Design of Electrical Sensors and Instruments on Fire Extinguishing Robots

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Abstract: Development technology in the digital era is developing very rapidly and provides many benefit various aspect not except in the field robotics. Robots are tool mechanic as well as electronics that can To do Duty physical made with intelligence artificial for make it easy profession human. The Indonesian Robot Contest (KRI) is event competition design build and engineering in field robotics. The Indonesian SAR Robot Contest (KRSRI) is one of the KRI transformation divisions from KRPAI which emphasizes mission on search and rescue disaster every fire year there is change competition rules but permanent maintain existence mission blackout fire. With existence change that, then required sensor and instrumentation design electricity for the Fire Extinguishing Robots for maximizing blackout fire or targets that have been set. Destination study this for designing electronic systems in the form of sensors and instrumentation used in the Fire Extinguishing Robots. Design this use microcontroller in the form of Arduino Nano, Arduino Mega, and STM32 which work process using Ultrasonic sensors, TPA64, UVTRON, IMU GY-25 and Proximity. Blackout fire conducted when the UVTRON sensor detects existence fire and TPA64 sensors found point fire, then the data will processed by Arduino Nano which Arduino Nano sends signal to servo for open CO2 valve and spray CO2 so that fire dead. System electricity used already in accordance with the target you want achieved that is extinguish fire. Robots can walk with good seen that the UVTron sensor at a distance of 5 - 150 cm the sensor can detect. Tested distance TPA64 sensor from 10 – 60 cm and the angle by -30° to 30°. At a distance of 10 cm visible temperature reading 50 ° C so read existence fire and more far distance so the more shrink read temperature.

1 INTRODUCTION

Development technology in the digital era is developing very rapidly and provides many benefit various aspect not except in the field robotics. Robots are tool mechanic as well as electronics that can To do Duty physical mad with intelligence artificial for make it easy profession human. The Indonesian Robot Contest (KRI) is event competition design build and engineering in field robotics (Kurnia et al., 2019). The divisions contained in the KRI are the Indonesian Fire Robot Contest, the Indonesian Search and Rescue Robot Contest, the Indonesian Wheeled Football Robot Contest, KRSBI Humanoid, the Indonesian Dance Robot Contest, and the Thematic Robot Contest Indonesia. The Indonesian SAR Robot Contest is transformation from KRPAI which emphasizes mission on search and rescue disaster frequent fires happened in Indonesia. On every year competition rules always changed but permanent maintain existence mission blackout fire, because that need existence design changes to the KRSRI robot for maximizing blackout fire with more fast (Rifai et al., 2021).

Robot problems are very complex, some study based on maximizing robotic motion at Fire Extinguishing Robots or also utilizing sensor instruments and devices electronic set (Mutolib et al., 2020). On research the movement of the autonomous robot adjusts from the function of the robot, such as the KRSRI robot, is a fire robot that moves and

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detects fire. Accuracy in controlling this robot is very important so that it can become useful rescue robots (Fuad et al., 2020; Sang et al., 2021). Research (Adriansyah et al., 2019; Iqbal & Aji, 2021) Developing a wall-following robot using PID algorithm with MATLAB help. Study this stages next after designing the Fire Extinguishing Robots.

Stages for planning system robotics that is planning, then knowing system that will developed and stages final that is give system control. Research (Rout et al., 2019; Su et al., 2019, 2021) system model in robotics defined on the system developed electronics and mechanics. Research (Agustinah et al., 2010; Pambudi et al., 2019; Sahal et al., 2019; Widanis et al., 2020) linear model resurrected system no in accordance with state actually because system robotics is very complex and requires a linearity process that looks for eigenvalues that really truly stable. design system is very important for can give system control on the robot then research (Juang et al., 2018) design with use appropriate instruments and algorithms on wall-following robots.

Designed robots study this is a firefighting robot fire. For can adjust the system from the rules and can designing with good so need changes to the robot design and electricity made To use support blackout fire as well as make it easy in troubleshooting robots and summarizing the previous wiring messy. Summary electrical wiring this could make it easy robot movement for more flexible. Besides Changes to electricity were also made changes to the microcontroller, the microcontroller used namely Arduino Mega, Arduino Nano, and STM32. Because there is change microcontroller so need conducted the application of the sensors used in the Fire Extinguishing robot with microcontroller new. With existence change this it is hoped that the robot can more fast in find and extinguish fire with movement flexible and effective.

2 RESEARCH METHODS

For reach destination from study this need it some stages method carried out. Method first determine the system flow shown in the block diagram of input process up to system outside. With know the block diagram of the input to output system, then explanation component from block diagram and continued with system flowcharts and for reach destination this. Method final for can reach destination this that is with the electrical system on this Fire Extinguishing Robots. Block diagram can seen in figure 1 below this.

