RESEARCH ON THE DISASTER-EXPLORATION UNMANNED VEHICLE SYSTEM BASED ON THE MULTI-SENSORS

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Abstract - The purpose of this research is to construct a disaster-exploration unmanned vehicle (UV) system based on multi-sensors. This UV system is integrated with the exploration unmanned ground vehicle (UGV), the injury ambulance UGV, and the unmanned aerial vehicle (UAV). Firstly, according to the task demands, three vehicles are all set up with the sensor module, core control module, motor drive module, and the remote control module. In addition, not only can the sensor module be applied to return back the situation of the disaster area, but it also collected the dynamic information of the vehicles to help to establish the accurate math models that will facilitate the subsequent designs of the stable controllers. Besides, additionally, we also set up the first aid box and the gesture control armband with the injury ambulance UGV. When the exploration UGV and the UAV send back the information of the injury location and the disaster area, the injured ambulance UGV will go to the injured location. If the injury person is conscious, then he can use the first aid box to carry out the simple treatment to avoid the injury worsening. If conditions permit, the injured person can also sit on the injury ambulance UGV and uses the gesture control armband to connect the core control module of the injury ambulance UGV. Then he can use some simple gestures to remotely control the injury ambulance UGV himself to return back to the hospital. Finally, in accordance with the different task characteristics, we design the adaptive controller and another various controllers to reduce noise and improve the robustness of the UV system. So that these designs yield the UGVs not only with the foundational functions of traction, navigation and obstacle avoidance, but also retain the considerable stability of the entire travel in the fact of unknown environment and unexpected disturbances. Even when encountering the sudden situations which require emergent obstacle avoidance, the UGVs can also taking into account the stability of smooth turn. These characteristics not only can reduce the vehicle vibrations to extend the components lives but also can help to extend the UV application in the areas of human factors engineering, such as the large-scale self-propelled public transportation could be developed.These stable controller techniques can effectively improve the comfort and stability of the carrying personnel or the precision material. Therefore, this study is really a practical and worthwhile research topic.

Keywords - Disaster exploration, Unmanned vehicle, Unmanned ground vehicle

I. INTRODUCTION

In recent years, the fast changes in the global environment and climate resulted in many disasters frequently. The case of Taiwan, during the past few years, from the 921 earthquake in 1999, Typhoon Xangsane in 2000, Typhoon Nari in 2001, and Typhoon Morakot in 2009, many natural disasters have caused the many casualties and destructions. Besides, according to the report of the "Natural Disaster Hotspot: Global Risk Analysis" in 2005, Taiwan may be the most vulnerable region on the planet. There are about 73% land and people exposed to three or morerisk factors for natural disasters [1].

Take Japan as another instance, on the 11th March 2011, a strong earthquake with a magnitude of 9 on the Richter scale hit the northeastern region of Japan and caused a combination disaster of the tsunami and the pollution of the nuclear radiation. Due to the nuclearpollution, the rescuers were not easy to enter the disaster area. That circumstance worsened the disastrous situation. This reality has also raised our motivation to develop the disaster exploration UV. Therefore, throw a sprat to catch a whale. We actively invested this research and hope it could be an example of a good deed for others to follow. Then, through the researches and developments of the UVs and concerted efforts, the casualties of disaster will be reduced in the future.

II. UV STRUCTURE

2.1. Configuration of the UGV

The UV system in this research is constructed based on the multi-sensors. It was integrated with UGVs and UAV. Among them, the UGVs include the exploration UGV(seen as Figure 1 and Figure 2)and the injury ambulance UGV (seen as Figure 3 and Figure 4). Currently, there are many applications in various fields about the UGV.According to the different capabilities, it can be divided intothe path following [2-4], target identification [5], object tracking [6], obstacle avoidance [7-9], and, etc.; however, perhaps the characteristics that no need personnel driving of the UV; therefore, it causes that not so much research discuss how to keep the features of the "stable controlling" and the "driving safety"currently[2-13].From the view of the controller design and the system integration, thesystem performance must be based on the whole stable response of the entire system. For this standpoint, this studycommitted on currently the less of research of stable controlling and driving safety of the UV. Imagine that if an UV system can not only track the target, follow the path, and avoid the obstacle, but it can also have both the features of stable controlling and driving safety when traveling

or steering. These properties not only can reduce the vehicle vibrations to extend the lives of components but also can help to execute the special tasks like the ammunition and the precision substance transportation. Finally, the design of this research can be applied to the disaster exploration and medical evacuation in the disaster area, especially some disaster areas that are extremely harmful to the casualties. Through this study, we hopethe casualties of disaster will be reduced in the future. Therefore, this is a worthwhile issue.



