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Smart stretcher

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Abstract
Stretcher is a tool that allows the cases to be transported from one place to another in the hospital or ambulances. The smart stretcher, on the other hand, can measure vital value (temperature, pulse) without the need for the relevant personnel in the hospital, making the patient transportation that is unique before, without the need for any connection, which allows the patient to reach the specified route. Designed for patients with walking difficulties or at risk of infectious disease. In this way, the hospital aims to provide value measurement and access to a doctor autonomously in a short time without the need for the relevant personnel. With this study, a faster treatment can be provided in hospitals and the required time can be reduced to half.

Keywords: Line follower sensor; electronics; pulse; infrared.

1. Introduction

As it is known, all stretchers up to now have been built to enable the patient to be transported from one place to another with human power. However, this situation sometimes causes chaos in hospitals. There are some examples in the literature such as a hydraulic funeral stretcher. Thanks to the hydraulic piston, they allow the stretcher height to be positioned between 320mm and 1600mm. It is used for the transportation of cadavers and corpses [1]. These types of stretchers are called telescopic stretchers. Apart from that, there are sliding wheeled and articulated stretchers [2]. Our aim is to eliminate the transportation of stretchers with human power and to save both time and power by measuring the vital values of the patient on the stretcher. At the same time, it is aimed to prevent the chaos that will occur in the hospital by taking the stretcher from a certain route. The Smart Stretcher is quite a savior for patients who have trouble walking. Within the scope of the project we designed in the literature, there are mobile laboratory robots and stretchers that detect IDs within the scope of similar projects. At the same time, an application that enables stretchers to work autonomously has not yet been found in the literature.

2. Material and method

One of the most important components of the Smart Stretcher is infrared color difference sensors. Thanks to these sensors, the stretcher is delivered autonomously to the relevant unit on the determined route. The path he will follow in doing this can be prepared with a white line on the black plane or a black line on the white plane. In this circuit, the engine, sensor and platform used should be selected well to ensure that the road tracking is at a certain speed and balanced. The sensor we use will control which direction the stretcher should go and the motor we use will control its speed (Figure 4) [3]. It is also equipped with sensors to measure the patient's pulse and temperature on the stretcher. In pulse measurement, heartbeat is detected with the pulse sensor and after the measurement is made with the codes received from Arduino Mega, it is reflected on the OLED screen. Similarly, the temperature measured by the non-contact infrared sensor is read by the Arduino Mega and reflected on the OLED screen [4]. Likewise, the stretcher is connected to the batteries with a button. This allows the user to determine when the stretcher wants to move autonomously. In Figure 1, Smart Stretcher Road route sections are shown in the designed hospital emergency department.

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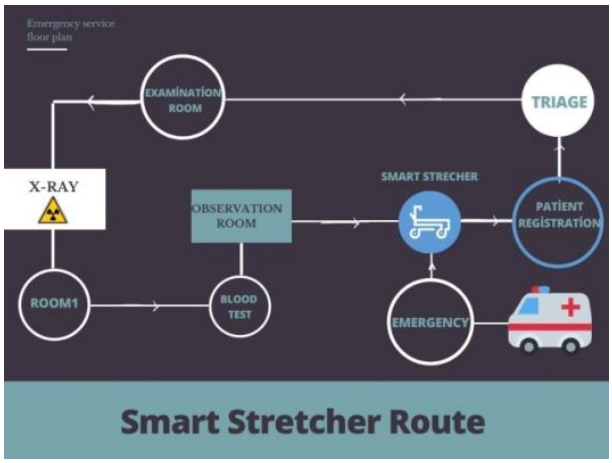

Figure 1. Smart stretcher road route sections.