Figure 1: Block Diagram.

Table 1: Proposed System.

Input	Process	Output
Design Sensors and Instruments for Extinguishing Robots Fire	**Sensors** : ultrasonic TPA64 UVTron Flame MPU6050 TCS3200 **Microcontroller** ESP32 STM32 **Actuator** Servo DC Motor Relay	Extinguishing Robot Sensor and Instrument System Fire

How it works of this robot i.e. Ultrasonic, TPA64, and UVTRON sensors are read by ESP32 Slave then the sensor reading sent to ESP32 Master. MPU6050 and TCS3200 sensors are read by STM32 then sent to ESP32 Master. The pushbutton and flame sensor are read by the ESP32 master. After all sensors are received by the ESP32 master, the ESP32 Master will display sensor data on LCD then accumulate for determine the output in the form of point fire and for leg movement. If result accumulation gives output in the form of spraying water, the ESP32 Master will send signal to the relay so that the relay turns on. After the relay is on, the DC motor turns on and sprays water. Components Used in the robot:

Microcontroller. On research this use 3 types microcontroller namely STM32F4, Arduino uno and Arduino nano. Arduino Mega 2560 is board development based microcontroller Arduino with using the ATmega2560 chip. On the fire, Arduino mega used as a slave that p*rocesses data from the sensor.* Arduino Nano is module based ATmega328 microcontroller in form a small, complete, easy series mounted on breadboard. On the fire robot Arduino nano is used as a slave that processes data from servo on gripper.

Sensor. Some of the sensors used in research this namely TPA64 sensor, UVTron sensor, Ultrasonic Sensor, IMU sensor and Proximity Sensor. The TPA64 sensor uses a core sensor, namely AMG8833.

AMG8833 8x8 Infrared Thermal Temperature Sensor Array is an infrared temperature sensor that has level precision tall based state-of-the- art MEMS technology. On this robot the TPA64 sensor works for look for point fire with could determine point x, point y, and point z fire against robots. Figure 2. Below is TPA64 sensor display.

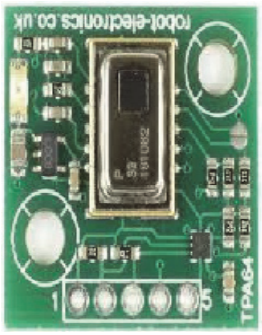

Figure 2: TPA64 sensor.

Figure 3: UVTron sensor.

Hamamatsu UVTron Flame Detector can detect fire in 5 meters distance. This sensor used as tool for detection source flames operating at a spectral length of 185 nm to 160 nm. On the fire robot fire, UVtron sensor working as detector ultraviolet lighton fire so that could extinguished by robots. Figure 3. Is display on UVTron sensor.

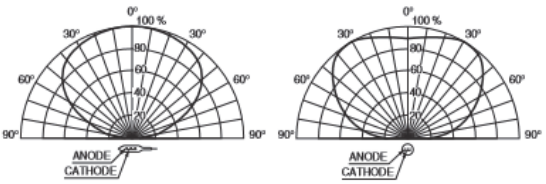

Figure 4: UVTron sensor range.

Ultrasonic sensor is a working sensor for change quantity physical (sound) becomes quantity electricity and vice versa. This sensor working for knowing distance wall so that the robot can avoid object that.

On the SRF04 sensor has range corner not enough from 45 degree but optimal angle of reading is at angle not enough of 15 degrees. Following is Figure 6 SRF04 sensor range:

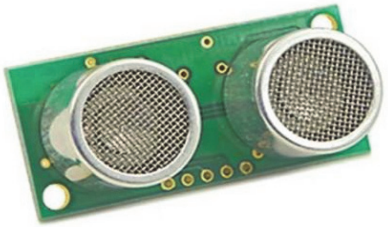

Figure 5: Ultrasonic Sensor.

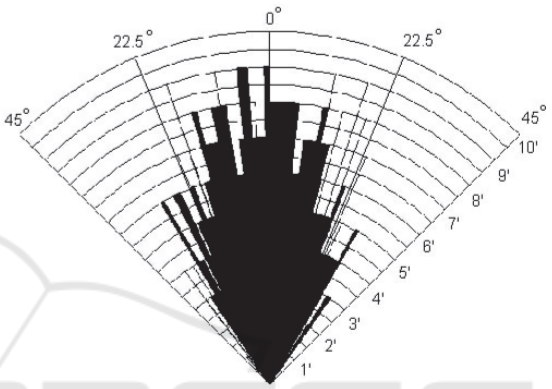

Figure 6: Ultrasonic sensor range.