Figure 1. The exploration UGV

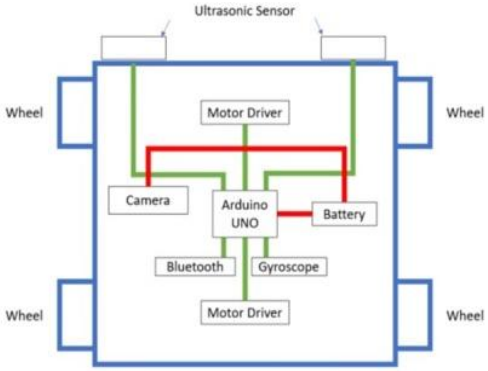


Figure 2. The architecture of the exploration UGV



Figure 3. The injury ambulance UGV

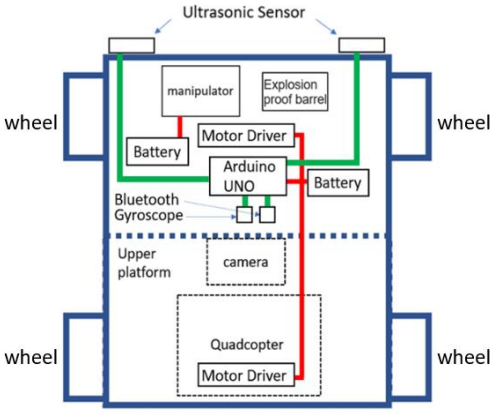


Figure 4. The architecture of the injury ambulance UGV

For the UGV construction, firstly, according to the mission demands, the exploration UGV and the injury ambulance UGVare all set up with the sensor module, core control module, motor drive module, and the remote control module. In addition,not only can the sensor modulebe applied to return back the situation of the disaster area, but it also collected the dynamic information of the vehicles to help to establish the accurate math models that will facilitate the subsequent designs of the stable controllers.

Besides, additionally, we also set up the first aid box and the gesture control armband (seen as Figure 5)with the injury ambulance UGV. When the exploration UGV and the UAV send back the information of the injury location in the disaster area, the injured ambulance UGV will go to the injured location. If the injury person is conscious, then he can use the first aid box to carry out the simple treatment to avoid the injury worsening. If conditions permit, the injured person can also sit on the injury ambulance UGV (seen as Figure 6)and uses the gesture control armband to connect the core control module of the injury ambulance UGV. Then he can use some simple gestures to remotely control the injury ambulance UGV himself to return back to the hospital.



Figure 5. The gesture control armband

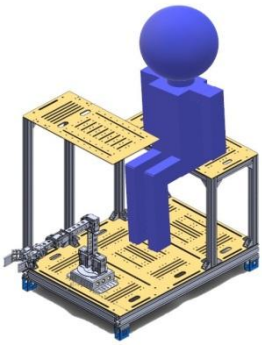


Figure 6. Injured personcontrols UGV to return back

2.2. Configuration of the UAV

In this study, we selected the scale model of the Cessna 182 for the experimental UAV. We call this UAV as “scale Cessna 182” for the clear definition to distinguish from the prototype Cessna 182. The ratio of the scale Cessna 182 to the original prototype Cessna 182 is 1: 6.65. Except to the higher resolution camera, the UAV is set up with the same modules as the UGVs in this research. The various parts of the body and the geometric parameters of the scale Cessna 182 are shown in Figure 7 [14,15], Figure 8[16], and Table 1.



Figure 7. Structure of Scale Cessna 182 [14,15].