2.1 Smart Stretcher circuit data set

Pro Engineer drawing program was used in the design phase of the Smart Stretcher. The platform is designed in layer by layer Pro Engineer drawings. It is designed which electronic material will be used in each platform. Connections below and above the platform are provided with jumpers through the gaps in the platforms. 9 V and 4 1.5 V batteries are used as the power source of the Smart Stretcher. Smart Stretcher Pro Engineer drawings as shown in figure 2, 3, 4, 5:

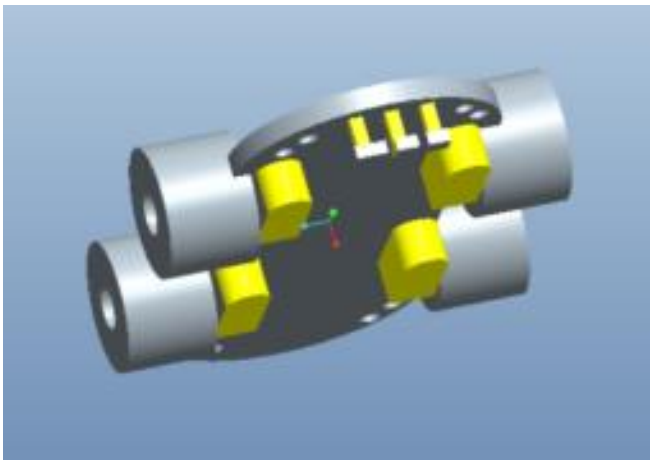

Figure 2. Smart stretcher bottom view.

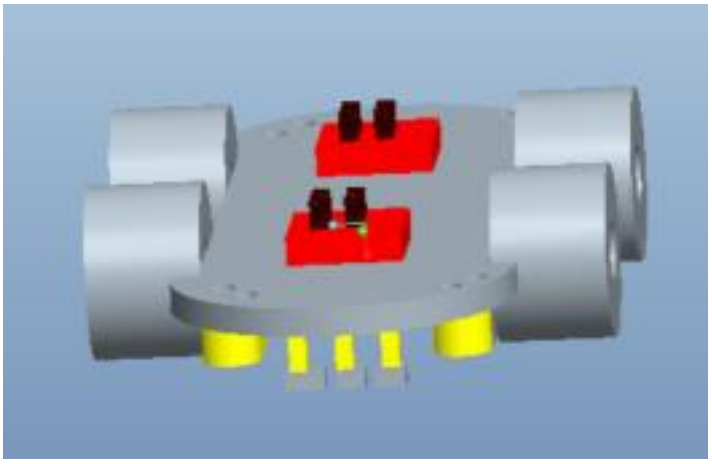

Figure 3. Smart stretcher first floor.

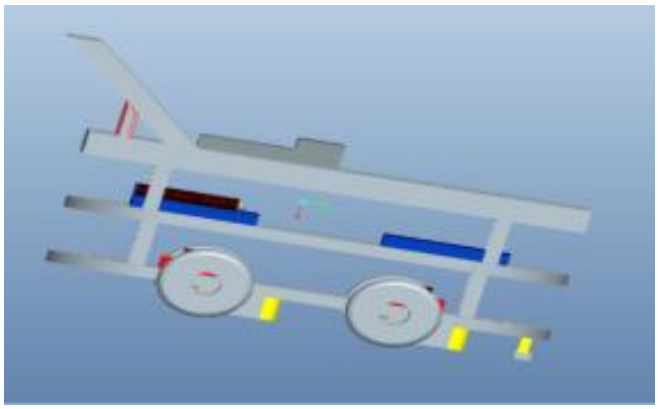

Figure 4. Smart stretcher left view.

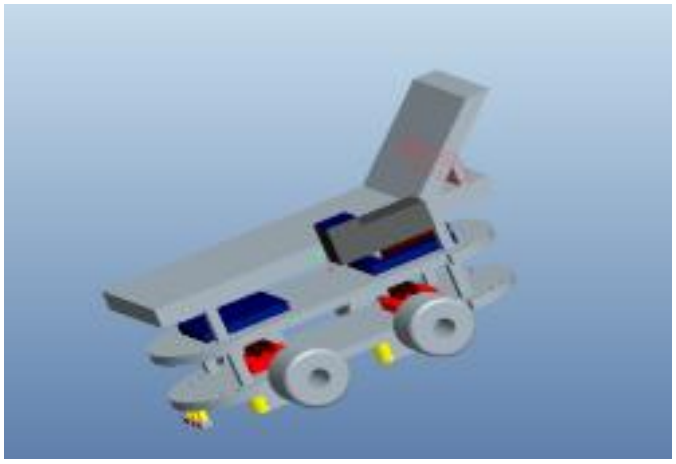

Figure 5. Smart stretcher right view.