The IMU GY 25 sensor is censor the balance in it there are accelero sensors (acceleration), gyroscope, and compass fire, GY 25 IMU sensor is used as balancer motion robot path to stay straight.

The proximity sensor is a proximity sensor that uses sensitive element to light (infrared) for detect object. On the fire robot fire, this sensor used for detect distance the wall on the sound damper obstacle because no allow using ultrasonic sensors.

Robots will always move the place because the work of the robot that runs, therefore that required supply portable power or can moved anywhere. On this robot use Li-Po battery because small size, large voltage and current in accordance with needs system electricity to robots. Li-Po battery used in this robot is Li -Po 3 sell batteries, namely with 3 x 3.7v or 11.1v capacity.

Servo, Sensor and STM32 use voltage work of 5vdc. supply the power available by the Li-Po battery is have voltage 11.1v, therefore that required reducer voltage.

First thing in blackout fire is check, whether there is fire or no, for detect existence fire so using UVtron sensor and tpa64 sensor. UVtron sensor could detect point fire small like fire on candles with range up to 2 meters. However, the UVtron sensor no could detect

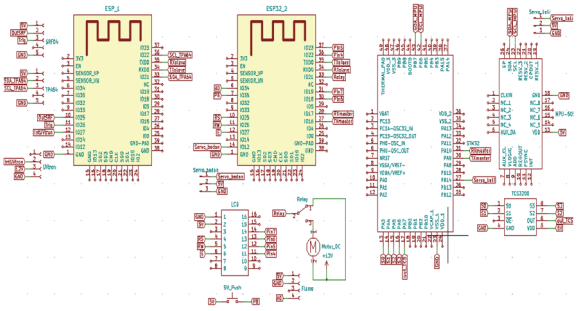

Figure 7: Design electrical sensor and microcontroller on the Fire Extinguishing Robots.

where location fire. For detect location fire , then robot Fire Extinguishing Robots using the tpa64 sensor. The tpa64 sensor has view by 60 degrees on the x- axis and 60 degrees on the y- axis. Reach corner from the sensor shared Becomes 8x8 matrix. That is 8 points to y- axis, and 8 points to x axis. With matrix the so obtained that each point have range 7.5 degree angle.

After knowing location fire, then the robot will shift to front location point fire. If the robot has is at appropriate in front of position fire, then the robot will check more formerly is distance between robot and fire already close. Checking the with using ultrasonic sensor or with infrared or with temperature the fire that has been detected. Use algorithm the use OR gate, so that if one condition fulfilled, then the robot will spraying CO2 that has been facing fire. For avoid robot stuck or Keep going To do blackout fire by Keep going continuously because no extinguished fire, then if the robot has To do spraying CO2 3 times, then the robot will carry on to Duty next that is save the victim. And for avoiding the stuck robot, also done existence calculation time, if the robot up to 30 seconds no could extinguish fire, then the robot will carry on to Duty next too.

Figure 8. Above is a firefighting robot system flowchart Working fire with method that is after the robot is turned on then the robot will initialize sensors. Then the sensor data will be checked by the ESP32 microcontroller, if UVTRON detects Fire, then then the flame sensor will detect point fire in 360 degrees. Then the robot will turn toward point fire. If the robot has facing, then TPA64 with more accuracy tall detect point fire based on score x, y, and z. After finding point, then the robot will adapt return point fire so that appropriate facing fire. If you have appropriate facing fire, then pump will light up then extinguish fire.

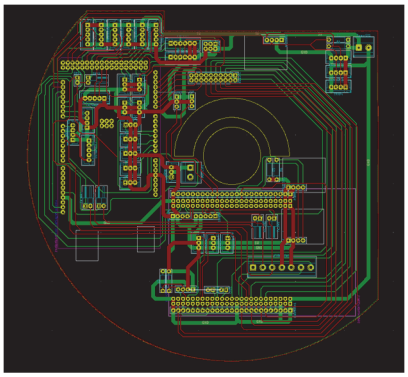

Figure 8: Flowchart System.