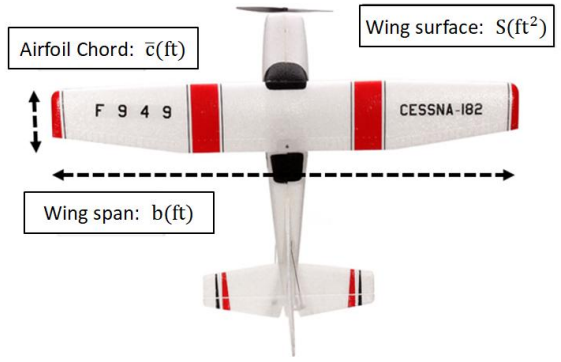


Figure 8. Geometry parameter definition of Scale Cessna 182 [16]

UAV part	Scale factor(SF = 6.65)
Wing span (ft)b	5.4135
Wing surface (ft^2)S	3.9346
True airspeed (ft/sec) V_{P_1}	85.3511
Dynamic pressure (lbs/ft^2) $\bar{q_1}=\frac{1}{2}\rho V_{P_1}{}^2$	7.4586
Steady state angle of attack (deg) α	0

Table 1 Units for Magnetic Properties

III. ESTABLISHMENT OF THE SYSTEM MODEL

3.1. Model establishment and programme of controller architecture for UGVs

In this study, although the disaster information can be collected simultaneously by the sensor module configured on the UGVs and UAV. However, for the injury rescue, we still need to apply the UGVs to help to complete the tasks. Therefore, modelestablishments and controller designs for UGVs are very important.

The mathematic models of UGVs were established from the known physical characteristics. We derived the transfer function between the various inputs and output responses, and then we could establish the mathematic models of UGVs. Figure9 is the simplified schematic diagram of UGV motion. The system parameters of UGV motion are also defined in Table 2. And the model establishments are described as follows.

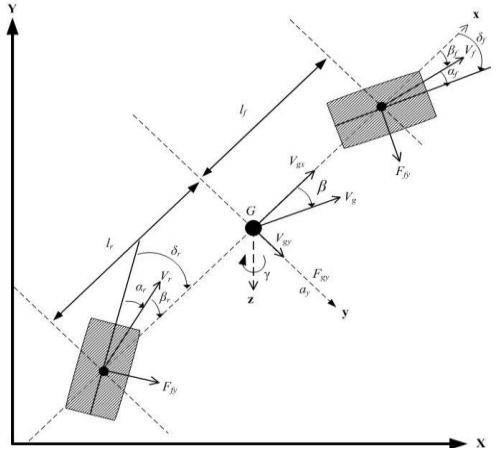


Figure 9. Simplified plane-movement of the UGV model [17]

name	parameter description
F_{gy}	Side force of the center of gravity
F_{fy}	Side force of the center of gravity of the front wheel
F_{ry}	Side force of the center of gravity of the rear wheel
G	Center of gravity of the UGV
β	Sideslip angle of the center of gravity
β_f	Sideslip angle of center of gravity of the front wheel
β_r	Sideslip angle of center of gravity of the rear wheel
L_f	Distance between center of gravity and axle center of front tires
L_r	Distance between center of gravity and axle center of rear tires
K_f	Steering stiffness of the front wheel
K_r	Steering stiffness of the rear wheel
δ_f	Front-wheel steering angle
δ_r	Rear-wheel steering angle
V_{gx}	Vertical speed of the center of gravity
V_{gy}	Lateral speed of the center of gravity
a_g	Center of gravity acceleration
a_x	Longitudinal acceleration of the center of gravity
a_y	Lateral acceleration of the center of gravity
I_z	Moment of inertia of the Z-axis
M	Mass of the UGV
V_g	Speed of UGV's center of gravity
γ	Yaw rate of the vehicle of the fixed coordinate system
V_f	Speed of the center of gravity of the front wheel
V_r	Speed of the center of gravity of the rear wheel
α_f	Sideslip angle of the front wheel
α_r	Sideslip angle of the rear wheel