As seen in Figure 2, 4 DC motor connections are connected to 4 wheels. As can be seen in Figures 3, the sensors are placed under the Smart Stretcher to detect the color difference on the floor. The sensor modules and connections shown in Figure 4 are located on the top layer of the platform. Arduino MEGA and battery connections are located on the 2nd floor of the platform shown in Figures 4 and 5. There are sensors that can measure temperature and pulse on the OLED screen on the arm apparatus on the upper part of the Smart Stretcher. At the same time, it enables the Smart Stretcher to operate autonomously by the user thanks to the button on this apparatus

Circuit elements are below: .

1- Upper and Lower Transparent Plexi Body: This part, which is the platform of the circuit, enables the placement of electronic materials [5][6].
2- DC Motor: It is an electric motor that converts direct current electrical energy into mechanical energy. When electric current is applied to the windings of the motor, there is a mechanism that will act with magnetic force. The DC motors used in the Smart Stretcher circuit depend on the examinations. Infrared color sensors in the circuit can be triggered by electric current, thus causing the wheels to turn [7].
3- Wheel: It connects to DC motors in the circuit and makes the circuit move in a certain route [8].
4- Battery Housing: The power source used to transmit the electric current to the mechanisms working with DC current is the connection type where the batteries are connected [9]. In the Smart Stretcher circuit, 1 quadruple battery slot and 1 battery slot for 9V battery are used.
5- Encoder Disc: It is a part you can use on the steering wheel to get the steering speed.
6- Screws and Nuts: It is used to connect the platform, wheel and motor to each other in the Smart Stretcher.
7- L298N Double Motor Driver Board with Voltage Regulator (Red PCB): It is the part that provides control of the motor by making electrical resistance adjustment, speed adjustment, starting and stopping settings for the motor it is connected to. This motor

driver board, which is prepared to drive motors up to 24 V, is used in the circuit. It has 2 channels and gives 2A current per channel. There are 4 screw holes on the card that allow the internal driver and 4 corners of the card to be fixed to the desired location. Connection parts are shown in Figure 6 [10].

8- 4 Way Tracking Module: Infrared sensors are one of the sensor types used for distance and dark / light detection. Infrared sensors usually contain an LED that emits infrared rays and a photodiode that controls the reflection of this beam. The LED inside the sensor produces a beam with the same wavelength as the information we want to control. The user can control the intensity of this beam. A photo component checks the infrared rays falling on the object and reflected back, and the sensor performs the detection job according to the returning beam signal (Figure 7, Figure 8). The 3 infrared sensors in the circuit follow the line of the circuit. For this, sensors give digital output, when they see black or white, their output signals are 0 or 1. In this case, when our sensors see the '1' output value when they see black, the logic that occurs will be as shown.

9 Jumper Cable: Provides the connection between electronic components in the circuit. It is divided into men and women.

10 Arduino Mega2560: It is an Arduino board containing an ATmega2560 based microcontroller. It has 54 digital input output pins. 14 of them can be used as PWM outputs. It has 16 analog inputs, 4 UART (serial ports), 16 MHz crystal oscillator, USB connection, adapter input, ICSP output and a reset button. It is compatible with all shields designed for Arduino Duemilanove and Diecimila. Arduino Mega 2560 is the advanced version that replaces Arduino Mega. Arduino Mega specifications (Table 1) and datasheet shown(Figure 9). The Arduino Mega 2560 can be powered by an adapter or battery from USB. The power source is automatically selected. The card can be powered from an external source between 6-20V. If a supply below 7V is used, the 5V output pin cannot deliver 5V and the card may operate unstable. If an external power supply higher than 12V is used, the voltage regulator may overheat and damage the board. Therefore, 7-12 Volts should be used. The difference of Arduino Mega2560 from other boards is that serial driver integration is not used. The ATmega16U2 is programmed as a USB-to-Serial converter instead of a Serial IC. Figure 10 shows the Arduino Mega2560 pins [11].

11 Arduino Heart Rate Monitor Sensor Module KY-039: This sensor, which has an infrared LED and a receiver on it, works with 5V. There is an infrared LED and a receiver on the sensor. It includes 3 pins, VCC, GND and signal pin [12]. It performs the pulse measurement process by interpreting the data on the development card with a signal pin on it. It is located in the upper arm apparatus of the Smart Stretcher.

