battery pack for storage, an inverter, interconnecting wires and sometimes solar cracking mechanism to enhance the output. Solar electric power is becoming more and more commercially viable. [5]

Most of the modules are wafer based crystalline silicon cell that use photons received from the sun to generate electricity using photovoltaic effect. The cells are to be protected from moisture and damage. In an array, the cells are connected in series connection. The modules employ MC4 connectors to get UV and weather proof conditions. [5]

E. GPS AND VDM NAVIGATION SYSTEM

![GNSS Navigation Image](image)

Figure 6. GNSS Navigation

GPS is GNSS based radio navigation system that provides time information and geo-location on or near anywhere in earth. The information is collected by four or more GPS satellites. The GPS technologies are independent of transmitted data by the user, many internet or telephonic reception. The technology has critical position capabilities that are used by military, commercial users and civil all around the world. It can be freely accessed by anyone freely with the use of a GPS receiver. [6]

Vehicle Dynamic Model (VDM) analyses data from different sensors like barometric altimeter, inertial measurement unit (IMU) and global navigation satellite system (GNSS) receivers. When compared to the conventional approach that uses inertial navigation system (INS), employing VDM improves the navigation performance significantly without requiring any additional hardware. Experimental results, as well as Monte Carlo stimulation results show an improvement of one to two orders of navigational accuracy magnitude especially during three minutes of GNSS outage. [7]
F. MOTORS AND MOTOR DRIVE (L293D)

The system uses DC gear motors. DC motor is a class of rotating electrical machines that are used to convert DC electrical energy to mechanical energy. [8] A gear motor is a special type of electrical motor that is made to high torque and also maintaining low speed or low horse power. Majority of the gear have an output of 1200-3600 revolutions per minute. These are mainly used to decrease the speed in a series gear arrangement which hence creates more torque. The above specified task is accomplished by attaching the gear box or an integration of gears connected in series to the main motor rotor and shaft using a second reduced shaft. The second shaft is connected in series to the gear box to create a series of reduction gears. [9]

L293D is a general motor driver which helps a DC motor to run on either side. It has 16 pin IC and can control two DC motors at a time. The working concept of this IC is based on H-bridge.

![Figure 7. L293D Integrated Chip](image)

An H-bridge is a special type of circuit that facilitates voltage flow in either direction. The clockwise or anti-clockwise rotation of the motor is dependent on voltage direction. A single L293D chip has 2 H-bridge circuits that help in rotating two DC motors separately. L293D can be used to drive small as well as big motors which make it highly used in robotics. [10]

G. SKID STEERING METHOD

![Figure 8. Skid steering mechanism](image)

Skid steering mechanism is a special type of driving technique used on vehicles that have tracks or wheels. It facilitates faster and sharper turns. The method engages one side of the wheel generating differential velocity at opposite side of the vehicle as the wheels in the vehicle are non-steerable. This method makes the performance better even for rough terrains. While taking right turn, the right motor moves in reverse direction whereas the left motor moves in forward direction till the vehicle completely undergoes a turn. [11]

H. DCS (DISTRIBUTED CONTROL SYSTEM)
The Distributed Control System is a computerized control system that is employed for a plant that needs a large number of control loops. In this, autonomous controllers are distributed all over the system. This system of control promises increased reliability and reduced installation cost by employing local control functions near the process plant with remote monitoring and supervision. They are highly used on large process plants where high security and reliability are crucial and the control room is not geographically remote. [12]

3. ARCITECTURE DIAGRAM AND MODULES

The series of events starts with a tap on the smart watch by the patient. This sends a signal to the nearby hospital providing the GPS location and the time of sending. The hospital serves as the Digital Controlling System. It checks out for the availability of any vacant heli-carriage. If present, the task is scheduled and the location is fed. If not then, the heli-carriage in the nearest proximity is assigned the task. It will take 2 institutional staffs and first aid equipments to support the aid during the journey. The smartest path to the patient is chosen on the basis of the A* algorithm used in the paper. While following the shortest path, the machine might encounter small obstacles like a mob or a heavy vehicle, the machine in that case would gain a height of nearly 6 to 7 meters by extendable wheels and would pass over the obstacle. In case of an even larger obstacles or a case of variable terrain, the machine takes a flight employing the solar power received from its solar panel as the main source of energy.

![Architecture Diagram](Image)

**Figure 9. Architecture Diagram**

The heli-carriage reaches the location coordinates as soon as possible to receive the patient and starts its way back to the hospital. It has its own control system responsible for taking decisions en route and sending an acknowledgement message to the hospital on receiving the patient.
4. ALGORITHM

A* ALGORITHM

The project deals with the heli-carriage to reach the patient using the shortest possible path and within least possible time. Hereby, the A* path finding algorithm has been used to reach the final destination from a given starting point. This algorithm uses heuristic estimate $h(x)$ on each node to every $x$ node sorted by the smallest route estimation through the nodes. This algorithm further has two types- Depth first search (DFS) and Best first search (BFS). Dijkstra’s algorithm is a special case of A*, where $h(x)=0$ for all $x$. A* gradually builds the shortest possible path from starting to the final node within least possible time. It is an efficient combination of algorithms Dijkstra and BFS. Dijkstra is known for finding the shortest path most efficiently but has a major disadvantage of being slow because of the way it implements brute force. On the other hand, BFS works faster but often the path it chooses is not the shortest. A* efficiently blends the pros of both the algorithms. A* selects a node closest to the initial position (Dijkstra’s algorithm) and closest to the final position (BFS algorithm). The heuristic function employed in A* algorithm helps to determine the order of the points in which they will be visited. The function also symbolizes the possibility to reach the destination from the present point. The function is a union of two other functions namely the cost function $g(n)$ which deals with the cost of travelling from the start node to the current node and approximation function $h(n)$ that finds the approximate distance from the current point to the destination. A* balancing uses the two methodologies to choose the smallest value of $f(n)$ guarantying a complete and optimal solution. The precision of the algorithm is done by heuristic function that underestimates the cost of a final node. A perfect heuristic function often creates a direct route to the final node without taking direction into consideration. The relationship between heuristic function and A* algorithm is:

- If $h(n) = 0$, then only $g(n)$ will play a role and A* behaves like Dijkstra’s algorithm, ensuring the shortest path.
- If $h(n) \leq$ cost of displacement from point $n$ to goal, A* finds the shortest path. The smaller the value of $h(n)$, the more the points to be checked by A*, making the algorithm slow.
- If $h(n) = $ cost of displacement from point $n$ to goal, A* will follow the best path without checking any other point making the algorithm fast.
- If $h(n)$ is marginally greater than cost of displacement from point $n$ to goal, A* does not guarantee to find the shortest path, the process is fast.
- If $h(n) > g(n)$, then only $h(n)$ plays a role, A* turns into BFS.

5. CONCLUSION

In this paper, we have tried to increase the chances of medical aid by minimizing the probability of unattended medical issues caused due to unavailability of first aid on time. The proposed system is a concrete step towards the dawn of a new technological era by eradicating all possibilities of human vulnerability due to remoteness. As the project deals with the ever accelerating fields of robotics and artificial intelligence, it has a very high scope of future extensions and enhancements.

6. REFERENCES

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