Table 2. The system parameters of UGV motion

Assume the speed of UGV's center of gravityis as below:

$$V_g = V_{gx}\hat{x} + V_{gy}\hat{y} \quad (1)$$

Differentiating the Eq. (1), we can get the acceleration:

$$a_g = \dot{V}_g = \dot{V}_{gx}\hat{x} + V_{gx}\dot{\hat{x}} + \dot{V}_{gy}\hat{y} + V_{gy}\dot{\hat{y}} \quad (2)$$

Besides, since $\theta = \gamma \times \Delta t$, therefore when $\Delta t \longrightarrow 0$, we can get the relationships as below:

$$\dot{\hat{x}} = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t}\hat{y} = \gamma\hat{y} \quad (3)$$

$$\dot{\hat{y}} = -\lim_{\Delta t \to 0} \frac{\Delta y}{\Delta t}\hat{x} = -\gamma\hat{x} \quad (4)$$

SubstitutingEq. (3) into Eq. (2),thenwe can get Eq. (5~7):

$$a_g = \dot{V}_g = \left(\dot{V}_{gx} - V_{gy}\gamma\right)\hat{x} + \left(\dot{V}_{gy} + V_{gx}\gamma\right)\hat{y} = a_x\hat{x} + a_y\hat{y} \quad (5)$$

$$\begin{cases} V_{gx} = V_g \cos\beta \\ V_{gy} = V_g \sin\beta \end{cases} \quad (6)$$

$$\begin{cases} \dot{V}_{gx} = \dot{V}_g \cos\beta - V_g\dot{\beta}\sin\beta \\ \dot{V}_{gy} = \dot{V}_g \sin\beta + V_g\dot{\beta}\cos\beta \end{cases} \quad (7)$$

Besides, from the Figure 9, we can find that when the UGV make a turn, the front-wheel steering angleδ_f willgenerate the pairs of the side forces: F_{fy} and F_{ry}. Therefore, according to Newton's second law of motion, we can get the UGV motion equations as Eq.(8), Eq.(9), and Eq.(10) :

Lateral force F_{gy} :

$$F_{gy} = M \times a_y = 2F_{fy} + 2F_{ry} \quad (8)$$

Yaw movement:

$$T_z = I_z \times \dot{\gamma} = L_f \times 2F_{fy} - L_r \times 2F_{ry} \quad (9)$$

$$a_y = \dot{V}_{gy} + V_{gx}\gamma = V_g\left(\dot{\beta} + \gamma\right)\cos\beta + \dot{V}_g \sin\beta \quad (10)$$

If V_g is a constant and the sideslip angle$\beta$is small (less than 5 degree), then we can simplify the Eq.(10) as the Eq.(11) and get the Eq.(12) :

$$a_y = V_g\left(\dot{\beta} + \gamma\right) \quad (11)$$

$$\begin{cases} F_{fy} = K_f \times \alpha_f \\ F_{ry} = K_r \times \alpha_r \end{cases} \quad (12)$$

From the Figure 9, we can also get the relationship between the sideslip angle and the steering angle:

$$\begin{cases} \alpha_f = \delta_f - \beta_f \\ \alpha_r = \delta_r - \beta_r \end{cases} \quad (13)$$

Sideslip angle can be also represented as Eq. (14):

$$\begin{cases} \tan\beta_f = \dfrac{V_{gy} + \gamma L_f}{V_{gx}} = \dfrac{V_g \sin\beta + \gamma L_f}{V_g \cos\beta} = \tan\beta \\ \tan\beta_r = \dfrac{V_{gy} - \gamma L_r}{V_{gx}} = \dfrac{V_g \sin\beta - \gamma L_r}{V_g \cos\beta} = \tan\beta \end{cases} \quad (14)$$

When $\beta \longrightarrow 0$, Eq. (14) can be simplified as Eq. (15) :

$$\begin{cases} \tan\beta_f = \beta_f = \beta + \dfrac{\gamma L_f}{V_g} \\ \tan\beta_r = \beta_r = \beta - \dfrac{\gamma L_r}{V_g} \end{cases} \quad (15)$$