12 OLED 0.96 inch 128x64 Pixel Display Module: 0.96" I2C OLED display provides easier use in Arduino and other microcontroller projects due to its low energy consumption, thinness and light weight. It has 128x64 resolution. It is located on the upper arm of the stretcher and the heart rate and shows the temperature measurements.

13 MLX90614 Contactless Infrared Temperature Sensor: It is the sensor that allows the temperature of the object and the environment to be measured without touching the object. A built-in 17-bit ADC and a powerful DSP give the MLX90614 high accuracy and resolution in measurements. It can measure the ambient temperature in the range of -40 to + 85 ° C. Object temperature can be measured between -70 and + 380 ° C [13]. This circuit element is located in the apparatus on the upper arm of the Smart Stretcher.

Pin Connections:

ENA: Left motor channel activation pin

IN1: Left motor input 1

IN2: Left engine 2nd travel

IN3: Right motor input 1

IN4: Right motor 2nd input

ENB: Right motor channel activation pin

EngineA: Left engine output

MotorB: Right motor output

VCC: Supply voltage input(4.8V-24V)

GND: Ground connection

5V: 5V output

Figure 6. Figure 6. Pin connections.

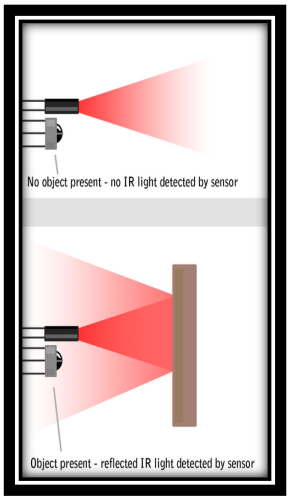

Figure 7. Sensor light diffraction.

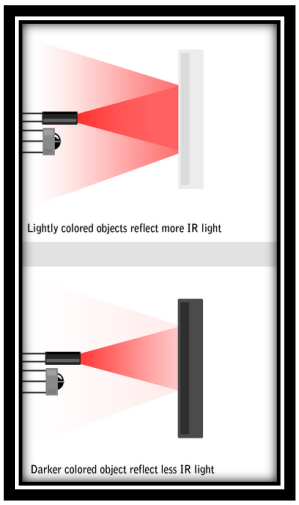

Figure 8. Sensor light reflection.

Table 1. Arduino Mega 2560 Specifications

Mikrocontroller	ATmega2560
Working Voltage	5V
Supply Voltage (Recommended)	7-12V
Suply Voltage (Limit)	6-20V
Dijital I/O Pins	54 (14 PWM)
Analog Input Pins	16
Current of I/O Pins	40 mA
3.3V Pin Current	50 mA
Flash Drive	256 KB
SRAM	8 KB
EEPROM	4 KB
Clock Frequency	16 MHz

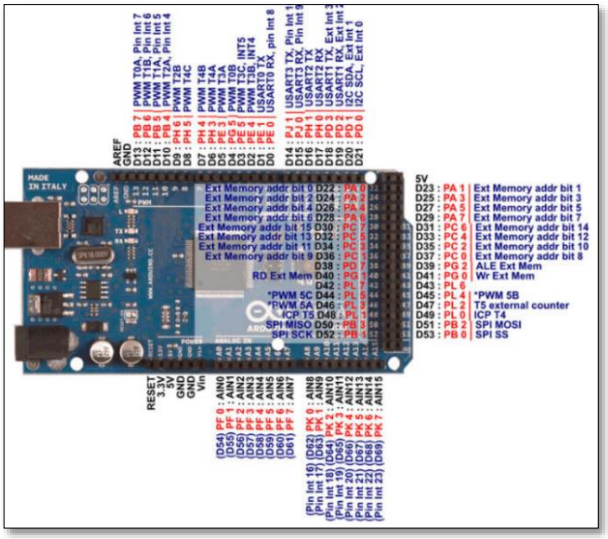

Figure 9. Arduino connections [11].