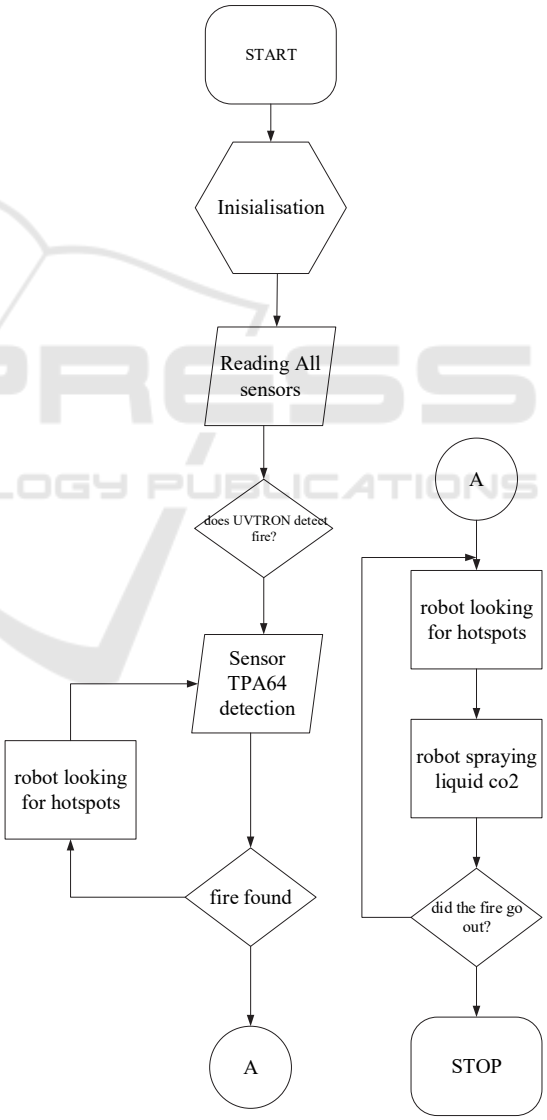

Figure 9: Layout of the Fire Extinguishing Robots.

3 RESULTS AND DISCUSSION

Testing from multiple sensors so that it can determine possible goals _ achieved . Figure 9 below this is appearance merging Among microcontroller and some sensors.

For can get results from electricity so conducted testing of the sensors used in the robot. Test first with knowing how much UVtron sensor remote could detect fire on candle

Table 2: UVTron Sensor Test.

No	Distance (cm)	Amount test	Success	failure
1.	5	5	5	0
2.	50	5	5	0
3.	100	5	5	0
4.	150	5	5	0
5.	200	5	4	1
6.	250	5	2	3

In table 2 above seen that with 5 trials and known different distance then at a distance of 5 - 150 cm the sensor can detect and not has a trial error but moment a distance of 200 cm has an error 1 time and a distance of 250 cm gets an error 3 times compared to 5 times or an error of 60% on the experiment with 250cm distance.

Test next namely the working TPA64 sensor for knowing how much remote TPA64 sensor can detect point fire, and for knowing how much precision fire could detected with coordinate 8x8 matrix.

Table 3: TPA64 . Sensor Testing.

No	Distance (cm)	Corner Fire	Point X	Temperature (°C)
1.	10	0	0	50
2.	20	-15	-2	43
3.	30	-30	-4	38
4.	40	15	2	32
5.	50	30	3	29
6.	60	15	0	28

In table 3 above showing that tested distance _ from 10 – 60 cm and the angle by -30° to 30°. Reading from the sensor if intensity temperature around 28 °C - 32 °C so no read existence fire because read at temperature normal room. At a distance of 10 cm visible temperature reading 50 °C so read existence fire and more far distance so the more shrink read temperature.

Test final that is with testing blackout Fire for knowing all systems that have designed. Collected data for know the system is running with breed with knowing distance, angle fire, robot movement and spraying . Table 3 below this show the data obtained of the proposed system.

Table 4: Robot movement and spraying data.

No	Distance (cm)	Corner Fire	Robot Movement	Spraying
1.	10	0	Stop	Spray
2.	20	-15	Swipe Left	Not
3.	30	0	Sliding Right	Spray
4.	40	15	Up	Not
5.	50	30	Turn	Not
6.	60	15	Turn	Not

Table 4 above showing that for can spray ensure corner spraying. Robot movement is also known from distance and angle fire, when distance is known to be 40 cm and has angle 15 ° then the robot moves Up or customize with angle on the robot so that the robot moves with method play rbody robots. For can spray so robot algorithm adjust with possible distance and angle set that is with angle 0° then can spray CO2 to fire or extinguish fire.

4 CONCLUSION

Fire Extinguishing Robots robot is a robot that has destination for extinguish fire. On this robot use various kinds of sensors for To do blackout fire. blackout fire with use CO2 liquid assisted with a number of sensor and actuator components. Robots can walk with good seen that the UVTron sensor at a distance of 5 - 150 cm the sensor can detect and not have errors. While the distance TPA64 sensor tested from 10 – 60 cm and the angle by -30° to 30°. At a distance of 10 cm visible temperature reading 50 °C so read existence fire and more far distance so the more shrink read temperature. Whereas results from whole for blackout fire seen from developed algorithm that at an angle of 0 degrees so spraying new CO2 liquid can sprayed.

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