SubstitutingEq. (15) into Eq. (13),thenwe can get Eq. (16):

$$\begin{cases} \alpha_f = \delta_f - \beta - \dfrac{\gamma L_f}{V_g} \\ \alpha_r = \delta_r - \beta + \dfrac{\gamma L_r}{V_g} \end{cases} \quad (16)$$

Again, we substituted Eq. (11), Eq. (12), and Eq. (16) into Eq. (8) and Eq. (9), then we can get the lateral forceand the yaw movement as Eq. (17) and Eq. (18):

$$\begin{cases} MV_g\left(\dot{\beta} + \gamma\right) = 2K_f \times \left(\delta_f - \beta - \dfrac{\gamma L_f}{V_g}\right) + 2K_r \\ I_z\dot{\gamma} = L_f \times 2K_f \times \left(\delta_f - \beta - \dfrac{\gamma L_f}{V_g}\right) - L_r \times 2K \end{cases} \quad (17)$$

$$\begin{cases} \dot{\beta} = \dfrac{-2\left(K_f + K_r\right)}{MV_g}\beta + \left(\dfrac{-2\left(L_f K_f - L_r K_r\right)}{MV_g^2} - \right. \\ \dot{\gamma} = \dfrac{-2\left(L_f K_f - L_r K_r\right)}{I_z}\beta + \dfrac{-2\left(L_f^2 K_f + L_r^2 K_r\right)}{I_z V_g} \end{cases} \quad (18)$$

Finally, we set sideslip angleβ and the yaw rateγ as the state variables of the UGV systems, and the steering angles δ_f and δ_r as system inputs, then we get the state space equation (SSE) of the UGV:

Exploration UGV:

$$\begin{cases} \begin{bmatrix} \dot{\beta} \\ \dot{\gamma} \end{bmatrix} = \begin{bmatrix} \dfrac{-2\left(K_f + K_r\right)}{MV_g} & \left(\dfrac{-2\left(L_f K_f - L_r K_r\right)}{MV_g^2}\right. \\ \dfrac{-2\left(L_f K_f - L_r K_r\right)}{I_z} & \dfrac{-2\left(L_f^2 K_f + L_r^2\right.}{I_z V_g} \end{bmatrix} \\ \begin{bmatrix} \beta \\ \gamma \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}\begin{bmatrix} \beta \\ \gamma \end{bmatrix} \end{cases} \quad (19)$$

Injury ambulance UGV:

$$\begin{cases} \begin{bmatrix} \dot{\beta} \\ \dot{\gamma} \end{bmatrix} = \begin{bmatrix} \dfrac{-2\left(K_f + K_r\right)}{MV_g} & \left(\dfrac{-2\left(L_f K_f - L_r K_r\right)}{MV_g^2}\right. \\ \dfrac{-2\left(L_f K_f - L_r K_r\right)}{I_z} & \dfrac{-2\left(L_f^2 K_f + L_r^2\right.}{I_z V_g} \end{bmatrix} \\ \begin{bmatrix} \beta \\ \gamma \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}\begin{bmatrix} \beta \\ \gamma \end{bmatrix} \end{cases} \quad (20)$$

In this research, we adopted the fixed-ratio control architecture as our 4WS control architectures. That means that the steering angle of the rear-wheel always keeps the fixed-ratio to the angle of the front-wheel to yield the stable driving (seen as Eq. (21) and Figure10). Because the fixed-ratio control architecture is easy to understand and extremely effective, besides, the adjustment of the controller parameters is relatively simple in the fixed-ratio mode. This situation makes that the software design of the control architecture can be implemented easier in hardware. These are the main reasons why we

selected the fixed-ratio mode as our control architecture.

$$\delta_r = K_{df}\,\delta_f \quad (21)$$

Where δ_f and δ_r are the steering angles of the front and rear wheels, respectively. K_{df} is the proportionality constant between δ_f and δ_r.