2.1 What is pulse?

Pulse is an indicator of how many times the heart beats in a minute. As the blood is being pumped, the pressure applied to the vessel wall is measured externally as a pulse. It is stated that the average heart rate in adults is 80.A very high heart rate is called tachycardia. When exercising for tachycardia at certain ages, care should be taken not to exceed certain intervals. At the same time, a low heart rate can occur if the heart is not able to pump enough oxygen-rich blood throughout the body.

With each contraction of the heart, some blood flows into the arteries and a corresponding expansion occurs in the arteries due to the stretching feature of the vessels. Where we find this point of expansion or multiplication is the part of the pulse to be measured. The best places in our body where we can find our heart rate are the wrists, neck, inside of the elbow, groin, temple and upper part of the foot. Counting the number of beats felt for 60 seconds after the pulse is found will give us the pulse (Figure 10).Pulse oximetry, another method for pulse measurement, is also performed with devices such as a pulse meter (Figure 11) [14][15]. The Smar Stretcher design meter measures heart rate and temperature (Figure 12).

Figure 10.Wrist based heart rate measurement.

Figure 11. Finger heart rate monitor [17]

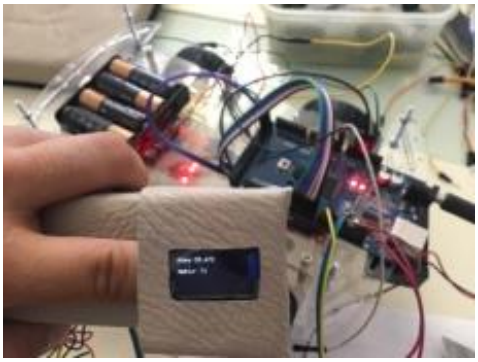

Figure 12. Smart stretcher heart rate measurement.

In the Smart Stretcher, heart rate measurement is made with the KY-039 heart rate sensor located in the upper arm of the circuit. The data detected by the sensor are read with Arduino Mega 2560, thanks to the data input it receives. For example, the pulse of the person on the OLED screen; It provides visual perception by the user as "Pulse: 75". Figure 12 shows the pulse measurement on the stretcher and arm apparatus.

2.1 What is fever?

Body temperature above normal is defined as fever. In general, the human body temperature is considered to be 36.5-37.0 C. Body temperature in children is higher than in adults, and fever has a certain rhythm during the day. Fever, that is, rise in body temperature, stimulates our body by certain bacteria or viruses or substances secreted, causing an increase in some body substances. These substances also affect our brain, causing high fever [18].

Two methods are generally used to measure body temperature. The first method is 36.8 ± 0.4 Cº when measured under the tongue. The second method is 37.0 C when measured internally, anal and vaginally. However, with today's developing technology, more hygienic measurements are made with non-contact infrared sensors.

Hyperthermia is a life-threatening condition that rises

above 40°C when temperature control cannot be achieved in the human body. In such a case, dryness may occur on the skin and skin after sweating and water loss[19]. Hypothermia is a decrease in body temperature below 1-2 C in humans. It occurs in people who are exposed to cold. It should be treated promptly [20].

Apart from these two conditions, a person has a basal body temperature. It is defined as a person's body temperature at rest. 36.22-37.8 Cº is considered normal in humans.

MLX90614 non-contact infrared temperature sensor in the Smart Stretcher circuit measures the temperature hygienically without touching the body surface. The temperature sensor is connected to the OLED display on the upper arm. The sensor reflects the detected heat to the OLED screen with Arduino Mega. Connections of electronic materials on the Smart Stretcher are made with jumper cables. Tables are used to more easily explain the connections of electronic components in the circuit, input and output pins, GND and VCC pins (Figure13).

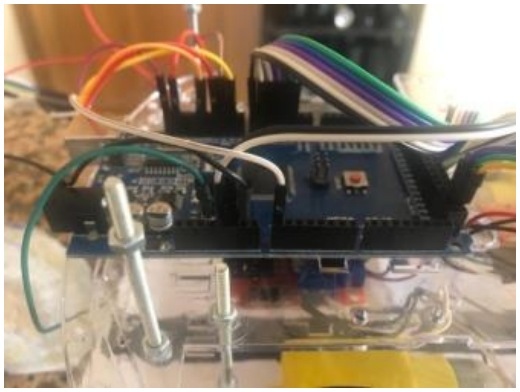

Figure 13. Smart stretcher Arduino connections.