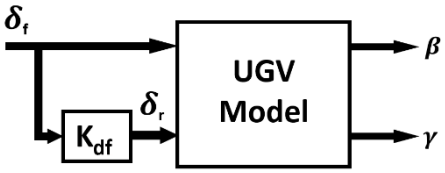


Figure 10. Block diagram of the fixed-ratio mode

Besides, comparing Eq. (19) and Eq. (20), we can reformulate Eq. (19) and Eq. (20) as form of the Eq. (22):

$$\begin{cases} \begin{bmatrix}\dot{\beta}\\ \dot{\gamma}\end{bmatrix} = \begin{bmatrix}a_{11} & a_{12}\\ a_{21} & a_{22}\end{bmatrix}\begin{bmatrix}\beta\\ \gamma\end{bmatrix} + \begin{bmatrix}b_{11} & b_{12}\\ b_{21} & b_{22}\end{bmatrix}\begin{bmatrix}\delta_f\\ \delta_r\end{bmatrix} \\ \begin{bmatrix}\beta\\ \gamma\end{bmatrix} = \begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}\begin{bmatrix}\beta\\ \gamma\end{bmatrix} \end{cases} \quad (22)$$

Set the differential value in Eq. (22) as zero, we can obtain the proportional constant K_{df}as Eq. (23):

$$K_{df} = \frac{a_{12}b_{21} - a_{22}b_{11}}{a_{22}b_{12} - a_{12}b_{22}} \quad (23)$$

The totally designed architecture of the control steering based on Matlab simulation for the 4WS UGVs is also shown in Figure 11. Substituting the proportional constant $K_{df}$of Eq. (23) into the design architecture in Figure 11, the UGVs will maintain better stability when the vehicle is turning.

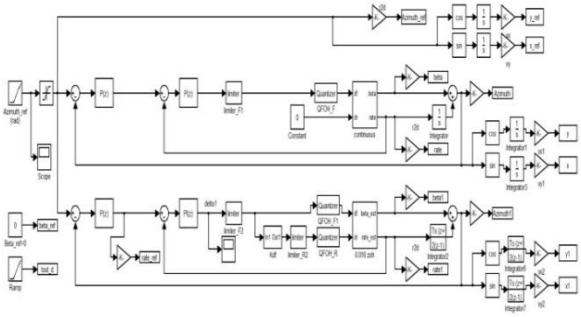


Figure 11. Matlab/Simulink programof the control steering architecture for UGVs

IV. EXPERIMENT RESULT

4.1. Experiment setting

To verify whether the design and construction of the disaster-exploration UV system is good, we must plan a proper experimental setting to verify the system design before experiment. Firstly,when the exploration UGV and the UAVfind the injury and send back the information of the injury location in thedisaster area, the injured ambulance UGV will go to the injured location. If the injury person is conscious, then he can use the first aid box to carry out the simple treatment to avoid the injury worsening. If conditions permit, the injured person can also sit on the injury ambulance UGV and uses the gesture control armband to connect the core control module of the injury ambulance UGV. Then he can use some simple gestures to remotely control the injury ambulance UGVhimself to return back to the hospital(seen as Figure 12 and Figure 13).

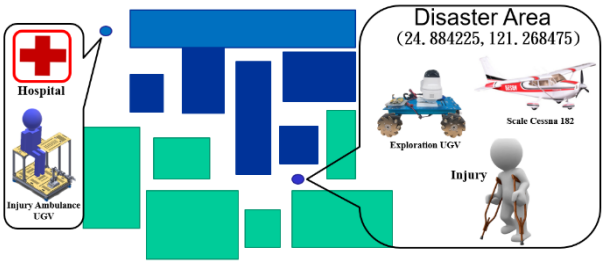


Figure 12. Injury ambulance UGVand the UAV send back the information of the injury location.

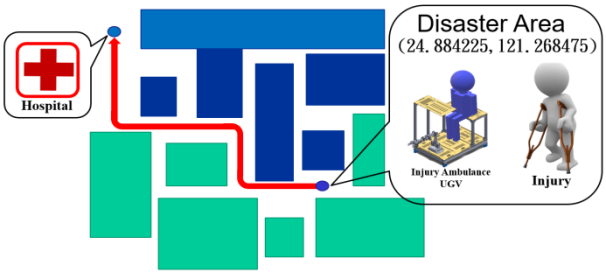


Figure 13. Injured ambulance UGV go to the injured location.

Secondly, since the most unstable situation of the UGVhappened when UGV encounters the obstacle and makes an emergent steering. Therefore, the experimental setting of the UGVmotion in this research is to set that UGV starts from the stationary state and accelerates. Afterwards, UGV encounters the obstacle unexpectedly and makes an emergent steering. The important consideration is that, during the whole travel, the UGV system designer has to take into account of the stable driving, especially when steering suddenly.Therefore, a rational turning radius needs to be considered in the setting of UGVs.Besides, the characteristics of the UGV model, driving speed of the UGV, detection range of the ultrasonic sensor, sampling period of the core control module that is in view of the sensor module to design the stable fixed-ratio control architecture in order to achieve a stably smooth Ackermann steering.Finally, in the UGV part of the research, due to the page limits, we just presented the experiment result of the exploration UGVto verify the controller design via Matlab simulation since these two UGVs architectures are similar. We will get the similar good result by the same design programme.

4.2. Experiment result of the exploration UGV

In this research, we applied the real dynamic information collected by the sensor module of the UGV to help to correct the originally derived rough mathematical model (seen as Eq. (19) and Eq. (20)), so we could establish the more accurate system

models(seen as Eq. (24), Eq. (25))and fixed-ratio control architecture of the UGV.

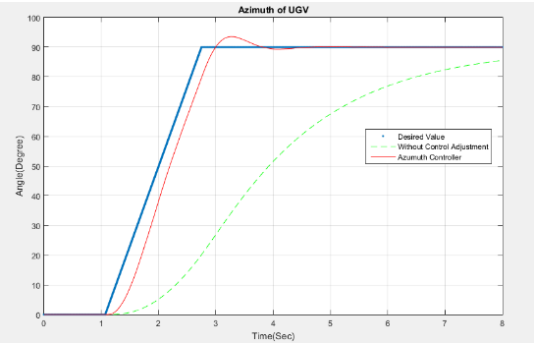
Collected exploration UGV:

$$\begin{cases}\begin{bmatrix}\dot{\beta}\\ \dot{\gamma}\end{bmatrix}=\begin{bmatrix}-19.3481 & -0.4690\\ -78.336 & -29.2103\end{bmatrix}\begin{bmatrix}\beta\\ \gamma\end{bmatrix}+\begin{bmatrix}12.\\ 19\end{bmatrix}\\ \begin{bmatrix}\beta\\ \gamma\end{bmatrix}=\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}\begin{bmatrix}\beta\\ \gamma\end{bmatrix}\end{cases} \quad (24)$$

Collected injury ambulance UGV:

$$\begin{cases}\begin{bmatrix}\dot{\beta}\\ \dot{\gamma}\end{bmatrix}=\begin{bmatrix}-5.4153 & -1.4376\\ -261.12 & -139.6389\end{bmatrix}\begin{bmatrix}\beta\\ \gamma\end{bmatrix}+\begin{bmatrix}3.5\\ 46\end{bmatrix}\\ \begin{bmatrix}\beta\\ \gamma\end{bmatrix}=\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}\begin{bmatrix}\beta\\ \gamma\end{bmatrix}\end{cases} \quad (25)$$

Besides, we applied the Matlab/Simulink to verify the goodness degree of the azimuth, yaw rate, and obstacle avoidance trajectories of the controller design and system integration of UGV. The design results of the collected exploration UGVare shown in Figure 14, Figure 15, and Figure 16. The Figure 14 is the azimuth simulation of the exploration UGV. In Figure 14, The blue line is the azimuth expectation (Desired Value), the green line represents the condition of the UGV without controller compensation (the Without Control Adjustment), and the red line is the system response improved by our fixed-ratio mode controller (Azumuth Controller). From Figure 14, it is obvious that although the azimuth response with controller improvement has a slight overshoot (red line). However, it just has a very small error compared with the expectations (blue line), and its response is much better than original UGV system (green line). That means our design really improved the original performance of the exploration UGVand advanced the reaction speed to avoid the obstacle.