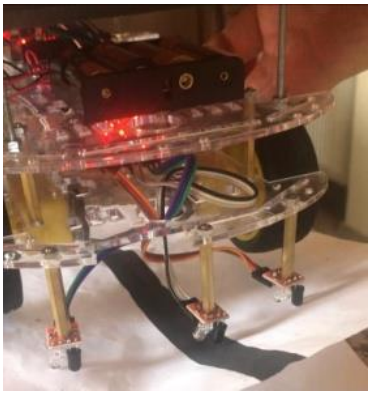

Figure 14. Smart stretcher sensor connections.

Infrared color sensors for Arduino codes compatible with Arduino Mega2560 used in the circuit and libraries for the pulse meter and non-contact temperature sensor sensors used in the circuit have been added (Figure14). In previous studies, what kind of software was used was investigated.

Figure 15.Smart stretcher left view.

As seen in Figure 15, the left arm apparatus of the Smart Stretcher is the measurement part. Arduino is used in the software part. The libraries of the sensors used were added to the Arduino program. The inputs and connections of the motors, OLED display and sensors are defined to be compatible with the Arduino Mega2560 pins used. It has been specified which engine the right, left and middle color sensors are connected to. It is indicated as an input signal to the color sensor that sees the line and an output signal to the motor it is connected to. The connections of the sensors for heart rate and temperature measurement are defined on the OLED display. An orientation was specified as "Place your arm for measurement" when there is no measurement defined in the sensors. All these software can be tested when the color sensors see the black color on the black and white platform to be executed on the Smart Stretcher.

3. Result and discussion

Autonomous route tracking was achieved on the stretcher with the infrared color sensing sensors used in the Smart Stretcher study. Likewise, MLX90614 Non-Contact Infrared Temperature Sensor and Pulse Meter Sensor Module KY-039, which provides pulse and temperature measurement while the patient is on a stretcher, was used

The circuit was originally designed with the ProEngineer drawing program. After the design phase of the circuit, the electronic materials that will provide the circuit electronics are determined and provided. Likewise, Arduino software was developed to provide electronic circuits as desired. In addition to the circuit, sensors that can make other measurements such as ECG measurement can be added and reflected on the OLED screen.

In the literature, while stretchers in hospitals were provided by mechanical manpower, this was achieved autonomously. With this project, which saves both power and time, complexity and possible accidents in hospitals can be avoided.

The measurements made with the pulse and temperature sensors used in the circuit are reflected on the OLED screen for easy understanding by the user. For the infrared sensors that detect the color difference used in the circuit, a path route was provided in the form of black printing on white paper so that the sensors, including black and white, can easily detect the color difference.

The software part was transferred and recorded with Arduino Mega used in the circuit. Arduino Mega2560 is preferred because it is more advanced for the circuit accent and the healthy operation of the software. The wheel power provided by the color sensors of the DC motors was selected to be compatible with the wheels, taking into account the weight of the platform and the circuit on it. Thin, light, translucent layers were used to hide the complex wire image of the circuit.

A button has been added for the circuit to be operated by user instruction. Necessary power is provided by 9V and 4 1.5V batteries so that it does not require any external power connection.

Hard board, mattress sponge and leather material are used in the external design of the circuit. It is aimed to provide an aesthetic and comfortable structure (Figure16) (Figure17).

A research stated in related article, the Hub engine is increasing day by day. Zero fuel cell electric vehicles are this problematic solution that could be good for the environment.

Hybrid vehicles have been developed to eliminate the restrictions of internal combustion and Electricity vehicles A hybrid Electricity vehicle is formed by a combination of commonly used internal combustion engine and battery and Electricity motor components of Electricity vehicles [21].
If you drive the hybrid Electricity vehicle in Electricity mode only, you will achieve zero emissions. Hybrid Electricity vehicles have less fuel consumption compared to vehicles with an internal combustion engine, but have a longer range compared to Electricity vehicles.

Rechargeable hybrid vehicles, on the other hand,have a much longer range because they can be charged directly from the Electricityity network.

Figure 16. Smart stretcher top view.

Figure 17. Smart stretcher right view.