. Figure 14. Comparison of azimuth responses of exploration UGV

Figure 15represents the comparisons between the original explorationUGV and the result after our controller compensation. From Figure 15, we could find that when UGV made asudden steering for the obstacle avoidance, the original UGV (green line) could not comply with the steering command (blue line) due to its natural characteristics, it had a very obvious difference from the expected value. However, after compensating by the fixed-ratio control architecture, the improving explorationUGV response (red line) could reliably follow the control commands (blue line) to obtain the expected driving and turning stability. Therefore, the fixed-ratio control architecture in this study can effectively improve the handling and the flexibility of the explorationUGV.

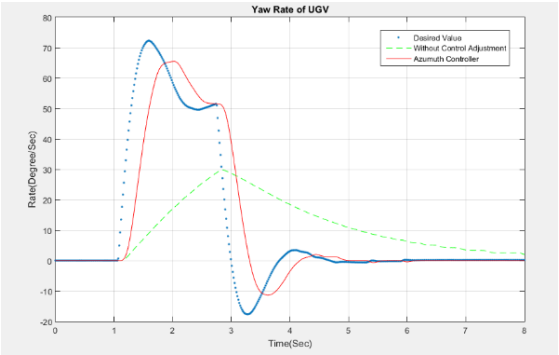


Figure 15. Comparison of yaw-rate response of the exploration UGV

Figure 16 is the driving-path comparison of the original and compensated exploration UGV. It could be obviously found that the original exploration UGV could not perform effective and immediate turning for the obstacle avoidance (green line) due to its under-steer property when encountering the hindrance. This situation is very dangerous and will lead to the risk. However, The explorationUGV compensated through the fixed-ratio control architecture could improve the travel path according to the obstacle position and made the UGV more efficient, quicker, safer,when steering (red line) to achieve the goal of obstacle avoidance with a the 90-degree turn (blue line). This result verified that the fixed-ratio control architecture in this study indeed improved the explorationUGV's performance and advanced the handling and flexibility of the explorationUGV to ensure the high stability when self-driving.

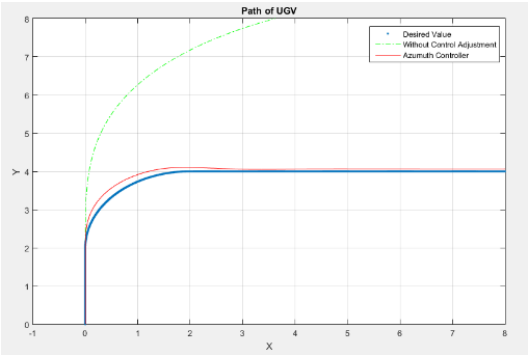


Figure 16. Comparison of driving path of exploration UGV.

V. CONCLUSION

The purpose of this research is to construct a disaster-exploration unmanned vehicle (UV) system based on multi-sensors. According to the missionrequirements, three vehicles are all set up

with the sensor module, core control module, motor drive module, and the remote control module. In addition, not only can the sensor module be applied to return back the disaster information, but it also collected the dynamic information of the vehicles to help to establish the accurate math models that will facilitate the subsequent designs of the stable controllers.

Besides, additionally, we also set up the first aid box and the gesture control armband with the injury ambulance UGV. When we got the injury location from the exploration UGV and the UAV, the injured ambulance UGV will get the command and self-drive to the injured location. If the injury person is conscious, then he can use the first aid box to carry out the simple treatment to avoid the injury worsening. If conditions permit, the injured person can also sit on the injury ambulance UGV and uses the gesture control armband to control the injury ambulance UGV himself to return back. Finally, in accordance with the different task characteristics, we design the controllersto improve the system response of the UV. So that these designs yield the UGVs could retain the considerable stability of the entire travel in the fact of unknown environment. Even when encountering the sudden situations which require emergent obstacle avoidance, the UGVs can also taking into account the stability of stable turn. These improvements not only can reduce the vehicle vibrations to extend the components lives but also can help to extend the UV application in the areas of human factors engineering, such as the large-scale self-propelled public transportation could be developed.These stable controller techniques can effectively improve the comfort and stability of the carrying personnel or the precision material. Therefore, this study is really a practical and worthwhile research issue.

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