During the construction phase of the Smart Stretcher, literature review and necessary research were carried out first. In some ABB studies, it has been observed that mini robots move materials from one place to another. These robots usually carry material within the laboratory. According to some sources, different types of autonomous robots that can be used as waiters are also used in some restaurants in China. Stretchers are used in the literature depending on the mechanical power.

The Smart Stretcher idea stage was inspired by these robots. Stretchers do not have a device that can measure the patient's temperature and heart rate, both of which appear on a single screen. With the Smart Stretcher, it is aimed to measure both heart rate and temperature while the patient is on the stretcher and to reflect the values on a single screen. Later, the required list for this circuit was made and provided.

It has been investigated what kind of problems may arise in cases caused by human errors in the use of stretchers in hospitals. A patient who came to a hospital in Izmir by heavy ambulance in 2012 put the vital values of the patient in a dangerous situation when the emergency adult section of the stretcher fell on the doorway. The Smart Stretcher Project was designed to prevent such human errors. During the literature review conducted during the Smart Stretcher theory stage, it was observed that the stretcher types used in hospitals today are completely dependent on manpower. In a previous study, there is a stretcher that can adapt to the smart ID card designed by MİKELSAN in 2015. This stretcher ensures that the identity information of persons is recognized by data entry Similarly, ABB company introduced smart in-lab mobile robots in 2019. There are these robots and some similar autonomous mini robots. ABB firm is of Swiss origin and cooperates with the BBC. Designed robots allow test tubes to be moved from one place to another in the laboratory. Likewise, there is an autonomous device in

Switzerland that allows blood, test tubes or medical inventory to be carried in the hospital. This device can also identify the elevator in the hospital and reach the floor where it will deliver the materials with a smart elevator.

However, such a work has never been tried on a stretcher before. Since the stretcher use, it can usually carry patients with human power. The Smart Stretcher works autonomously by following a line that goes to a specific route. Normal stretchers do not have functional body measurement, but the Smart Stretcher operation provides heart rate and temperature measurement. The measurements made for easy understanding by the user will be reflected on a screen in the arm apparatus.

A button has been added for the stretcher to operate with user instruction. At the design stage, it was an idea to use a weight sensor instead of this button. However, it was concluded that the weight sensor would not be suitable for this project, considering the accidents that may occur due to the early activation of the weight sensor while settling in the area where the patient will lie or sit. This study we designed can also be developed for ambulances. Smart Stretcher, a stretcher track was designed to prevent it from hitting people in the hospital. However, considering the complex environments in hospitals, a motion sensor and warning light can be added to the stretcher.3D supported Pro Engineer program was used in the visual design part. Autocad or Solidworks program can be used instead of this program. The circuit skeleton and connection type are clearly shown in Figure 18.

Figure 18. Smart stretcher right view.

4. Conclusion and recommendations

We investigated what paths we should go through in order to realize this work, which started in theory. We investigated the working mechanisms and logic of pre-designed circuits with the literature review and the materials used. With the working logic of the sensors we use, we experienced the use of Arduino Mega 2560 on a stretcher for the first time. By providing stretcher design on Pro Engineer, we visually supported our project with computer-aided drawing and made it easier for the user to perceive our project. We learned the working principles of Arduino Mega2560. We learned the DC motor operating principles.

In order to adapt this work, whose prototype we have designed and developed, to a real stretcher, a more advanced engine and appropriate wheel should be used when calculated considering the average human weight. In the realization of the project, a motor type that is also used in electric bicycles, which is Hub motor type, can be suggested. Considering the wheel diameter of an average stretcher, 25-30 cm, 250 V, motor 2000 RPM, wheel 250 RPM 1:8 gear ratio, 275mm Hup motor can be preferred. Considering that the average human weight is 150 kg, the 250V Hup motor can lift a maximum of 150-200 kg weight per second. In order to adapt the prototype to a real stretcher, it will be sufficient to select the appropriate engine and wheel.

We supported our circuit with Arduino codes. We fixed the circuit elements with Jumper cables. We strengthened the connection points by soldering. We designed a bed made of leather and sponge so that the Smart Stretcher is an adjustable curved mattress. Likewise, we surrounded it with a sheet to eliminate the appearance of the cable. We gained experience in sensors in Arduino software.

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